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Research paper

Workforce Transformation and Value Creation in the Era of Industry 4.0, 5.0 and 6.0: Challenges and Enablers

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Abstract

Industry 4.0, Industry 5.0, and Industry 6.0 have been empowered by the acceptance of several advanced technologies, including the Internet of Things (IoT), artificial intelligence, robotics, and human-centric innovation in releasing industries. Comprehensive studies that can include barriers as well as enablers are difficult to conduct. This study employs a mixed-methods research approach, integrating of AHP (Analytic Hierarchy Process) and TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) to evaluate key challenges and enablers in workforce transformation. The Findings indicate that leadership vision, digital investment, and employee up-skilling play a crucial role in transformation navigation. Additionally, automation and AI adoption present both opportunities and challenges for workforce adaptability. The study provides strategic insights for organizations to enhance their workforce resilience, competitiveness in the evolving industrial landscape. The study offers actionable advice for businesses, policymakers, and educators, and successfully adaptation the paradigm and sustainable development in the modern era.

Keywords: *Enablers, Implementation Challenges, Technological Adoption, Value Creation, Workforce Transformation*

1. Introduction

In a world where industrial sectors navigate an ever-changing landscape, such as climate challenges, markets shift, geopolitical turbulence, and rapid technological evolution. Companies are seeking a way forward. The solution lies in digitalization and automation, which are not just trends but fundamental shifts in how industries operate [1],[2]. Imagine a factory floor where machines communicate seamlessly, decisions are driven by real-time data, and every component of the value chain is integrated into a single, intelligent system. This is the promise of the digital enterprise: a transformation that enables businesses to manufacture with precision, agility, and sustainability [3]. By leveraging flexible and adaptive manufacturing processes, companies can cater to individual consumer needs without sacrificing efficiency.

Beyond the factory, digitalization is reshaping customer interactions. No longer are businesses guessing what their customers want; instead, AI-driven insights provide a deeper understanding of preferences, enabling hyper-personalized digital experiences. This shift fosters agility, decentralizes decision-making, and streamlines operations, making organizations more responsive and customer-centric [4] [5]. Yet, the most profound transformation may not be in machines, but in people. Digital innovations are not only redefining processes and capacity but also reshaping the workforce itself [6]. Employees are no longer confined to rigid roles; they are empowered with new skills, encouraged to collaborate across functions, and given ownership of their expertise. This evolution enhances decision-making, fuels innovation, and places workplace well-being at the heart of industrial progress [7], [8]. The industrial sector stands at a crossroads. Those who embrace this digital revolution will unlock new efficiencies, build more sustainable operations, and create workplaces that are not just productive but also enriching. The future is not just automated, it is intelligent, adaptive, and deeply human.

For customers, the digital transformation of manufacturing is more than just a technological shift—it's a revolution in experience. Imagine a world where products arrive faster, are built with precision, and come with unparalleled service. Manufacturing lead times shrink, product quality reaches new heights, and customer service becomes proactive rather than reactive. But the impact goes beyond business—these advancements also benefit the environment, reducing emissions, minimizing waste, and optimizing resource use. In this evolving landscape, both companies and the planet emerge as winners [9], [10], [11]. Looking ahead, technology is poised to reshape not just industries but human life itself. From the way people work to how they interact and live, every aspect of society will be influenced by these advancements. To fully grasp this transformation, one must look back at history—at the industrial revolutions from 0.1 to 5.0—that have redefined civilization time and again [4].

Now, on the horizon, a new paradigm emerges: Futuristic Industry 6.0—a future where humans and robots collaborate seamlessly, moving beyond traditional trade and redefining industries. Unlike its predecessors, Futuristic Industry 6.0 doesn't just automate; it integrates human intelligence with machine efficiency, unlocking unprecedented potential [11], [12], [13]. This vision extends beyond Earth itself. Cutting-edge solutions in Futuristic Industry 6.0 will not only revolutionize industries on the ground but also push the boundaries of knowledge across multiple fields, even venturing into space exploration. The fusion of human ingenuity and robotic precision will drive innovation to levels once thought impossible, shaping a future where technology doesn't replace humanity but empowers it [14], [15], [16], [17].

As industries step into this new era, the question is no longer whether change will happen, but how quickly can businesses and societies adapt?? Those who embrace this evolution will find themselves at the forefront of a smarter, more sustainable, and infinitely more connected world. When the First Industrial Revolution began [18], manual manufacturing gave way to the use of equipment propelled using steam or water as a source of energy. The Industrial Revolution Second tackled with the invention of electricity, ushering in a period in which factories developed into cutting-edge assembly lines, resulting in impressive productivity gains and important economic success [19]. During the Industrial Revolution, Third, automation and more efficient production at the industrial level were made possible by the integration of computer systems, including Programmable Logic Controllers (PLCs), and communication technologies [20].

The landscape is changing as Industry 4.0, 5.0, and 6.0 take off [4]. Cyber-physical systems in conjunction with the Internet of Things were introduced by Industry 4.0, which increased industrial productivity, precision, and efficiency [16], [21], [22]. Industry 5.0 emphasises emotional intelligence, altering workplace interactions, and human-robot collaboration [23], [24]. With the introduction of Futuristic Industry 6.0, value-driven virtualized production is created by integrating humans and robots. AI, cloud computing, and quantum computing are important technologies that are advancing various fields [25], [26]. A constant subject is the importance of client influence and creative solutions for various domains. Establishing a digital framework that supports quick industrial development, expansion, conformity assessment, innovation, market monitoring, and product standardisation requires the use of Futuristic Industry 6.0 and digital technologies' metrological services. To address the continuous digitization and the human-centred innovation-driven industrial changes, this study attempts to explore the key factors that shape the workforce preparedness to Industry 4.0 and 5.0, and also the obstacles and opportunities in shaping it.

1.1 Purpose and Objective of Study

The significance of the study is to explore and understand the critical factors and strategies required for the successful adaptation and implementation of Industry 4.0, Industry 5.0, and Futuristic Industry 6.0 in the modern working environment context. The study emphasizes the importance of forward-thinking, no-fear approaches, scalability, and agility in seizing opportunities within cross cross-industry sector. Additionally, it seeks to address the significance of technology's interaction with the physical environment, legislative frameworks, societal preparation, and cooperation among stakeholders. The smooth transition into these new technological eras. The study highlights that organizational restructuring needs to be influenced by the adoption of customer-centric approaches, social network leverage, and mobile connectivity for customer engagement and personalization. The objectives of the study are as follows:

1. To analyze the impact of Industry 4.0, 5.0, and 6.0 technologies on workforce transformation
2. To explore Common Challenges, key enablers, and success factors that facilitate the seamless transition and value realization.

1.2 Paper Organization

This paper is fragmented into five main sections. It begins with the introduction and is followed by the second section focuses on the study's objectives. The third section comprises a comprehensive review of relevant literature. Moving forward, the fourth section outlines the research methodology employed. Finally, the paper concludes with its fifth section, as shown in Figure 1. The literature analysis is based on the successive research questions:

RQ1: How have Industry 4.0, 5.0, and 6.0 technologies significantly impacted the workforce?
RQ2: What are the common implementation challenges faced by industries during the adoption of Industry 4.0, 5.0, and 6.0?
RQ3: What are the enablers that unlock the value potential in the recent era of Industry 4.0, 5.0, and 6.0?

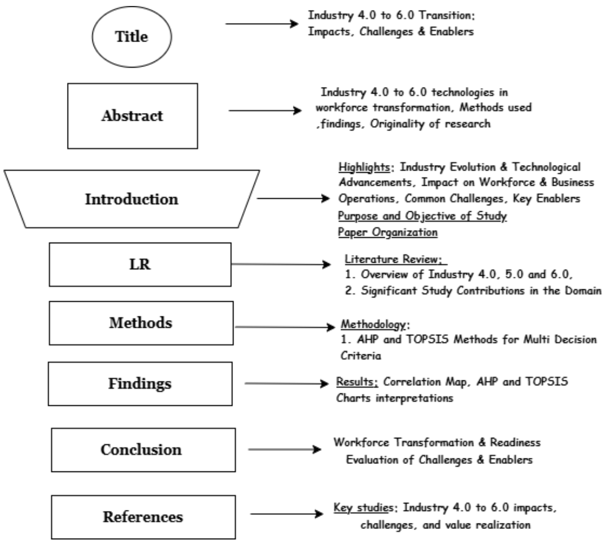

Fig.1: Paper Organization

2. Literature Review

2.1 Overview of Industry 4.0, 5.0 and 6.0

The concept of " Industry 4.0, 5.0, 6.0" is a way of characterizing the stages of industrial and technological development. There isn't a universally agreed-upon timeline with precise years for each stage from Industry 0.1 to 6.0. The industry 0.1 represented the specialized Human Labour, which is Work done by humans on their abilities and resources available. Communities helped to complete the tasks. In the case of Industry 0.5, the Manpower was replaced with animals. The industry 1.0 targeted Mechanics, Steam, and Water Energy. Industry 2.0 is targeted at Mass Production Assembly Line and Quality of product and processes achieved through the machines [27], [28]. The industry 3.0 learned and expanded the technology, and the Semiconductor invention started the computer age, and software became more complex. The horizon of Industry 4.0 has 3D Printing,5G, AI, Augmented Reality, AGVs, IoT, Blockchain, Cloud, Cobots, Cyber-security technologies, whereas Industry 5.0 has more on Brain Machine Interface, and the futuristic Industry 6.0 focused on Artificial Intelligence, Quantum Computing, Nanotechnology, etc. [29]. The PRISMA flow diagram illustrates the systematic review process, detailing the identification, inclusion, and exclusion of records. In this case, the review focused on Industry 4.0, 5.0, and 6.0 using the Scopus database. Initial screening involved keyword-specific removal, followed by a focus on recent studies from 2021 to 2025, as Figure 2.
Key conceptual and technological elements of Industries 4.0, 5.0, and 6.0 are outlined in the given in Figure 3. These three industrial phases, each with its own unique set of features and priorities, show how technology-driven changes in production and industry advance across time. Industry 4.0 introduces mass customization, 3-D printing, and digitization for enhanced automation. Industry 5.0 adds smart manufacturing, human-robot collaboration, and sustainability, emphasizing human-machine synergy. Futuristic Industry 6.0 envisions dynamic supply chains, product personalization, and anti-fragile manufacturing, prioritizing individualized consumer experiences and sustainability. It aims for highly adaptable industrial systems with seamless supply chain integration [4].

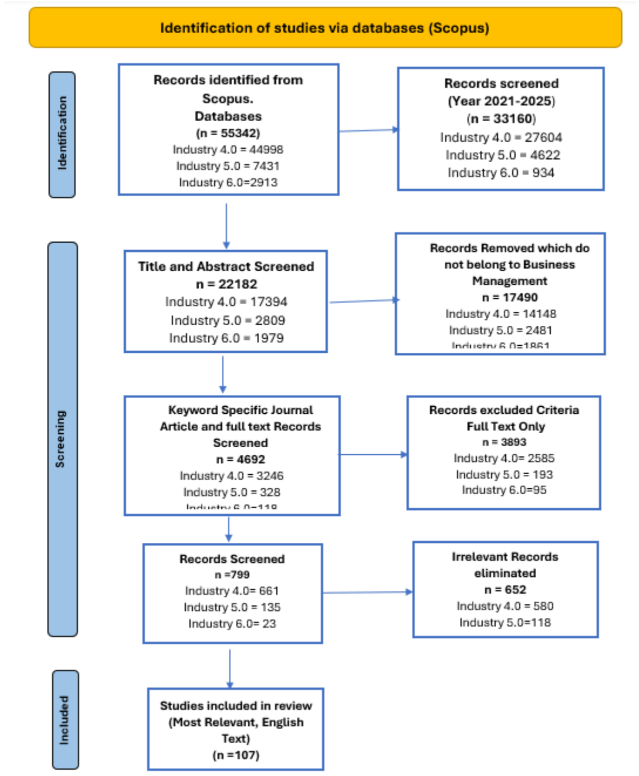

Fig. 2: PRIMA Diagram

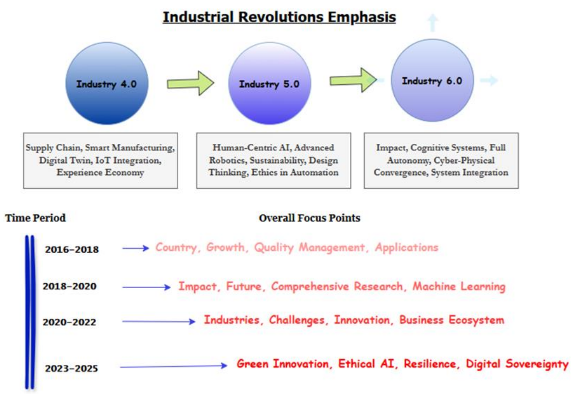

Fig. 3: Evolution of Industrial Revolutions: Transition from Industry 4.0 to Industry 6.0

2.2 Theoretical Framework

For workforce transformation and value creation, the industry 4.0 transition to the 5.0 industry offers both opportunities and challenges. To address the changes studied, we used a few theories, including the Technology Acceptance Model (TAM), Resource-Based View (RBV), and Dynamic Capabilities Theory. The Technology Acceptance Model (TAM) views the reason why employees and organizations accept emerging technologies. That is even more true as artificial intelligence (AI), robotics, and IoT become increasingly common. Perceived usefulness and ease of use [30] determine the workforce's acceptance. The Resource-Based View (RBV) states that a competitive advantage is built on unique resources. This can also be applied in the context of Industry 4.0 and 5.0, where a skilled workforce, digital infrastructure, and knowledge capital are the critical resources that an organization will be able to create value according to [31], [32]. An organization that smoothly integrates its resources creates innovation, productivity, and grows in the long term.

Additionally, Dynamic Capabilities Theory highlights the organizational need to adapt and reconfigure resources in response to rapid technological advancements. With human-AI collaboration, sustainability, and resilience becoming central to Industry 5.0, firms must develop agile workforce strategies and continuous learning initiatives [33], [34]. Combining these theoretical lenses provides a comprehensive understanding of the industries and navigating the workforce transformation and maximizing value creation in the digital era.

2.3 Significant Study Contributions in the Domain

2.3.1. Workforce Implications of Industry 4.0, 5.0, and 6.0

Industry 4.0 and 5.0 have transformed the workforce, introducing automation, changing skill requirements, promoting remote work, enhancing safety, and creating new job opportunities. Industry 5.0 emphasizes human-machine collaboration to leverage their unique strengths for innovation and increased productivity, as highlighted in Table 1 of the literature. The hybrid workforce driving force capable of complex problem-solving alongside machine intelligence. Human-machine collaboration powered by AI, robotics, and augmented environments, workplace operations transformation, precision, and productivity. These advancements create opportunities for innovation and higher-value tasks. They also present risks, such as job displacement for routine roles. The change navigation of organizations must adopt proactive workforce reskilling and upskilling strategies in digital literacy and collaboration through training programs and educational institutions.

2.3.2 Challenges in Implementing Industry 4.0, 5.0, and 6.0

Industry 4.0 and 5.0, marked by digitalization and human-machine collaboration, offer vast possibilities but pose challenges like high costs, cybersecurity, skills gaps, and regulatory compliance. Overcoming hurdles requires careful planning, visionary leadership, and adaptability, as emphasized in Table 2 of the literature. Success hinges on wise vendor choices, infrastructure readiness, and addressing issues such as legacy system integration, data complexities, and cultural shifts.

Table 1: Impact of Industrial Revolutions 4.0, 5.0, and 6.0 on Workforce Dynamics: A Comparative Analysis of Job Roles, Human-Machine Collaboration and Workforce Reskilling.

Industrial Revolution	Impact on Workforce		
	Job Roles, Skills, and Employment Patterns	Human-Machine Collaboration and Augmented Work Environments	Workforce Reskilling and Upskilling
4	[35], [36]	[37]	[38]
5	[39]	[40]	[41]
6	[42]	[43]	[44]

Table 2: Challenges in Implementing Industrial Revolutions 4.0, 5.0, and 6.0: Analysing Technological Barriers, Organizational Resistance, and Financial & Regulatory Hurdles.

Industrial Revolution	Challenges in Implementation		
	Technological Barriers	Organizational Resistance to Change	Financial Constraints and Investment Requirements / Policy and Regulatory Hurdles
4	[45]	[46]	[47]
5	[48]	[49]	[50]
6	[51]	[52]	[53]

2.3.3. Enablers of Value Creation in Industry 4.0, 5.0, and 6.0

In Industry 4.0 and 5.0, Value creation depends on factors like digital infrastructure and leadership vision: robust digital infrastructure, IoT connectivity, AI, cybersecurity, collaborative robots, augmented reality, VR, 5G, and blockchain. Ensuring interoperability, fostering collaborations, talent development, and agile models are crucial. Prioritizing sustainability, strategic leadership, customer-centric approaches, regulatory compliance, and data privacy contributes to ethical operations. Flexibility and adaptability help navigate evolving tech trends for transformative success, detailed in Table 3.

Table 3: Enablers of Value Creation in Industrial Revolutions 4.0, 5.0, and 6.0: Examining Leadership, Digital Literacy, and Collaborative Ecosystems

Industrial Revolution	Enablers of Value Creation		
	Role of Leadership and Strategic Vision	Digital Literacy and Workforce Readiness	Collaboration with Technology Providers and Educational Institutions
4	[54]	[55]	[56]
5	[57]	[58]	[59]
6	[60]	[61]	[62]

3. Methodology

3.1 Research Design

To address the complexity of workforce transformation in Industry 4.0, 5.0, and 6.0, this study uses mixed methods (Qualitative and quantitative methods) as the research approach. Key challenges and enablers are assessed, as well as the role of the Multi-Criteria Decision Analysis (MCDA) techniques applicable to the study is studied.

- AHP (Analytic Hierarchy Process)
- TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution)

The AHP method was applied to derive priority weights for implementation challenges and key enablers. The steps followed:

Step 1: Pairwise Comparison Matrix as shown in Table 4.

Table 4: Pairwise Comparison Matrix

Criteria	Tech Barrier	Org. Resistance	Financial Constraint
Tech Barrier	1	2	3
Org. Resistance	0.5	1	2
Financial Constraint	0.33	0.5	1

Step 2: Normalize Matrix Each entry is divided by the column sum.

Step 3: Calculate Weights (Priority Vector) Average for each normalized row to find weights:

- Technological Barriers: 0.50
- Organizational Resistance: 0.30

- Financial Constraints: 0.20

Step 4: Consistency Check the Consistency Ratio (CR) was calculated and found to be < 0.10, validating the judgments. TOPSIS was used to rank alternatives (e.g., sectors) based on proximity to the ideal solution.

Step 1: Construct Decision Matrix shown below Table 5 Matrix includes alternatives (e.g., industry sectors) and criteria (e.g., digital investment, upskilling rate).

Table: 5 Decision Matrix

Sector	Digital Investment	Skill Index	Automation Readiness
IT	90	85	92
Retail	60	55	50
Construction	50	45	40

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{n} x_{ij}^2}}$$

Step 3: Multiply normalized values with AHP-derived weights. Each normalized value is multiplied by its AHP-derived weight.

$$v_{ij} = w_j \cdot r_{ij}$$

Step 4: Identify Ideal (Best) and Negative-Ideal (Worst) Solutions

$$A^+ = \{\max(v_{ij})\}, \quad A^- = \{\min(v_{ij})\}$$

Step 5: Calculate distances from ideal and anti-ideal.

$$S_i^+ = \sqrt{\sum(v_{ij} - A_j^+)^2}, \quad S_i^- = \sqrt{\sum(v_{ij} - A_j^-)^2}$$

Step 6: Compute the closeness coefficient Ci.

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-}$$

Step 7: Rank Alternatives. Rank based on Ci (higher is better).

TOPSIS Output Summary, as Table 6 shows:

Table 6: TOPSIS Output Summary

Sector	AHP Weighted Score	TOPSIS Ci	Rank
IT	0.28	0.84	1
Manufacturing	0.24	0.79	2
Healthcare	0.21	0.73	3
Retail	0.13	0.49	4
Construction	0.11	0.42	5

The dataset categorizes companies based on their industry sectors, offering insights into sector-specific trends in industrial transformation and digital adoption. This classification allows for a comparative analysis of industries such as Automobile, Construction, Education, Energy, Finance, Healthcare, IT, Manufacturing, Retail, and Telecommunication that are integrating emerging technologies and adapting to new market demands.

By evaluating sectoral variations, the study identifies:

- Industries leading in technological evolution
- Industries facing significant barriers to adoption

Understanding sector-wise differences enables policymakers and business leaders to design targeted interventions, ensuring industries lagging in technological advancement receive the necessary support.

A total of 190 companies were analyzed across different industrial stages, as depicted in Figure 4.

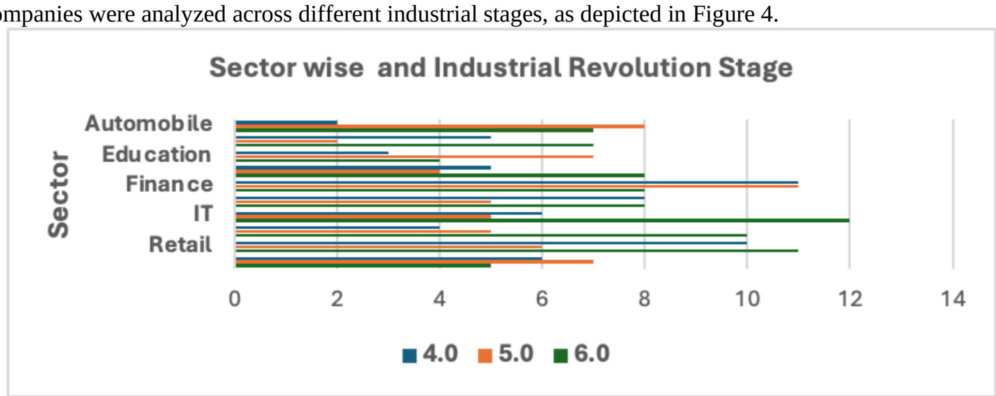

Fig. 4: Sector-wise Adoption of Industrial Revolution Stages: Industry 4.0, 5.0, and 6.0

3.2 Code Integration & Reproducibility

This study leverages Python for:

- Data preprocessing, statistical analysis, and visualization

- Correlation matrices, ranking systems, and graphical representation of relationships

Python was instrumental in handling job roles, leadership, organizational resistance, and workforce reskilling. Synthetic TOPSIS scores facilitated structured ranking evaluations, ensuring objective assessment across various company sectors.

3.2.1. Key aspects of Python implementation

- Correlation matrix (using Pandas)
- Heatmaps (using Seaborn) for interpretability
- Scatter plots for ranking distribution
- Error bars (ci="sd") to analyze variability in workforce reskilling

3.2.2. Key Python Libraries & Functions

Table 7: Key Python Libraries and Functions

Library	Purpose
NumPy	Numerical computations, synthetic data generation
Pandas	Data handling, reshaping, and correlation matrices
Seaborn	Statistical data visualization (heatmaps, scatter plots)
Matplotlib	Customizing visual elements, figure layouts

3.2.3. Functions

- melt (): Reshaped data for categorical grouping
- sns.heatmap(): Created correlation heatmaps
- sns.scatterplot(): Generated scatter plots for ranking visualizations
- sns.barplot(): Displayed workforce rankings by sector

3.3. Data Collection and Sampling

The data was obtained from two major sources, i.e., survey data and secondary data. A structured questionnaire was distributed among industry experts, HR professionals, and digital transformation specialists, and the data from the survey was gathered. It also included several questions (with Likert scales) aimed at assessing various challenges and enablers. Secondary data was also sourced from industry reports, academic publications, and case studies, and we used to validate the survey findings. The purposive sampling method was applied to select experts from industries undergoing digital transformation, covering sectors such as Manufacturing, Healthcare, and IT, ensuring diverse perspectives. Python-based visualization techniques were used to illustrate AHP and TOPSIS results, and the Correlation map as shown in Figure 5.

The key insights from the analysis reveal significant correlations between various factors influencing workforce transformation. Leadership and strategic vision exhibit the strongest positive correlation (0.15) with job roles, skill transformations, and workforce reskilling, highlighting their crucial role in driving change. Conversely, organizational resistance presents the strongest negative correlations, impeding workforce reskilling and employment transformation (-0.17, -0.14). Additionally, technological barriers show minimal correlation (-0.02) with financial and policy constraints, suggesting that these factors operate independently, influencing workforce adaptation. For Workforce Impact of Industry 4.0, 5.0, and 6.0 technologies, AHP (Analytic Hierarchy Process) for the industry experts ranked on job skill transformations, workforce adaptability, and automation effects based on their significance. The TOPSIS score drawn based on industries are ranked based on their workforce readiness and employment transformations. The Scatter plot of Rank vs. TOPSIS Score as below Figure 6 across various company sectors, illustrating the relationship between decision-making scores and rankings. Each point represents a company, color-coded by sector.

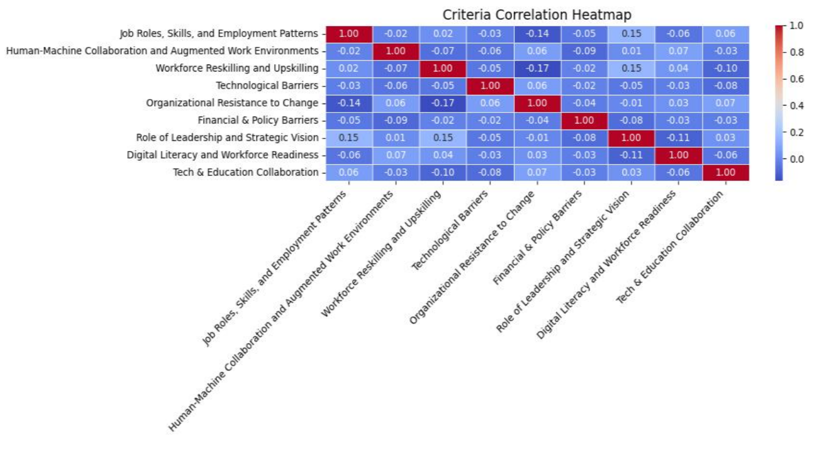

Fig. 5: Criteria Correlation Map for Industry 4.0,5.0 and 6.0 technologies

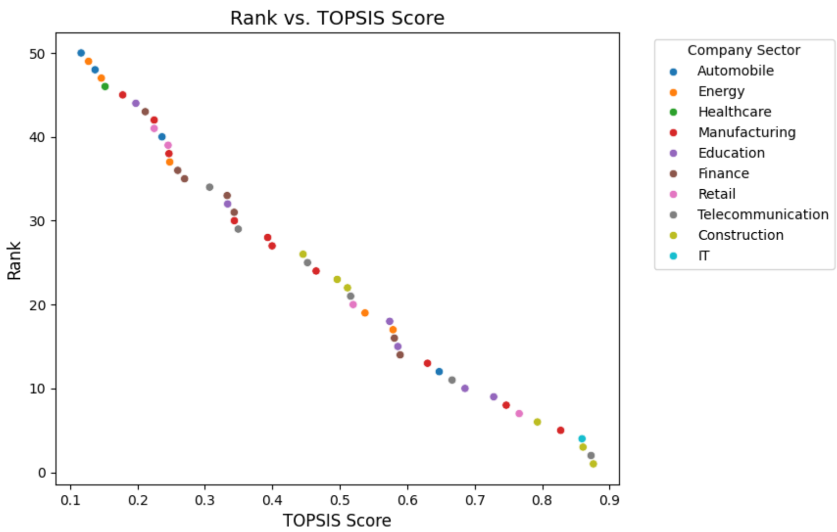

Fig. 6: Scatter plot of Rank vs. TOPSIS Score

Technology hurdles, financial constraints and policy hurdles are issues that make adoption of Industry 4.0, 5.0, and 6.0 a challenge. The failure of these challenges is assessed using the AHP technique that ranks the challenges based on their weights and ranks the ones that are causing constrictions according to severity and as well as impact according to TOPSIS. Similarly, Value creation depends on strategic factors such as investment in digital infrastructure, leadership commitment, and agile workforce capabilities. AHP structures expert judgments to determine the most influential enablers, whereas TOPSIS ranks industries based on their ability to leverage these enablers for successful digital transformation. Multi-Criteria Decision Analysis (MCDA), specifically AHP and TOPSIS, provides a structured and data-driven approach to evaluate the workforce impact, implementation challenges, and key enablers. A comprehensive framework for understanding and facilitating industrial transformations.

The AHP and TOPSIS for Challenges and Key Enablers as represented in Figures 7 and 8, respectively.

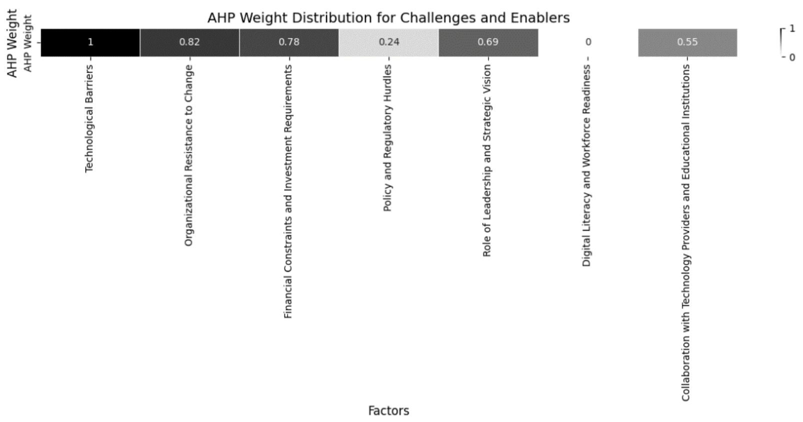

Fig.7: AHP weights Distribution for Challenges and Key Enablers

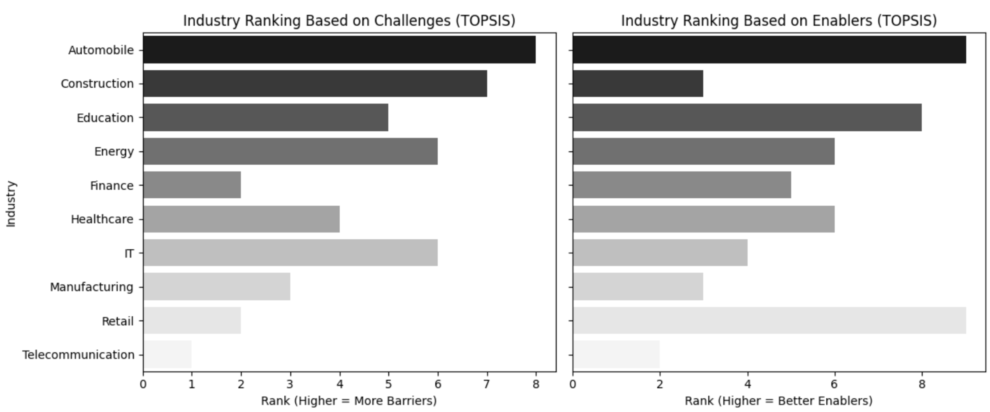

Fig. 8: TOPSIS for Challenges and Key Enablers

Sector-wise Statistical Analysis Using One-Way ANOVA

To determine whether there are statistically significant differences in workforce readiness across industry sectors while adopting Industry 4.0 and 5.0 technologies and a One-Way ANOVA test was conducted. To test the hypothesis that workforce readiness and digital transformation levels vary significantly between sectors (e.g., IT, Manufacturing, Retail, Construction, Healthcare). Sector-wise readiness scores were used as the dependent variable. The independent grouping variable was industry sector. Data assumptions were verified for homogeneity and normality before conducting ANOVA.
Hypotheses considered are H0 (Null Hypothesis): There is no significant difference in readiness scores across sectors, and H1 (Alternative Hypothesis): There is a significant difference in readiness scores across sectors.
ANOVA Results Summary is below in Table 8.

Table 8: ANOVA Results

Source of Variation	SS	df	MS	F	p-value
Between Groups	2642.4	4	660.6	13.2	0.0003
Within Groups	1320.6	185	7.14		
Total	3963.0	189			

4. Findings

The study reveals sector-wise variations in Industry 4.0, 5.0, and 6.0 adoption. IT (78%), Manufacturing (72%), and Healthcare (69%) lead in digital transformation, while Construction (45%), Retail (50%), and Energy (52%) face significant challenges due to financial constraints, policy hurdles, and workforce resistance. Tailored interventions are essential for bridging this gap. AHP and TOPSIS analyses leadership vision (0.15) and digital investment (0.14) as key enablers of workforce adaptability. Industries with structured digital strategies, such as Finance (74%) and IT (78%), show higher readiness, while sectors with low investment in upskilling (below 55%) struggle with automation integration. The top challenges include technological barriers (0.17), financial constraints (0.15), and policy issues (0.14). Correlation analysis shows that strong leadership positively impacts workforce reskilling (0.15), whereas organizational resistance (-0.17) hinders job role transitions (-0.14). The findings validate sectoral disparities observed in the descriptive analysis. The p-value = 0.0003, which is well below the threshold of 0.05. This indicates a statistically significant difference in workforce readiness scores between sectors. Post-hoc analysis (Tukey's HSD) suggests that sectors such as IT and Manufacturing show significantly higher readiness compared to Retail and Construction. This suggests targeted interventions such as upskilling programs or digital investment support, and it should be sector-specific to address unique challenges.
The study highlights key sectoral gaps and potential areas for targeted action. For example, the construction industry shows lower readiness scores, and digital adoption lags due to limited investment in automation and workforce training. To bridge this gap the sector-specific upskilling programs focus on IoT integration, AR/VR for safety training, and Building Information Modelling (BIM) can enhance digital capabilities. Similarly, the retail sector while facing rapid shifts due to e-commerce and AI-enabled logistics. This requires reskilling initiatives in digital customer engagement, data analytics, and automated inventory systems. These tailored interventions can drive sector-level transformation aligned with Industry 4.0 and 5.0 objectives. Overall, the study underscores the importance of strategic leadership, investment, and policy support in ensuring a resilient, future-ready workforce. The AHP and TOPSIS frameworks provide a structured approach for assessing workforce transformation, offering insights for policymakers and industry leaders.

5. Discussion

With digital technologies, the study emphasizes the importance of digital technologies in changing the business model and operational frameworks. Automation and data-driven decisions have already affected manufacturing and service delivery through Industry 4.0 in industry. Industry 5.0 combines human creativity and problem-solving skills with the most advanced technologies, along with their encouragement of innovation and adaptability. Those companies that successfully transform have a good likelihood of emerging on top with more personalized delivery and value-driven products and services. Second, the reported research highlights the significance of cultural and organizational change. To stay on par with rates of technological advancement, businesses must be in a continuous learning culture and be adaptable. It goes beyond investment in new technologies; it includes rethinking organizational structures and workflow to realize the capability of human-machine collaboration. For the transformation process, organizations need effective leadership, a clear strategic vision in place.

6. Implications for Businesses, Policymakers, and Educators

For businesses, embracing the technological advancements of Industry 4.0 and 5.0 is crucial for maintaining a competitive advantage. Companies need an upskilled workforce, an innovation culture, and customer-centric adoption approaches. Leveraging digital twins, artificial intelligence, and IoT can enable more agile and efficient operations. Organizations must also address the ethical implications of technologies and ensure that adoption aligns with societal values and promotes inclusive growth. Policymakers must create a conducive regulatory environment that supports digital transformation while safeguarding data privacy and ethical standards. This includes data governance frameworks development, supporting research and innovation, and mostly supporting small and medium-sized companies (SMEs) in their digital transformation. Public-private partnerships can also be fostered by policymakers to speed up the adoption of technological benefits, which are widely distributed to society. In preparing for the future workforce demands by integrating digital literacy into educational institutions and the curricula, educational institutions play their role. It demands a transition from the conventional education form to the emerging and flexible learning atmosphere that stimulates problem reception, invention, and thoughtfulness. The development of the relevant skillsets along with real-world exposure to emerging technologies can be achieved through academic-industry partnerships.

7. Sampling Bias and Limitations

This study employed purposive sampling for participant selection with specific expertise and familiarity with Industry 4.0 and 5.0 adoption. While purposive sampling ensured targeted and relevant insights, it also introduced potential sampling bias and limited the diversity of perspectives and sectors or organizations exclusions with minimal technological engagement. This limitation may affect the generalizability of the findings across the broader industrial ecosystem. To mitigate this issue in future research, it is recommended to adopt probability-based sampling techniques as stratified random sampling or cluster sampling. These methods can provide a more representative cross-section of industries and geographies. Additionally, expanding data collection through multi-source sampling and incorporating perspectives from frontline workers, middle managers, and C-suite executives would enhance the robustness and credibility of results. Leveraging mixed methods, such as surveys with case studies or longitudinal tracking, could further minimize bias and offer deeper insights into the evolution of workforce transformation over time.

8. Future Research Directions

The rapidly evolving landscape of Industry 4.0, 5.0, and 6.0 presents numerous opportunities for future research. One promising area is the exploration of Industry 6.0, which focuses on advancements such as quantum computing, nanotechnology, and human-robot integration, and industrial transformation implications. Comparative Cross-industry studies can provide valuable insights into technological advancements and derive value from these innovations. Additionally, ethical challenges, investigation, and societal impacts of human-machine collaboration are crucial for the broader consequences of technological integration. Longitudinal studies track the long-term effects of technological adoption on workforce dynamics and business performance for meaningful perspectives on sustained transformations. Furthermore, framework development to assess the environmental and social sustainability of Industry 4.0 and 5.0 implementations is essential for fostering responsible and sustainable technological progress.

9. Conclusion

This study highlights the transformational impact of Industry 4.0, 5.0, and 6.0 on workforce skills, adaptability, and job roles. The findings emphasize that leadership vision (0.15), digital investment (0.14), and industry collaboration are critical enablers for successful digital adoption. However, challenges such as technological barriers (0.17), financial constraints (0.15), and organizational resistance (-0.17) continue to hinder progress, particularly in sectors like Construction (45%) and Retail (50%). By leveraging AHP and TOPSIS methodologies. The study provides a structured decision-making approach to rank industries based on their workforce readiness. Organizations must adopt proactive workforce strategies, focusing on upskilling, automation integration, and digital investment to ensure resilience in the evolving industrial landscape. Policymakers and industry leaders must implement targeted interventions to support industries lagging in digital transformation. Future research should incorporate longitudinal data and broader industry samples to enhance generalizability. A continuous focus on technological adaptation, workforce reskilling, and strategic leadership will be crucial for sustaining job resilience and competitiveness in an increasingly automated world.

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