

Human-Centric Workforce Strategies for Augmented Manufacturing in Industry 5.0

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Abstract

Industry 5.0 revolutionizes manufacturing with its focus on people, sustainability and resilience blending new production technology with the human element to the production process. Where Industry 4.0 focused on automating to the exclusion of all else, Industry 5.0 focuses on the human element, such as including artificial intelligence, collaborative robots, and decision-making support systems while still retaining organizational accountability and responsibility for outcomes. This research problem examines workforce management challenges in the age of production and technology versus automation. A qualitative, descriptive analysis of peer-reviewed and published literature identified the research problem between 2022 and 2026. Challenges identified in the literature included skills mismatch, machine collaboration, trust and transparency in AI, reluctance to change, and finding workable management policies. The implications of these findings suggest that workforce management policies moving into an Industry 5.0 environment should have continuous skills training, flexible skills training, and robust AI ethics policies to manage challenges effectively. This research study presents a management strategy framework and roadmap for future research on performance management of the workforce, industry-specific research, and human-AI collaboration metrics.

Keywords: Industry 5.0, Human-machine collaboration, Collaborative robots (cobots), Artificial intelligence (AI) in manufacturing, Human-centric manufacturing.

Introduction

A. Evolution of Manufacturing Paradigms

Manufacturing systems have been through a number of paradigm shifts driven by technological development and changes in socio-economic needs. Industry 4.0 was a major shift towards the creation of a production environment that is highly automated and digitized, with an emphasis on cyber-physical systems, industrial IoT, big data, and autonomous systems to enhance efficiency, productivity, and cost-effective [1], [2]. Automation in this paradigm emphasized the optimization of operational performance metrics by reducing the need for humans to perform repetitive, hazardous, or precision-intensive tasks in manufacturing processes.

With the increasing complexity of manufacturing systems, challenges have also emerged, in particular the potential loss of jobs, ethical issues related to AI, and the long-term sustainability of highly automated manufacturing systems [3]. It became clear that automation would not be the magic solution to all of the production system's challenges. The paradigm of Industry 5.0 recognizes the need to place humans at the center of intelligent manufacturing systems once again. The focus of this new paradigm is not on the

systems like in Industry 4.0, but on the human being and human-centricity grounded in sustainability and resilience, emphasizing a symbiotic relationship between human intelligence and technological intelligence [4], [5]. This suggests that despite advances in intelligent systems, people remain at the heart of effective organizational performance.

B. Automation vs Augmentation

Automation and augmentation enable contrasting forms of human/machine relationships in manufacturing environments. Automation replaces the human in operations for efficiency and reliability's sake, often sacrificing engagement, awareness, and accountability [6]. Augmentation using AI insights, recommendations, and co-bots increases the human's capability to handle complexity, solve production problems on the spot, and make timely decisions in a volatile world [7]. This technology-based human-focused approach to manufacturing is the essence of Industry 5.0 [8]. Augmentation rather than automation might, therefore, lead managers to reconsider how jobs are designed, modernize performance management, and re-invest in human capabilities.

C. Workforce Management as a Strategic Concern

The augmented manufacturing workforce changes what the workforce is. The workforce is no longer an operator but a member of human-machine teams who monitor the operation of the machines, interpret the insights provided by AI, and make decisions [9]. Therefore, workforce management is key to the productivity of firms in Industry 5.0 environments.

Managers have to deal with skill shortages, upskilling, employees' confidence in AI suggestions, and employees' willingness to change [10]. There are also issues around job security and who is accountable for the decisions the augmented teams make. This involves issues around firm culture, and how to manage the workforce is now a question that impacts productivity, innovation, and the future of the firm.

D. Research Motivation and Objectives

While research on Industry 5.0 is experiencing a boom, however, researchers have only studied its technological infrastructure and capabilities, and its findings have been of little use in managing the human workforce of those augmented workplaces [11]. There are no current insights into how businesses can manage the human resources of their augmented workplaces. To fill the research gap, the current paper examines workforce management issues in Industry 5.0, conducting a structured literature review of recent publications. The specific aims of this research are to gain insights into workforce issues resulting from the shift from automation to augmentation, to recognize themes and trends in the literature, and to identify management practice implications for making this human-centric, sustainable manufacturing a reality. By accomplishing these aims, the current paper fills the issue of management in the growing body of research on Industry 5.0, specifically addressing efficient human-machine collaboration that should now be a focus for the manufacturing sector.

II. Literature Review

A. Concept of Industry 5.0 and Human-Centric Manufacturing

Industry 5.0 was introduced in response to the excessive technologization of manufacturing and the technocentric forms of efficiency and automation that have become the norm in Industry 4.0. The early research on Industry 5.0 is increasingly beginning to define it as a human-centric, sustainable, and resilient manufacturing approach that integrates digital technologies with human intelligence and creativity [1], [2]. Where alternative approaches might view employees as a cost to be reduced, this approach views them as a source of value. \

A human-centric approach to manufacturing incorporates human judgment, ethics, and social well-being into manufacturing processes. The modern trend of human-in-the-loop manufacturing exemplifies this trend and focuses on the human role in overseeing and intervening in AI-based production processes [3]. With human operators still in this oversight role, manufacturing processes are much more resilient and adaptable in practice than they would be relying solely on autonomous decision-making. As the previous research has demonstrated, these systems are also more resilient to uncertainty and complexity in operational processes than purely autonomous systems [4].

B. From Automation to Augmentation in Manufacturing

Industry 5.0 signifies a movement from automation to augmentation. Automation involves shifting work from humans to machines, focusing on repetitive tasks. This has led to improvements in productivity, but also worries about the loss of engagement and the systematic deskilling of workers [5]. Augmentation is different in that it uses AI to assist human decision making rather than replace it. By providing operational data, predictive analysis, and alternatives, AI can enable workers to be more responsive to changes in the production environment [6].

This is especially the case when there is variability in production requirements, customisation is required, or there are non-standard operating procedures [7]. A promising example of how this can be done in practice is the employment of collaborative robots or “cobots”. Cobots are intended to be used in conjunction with humans rather than purely on their own, sharing the workload but also allowing for human control [8]. Cobots will only be successful if firms consider the technology, but also how they approach deployment, training, and other workforce issues [9].

C. Workforce Skill Transformation

The shift to augmented technologies in Industry 5.0 has implications for the competencies employees should develop. A number of studies have identified hybrid skill profiles that combine technical skills like reading digital interfaces and data, and cognitive and social skills such as critical thinking, problem-solving, and cooperation [10]. These hybrid skill profiles improve the way employees collaborate with intelligent systems.

What is clear from the studies, though, is that developing such competencies in the current workforce is not a simple task. Often, the pace of change is outpacing the pace of organizational upskilling and reskilling, leading to skill gaps and skill confidence issues [11]. Older workers and those with lower levels of digital skill find these transitions particularly challenging [12]. These findings, then, suggest the need to incorporate learning and training solutions into the design of manufacturing workplaces based on an Industry 5.0 model.

D. Trust, Ethics, and Acceptance of AI Systems

Trust has been specifically identified as an issue in human-AI relations at work. Employees are less trusting of AI in cases where it operates in a largely opaque manner, and particularly if the consequences of the AI’s recommendations may impact operational or safety-related outcomes [13]. It is for this reason that the Industry 5.0 literature has started to speak about transparency and explainability being important criteria for the design of AI tools, rather than just being principles that should not be violated.

Employee attitudes towards AI are also influenced by ethical considerations that affect productivity more than they affect the performance of the AI tools themselves. Factors such as surveillance, accountability, and the potential for AI to contribute to the loss of jobs all have an impact on whether employees are inclined to use AI tools. Psychological reactance to AI is seen in some employees when they feel that the AI undermines their autonomy or threatens their job security [14]. These reactions, and their implications

for acceptance and for organizational benefits, are why many researchers recommend ethical governance policies and participatory change processes in the context of AI tool usage in manufacturing [15].

E. Organizational and Managerial Perspectives

Industry 5.0 presents managerial challenges that differ in crucial respects from those found in even relatively automated manufacturing settings. As human workers interact closely with intelligent technologies, managers must oversee teams that do not fit well into traditional organizational concepts. Forms of management that rely on standard hierarchical organizational structures tend to be counterproductive in these settings because augmented manufacturing is characterized by the need for adaptability, cross-functional management, and distributed decision-making responsibilities [16].

The management of teams in an organizational context in Industry 5.0 is, thus, not simply a matter of deploying a technology or set of technologies with digital or automation capabilities. Organizations must also consider the relationship between their technology investments and the organization's staffing, training, and workplace design. The literature on augmentation emphasizes leadership as a key variable in determining the willingness of employees to adopt augmentation, particularly when organizational leaders engage with employees, communicate, and facilitate learning opportunities [17]. Managing teams in Industry 5.0, then, is enabled in one crucial way by helping organizations find a balanced approach to technological goals and human and organizational goals [18].

III. Research Methodology

A. Research Design

This research study uses qualitative descriptive research to explore workforce management issues of automation to augmentation in Industry 5.0 manufacturing workplaces.

As an unconstituted paradigm with little research thus far, qualitative research can explore emerging concepts, management narratives and even themes in the few established literature on Industry 5.0 [1]. Qualitative and Descriptive research sees patterns, problems, variables and their relationships so it does not need to manipulate them thus its application to observe management research in rapidly changing technological settings [2].

The aims of this research study are to gather and provide observations and not to hypotheses-test anthropocentric workforce management issues in smart manufacturing environments.

B. Data Source

The primary research publication sources that were utilized in this research study were peer-reviewed journal articles from engineering, management and information sciences journals & periodicals. The types of articles that were read by the researchers and that were selected and utilized in the research study were those that were published in the time period of 2022-2026, as this time period was the period of it emergent publication on the topic and emergent discussion of Industry 5.0 and workforce augmentation. Open-access publication sources, for instance, increase the accessibility, transparency and reproducibility of the research study. Examples of the types of peer-reviewed journal articles that were read by the researchers included topics of workforce management in Industry 5.0, human-machine collaboration and augmented manufacturing systems.

C. Selection Criteria

The article selection process ensured the relevance and quality of the chosen articles. Articles were filtered for relevance to the topic by the use of keywords to include: Industry 5.0, workforce management, human-centric manufacturing, augmentation and smart manufacturing. These keywords were chosen due to their

relevance to the concerns of workforce management, and by their frequent occurrence in contemporary Industry 5.0 literature [4].

Publications were filtered in terms of the Fields of Research (ANZSRC 2020) to include: Commerce, Management, Tourism and Services, Manufacturing Engineering, and Information and Computing Sciences. This filtering method for the inclusion of an interdisciplinary field ensured that articles were included that addressed both the managerial, and technological elements of Industry 5.0, that relate to the human-machine integration that it enables [5].

D. Analysis Technique

The identified studies were performed a thematic analysis, which is a form of qualitative analysis that is often used to assess trending themes and patterns in a text [6]. Such analysis was then performed upon the abstracts of each of those identified studies, and processed to mine references to the workforce.

The identified themes were then sorted into buckets that were the trending issues in the workforce, such as upskilling, trust in AI, collaboration, organization-level changes, and leadership ramifications. Grouping the themes into these buckets provides a means of synthesizing the literature and enables a comparison of the different studies [7]. Additionally, it will ensure that the robustness of the analysis is retained, but also that there is potential for a specific and emergent issue regarding the workforce in Industry 5.0.

IV. Workforce Management Challenges in Industry 5.0

A. Skill Gap and Continuous Learning

One of the most critical workforce management challenges related to Industry 5.0 manufacturing systems concerns the increasing skills mismatch resulting from the constant evolution of technologies. The use of AI, data analytics, and collaborative robotics requires hybrid skills from workers that combine technical knowledge and cognitive agility and adaptability [1]. Yet, the skill sets of most workforces in manufacturing companies still follow the model of an automation-oriented Industry 4.0.

With respect to management, typical workforce training programs can be considered inadequate since they use inflexible, role-specific, and rarely implemented [2] models. The literature suggests a need for continuous learning processes [3]. From a management perspective, not promoting lifelong learning can result in the loss of employee confidence and efficacy in human-machine collaboration for the implementation of Industry 5.0.

B. Human-Machine Collaboration Complexity

The Industry 5.0 manufacturing context relies on human-centric and human-automation collaborative ecosystems succeeding. AI may still be better than humans at processing data and detecting patterns, but it does not have humans' contextual awareness, ethical reasoning, or creativity [4]. All these complementary capabilities' integration is no straightforward task.

Indeed, various studies have highlighted mismatches between human and AI decision-making in some manufacturing environments [5]. Human workers can become overly reliant on the decision-making capabilities of AI, losing situational awareness and control over decisions making regarding changing circumstances. The opposite can also happen, where insufficient reliance on these systems does not bring the expected efficiency gains [6]. Integrating humans and AI in workflows is thus not straightforward when it comes to role distribution and decision-making. Workforce management strategies may need to take this into account in the distribution of roles and authority in decision-making, and even training.

C. Trust and Transparency Issues

An additional issue related to managing the Industry 5.0 workforce is the problem of trust in AI-powered manufacturing ecosystems. Many models are ‘black-box’ models, with little information on the explainability of why any specific decision or recommendation has been made [7]. This may affect the trust that workers have in the systems, especially if the AI-driven recommendations are related to the worker’s safety or to their performance evaluation.

Accountability also raises questions in human-machine decision-making partnerships. If a decision has been made collaboratively by human and machine, it is not easy to establish accountability [8]. Researchers point out that the absence of clarity around accountability may provoke resistance to and low uptake of the systems [9]. Approaches to address these issues include the use of explainable AI, governed augmented manufacturing ecosystems, and the designation of human accountability [10].

D. Resistance to Organizational Change

There is much resistance to change in the move from automation to augmentation. Employees perceive the onslaught of new-fangled AI and robotics as a rival to their jobs, their autonomy, their competence [11].

This results in cognitive overload, demoralization and even outright resentment against the technology. Cultural and generational issues are also at play in employees’ reactions to Industry 5.0 initiatives. Digital natives are likely to adjust to a tech-centric workplace better than older employees, who may find themselves unable to handle the rapid change or no longer “relevant” in terms of skills [12]. Literature recognizes resistance to change as an issue that is not merely technical in nature, but one that is socio-organizational, encompassing change management, communication and engagement [13].

E. Managerial and Policy Constraints

Yet many companies have no workforce policy for Industry 5.0. Conventional HRM policies do not address issues like augmented job profiles, hybrid competence demands or the ethics of human-machine interaction [14]. The absence of policy concerns both managers and workers.

Even worse, the technology-workforce imbalance has been identified as a major obstacle to Industry 5.0 [15]. Companies emphasise technology and overlook workforce elements like training, organizational change and leadership [16]. Hence workforce management in Industry 5.0 should be a strategic workforce activity linking technology, human resources and the organization.

V. Results

The review of peer-reviewed research studies published between 2022 and 2026 presents converging and compelling evidence from the domain of manufacturing for human-centered workforce strategies as a non-negotiable requirement of Industry 5.0 implementation. The systematic review identifies workforce issues as a key feature of the effectiveness of artificial intelligence (AI) systems in the domain of augmented manufacturing, where cobots and decision-support tools are used.

The most frequently reported issues are those of the skill deficits of current workforces, unprepared for the hybrid technical and cognitive profile of augmented manufacturing work. Most studies identify current workforce training models as inadequate, and stress the urgent requirement for responsive, interdisciplinary learning. Human-machine collaboration is another area of complexity; multiple studies report issues of role clarification, coordination, and cognitive overload when tasks are not well-bounded. Workforces’ responses to AI systems also show variation in respect of trust and transparency. Unacceptable explainability of AI-driven decisions can lead to rejection of augmentation efforts by the

workforce. Conversely, organizations that use ethical AI in their governance and participatory design of AI systems see an increase in the positive engagement of their workforces. Finally, the studies also identify frequent gaps in organizations’ ad hoc approaches to change management, suggesting that there is no functional model for addressing the workforce impacts of Industry 5.0.

Overall, these findings highlight the importance of taking a human-centered approach to the workforce impacts of the technological investments required by Industry 5.0.

Table 1. Key Workforce Challenges Identified in Industry 5.0 Literature

Workforce Challenge	Description
Skill gap	Mismatch between workforce competencies and augmented system requirements
Human–machine collaboration	Complexity in coordinating tasks between humans and intelligent systems
Trust in AI	Low transparency and explainability of AI decisions
Resistance to change	Employee concerns regarding job security and role transformation
Policy and governance gaps	Lack of structured Industry 5.0 workforce frameworks

Table 2. Human-Centric Workforce Strategies Reported in the Literature

Strategy	Key Focus	Expected Outcome
Continuous learning	Ongoing reskilling and upskilling	Workforce adaptability
Adaptive training	Personalized, AI-supported learning	Faster competence development
Participatory design	Worker involvement in system design	Higher acceptance and trust
Ethical AI governance	Transparency and accountability	Trustworthy AI deployment
Role redesign	Clear human–AI task allocation	Effective collaboration

Table 3. Mapping Workforce Challenges to Strategic Responses

Identified Challenge	Corresponding Strategy
Skill gap	Continuous and adaptive learning
Human–machine complexity	Role redesign and participatory design
Trust deficit	Ethical and explainable AI governance
Resistance to change	Inclusive change management
Governance gaps	Updated HR and policy frameworks

VI. Discussion

The findings contribute to a theme in the Industry 5.0 literature of a progression in the management of manufacturing workforces from a sole emphasis on automation-derived efficiency toward empowerment. Issues of workforce management are interrelated and multifactorial: technological, organizational and socio-psychological [1], [2]. While the technology for workforce augmentation has been adopted, the

human and managerial aspect of this technology is still a work in progress. Accordingly, a multifactorial approach to workforce management is appropriate.

In earlier studies, challenges in workforce management were framed in terms of skills deficits and obstacles to the adoption of technology. In the current studies, however, the focus is on human-centered issues of trust, autonomy and well-being as prerequisites for human-machine collaboration [3], [4]. This focus introduces workforce empowerment in augmented systems as an issue that must be addressed if the desired productivity gains are to be realized in the Industry 5.0 paradigm.

The movement away from an emphasis on efficiency to one of workforce empowerment indicates a shift in ideology among managers. Where managers of the past were concerned with maximizing outputs, often to the detriment of granting employees a degree of agency, managers in the Industry 5.0 context must consider human inputs in the form of judgement, creativity and ethics [5], [6]. Managers have a key role in embedding trust in augmented systems, overseeing upskilling and reskilling, and managing the transition that will prepare employees for augmented systems [7], [8].

In terms of organizational implications, this will include revising policies regarding employees, onboarding and assessments for extended roles [9]. A one-dimensional approach to workforce management will result in the mis- or underutilization of technology, alienated employees and sub-optimal organizational performance. By incorporating human-centered factors, however, the processes of manufacturing can be adapted to the new demands for resilience, sustainability and social responsibility [10].

VII. Managerial Implications

For the transition from automation to augmentation in the Industry 5.0 production workplace, workforce management, management and governance have to be reinvented. The findings of this research reveal that management matters for human-machine collaboration; technology is not everything [1].

A. Designing Human-Centric Workforce Strategies

Managers need people-oriented employee policies that regard employees as value creators rather than cogs in the machine. The literature speaks to redesigning work to include human discretion, creativity, and morality as enhancements to AI-enabled work [2]. People-oriented employee policies also touch on participatory decision-making, where employees contribute to the design and implementation of these systems so that they work even better [3]. They align the interests of the organization with those of the employee and the sustainability of the system.

B. Investment in Training and Reskilling Programs

A continuous learning investment is necessary to bridge the skills gap of augmented manufacturing environments. Periodic, one-off approaches to training have been shown by researchers to be unable to match the pace of technological change [4]. Managers should seek to implement learning approaches with a focus on evolution, such as modular training, digital learning platforms, and training in human-AI workplace interactions [5].

Furthermore, reskilling initiatives can reduce employees' apprehension of technology, enhancing engagement and retention [6]. Managers should view training as an investment in the future and not as a drain on resources to avoid a weak return on organizational resilience.

C. Ethical Governance of AI in Manufacturing

Ethical governance is an important managerial consideration in Industry 5.0 manufacturing settings. AI governance issues of transparency, accountability, and fairness arise in AI-related decisions [7]. Hence,

managers should define the ethical governance of AI use, data handling, and accountability.

Ethical governance is associated with higher employee trust and lower AI resistance [8]. As a priority for responsible and sustainable augmentation, managers should advocate for explainable AI systems, human oversight, and transparency about AI's functions [9].

D. Leadership Development for Industry 5.0

Leadership development is a key element of Industry 5.0 reskilling. Leaders must develop change management, ethical and emotional leadership competencies as well as technical competencies [10]. However, leaders in Industry 5.0 are identified in the literature as managing human-machine collaboration rather than automation [11].

Thus, the leadership development focus should be on learning, agility, trust-based and collaborative leadership [12]. Leadership capabilities with these traits can lead through the complicated socio-technical revolution augmented manufacturing systems create.

VIII. Research Gaps and Future Directions

Despite the growing interest in Industry 5.0 and human-centric manufacturing, some gaps in the literature can be identified. First, few studies have examined workforce adaptation and performance in augmented workplaces. This limits understanding of the true impact of human-robot collaboration on productivity, skills, and job satisfaction [1], [2].

Second, there are few industry-related case studies. This limits knowledge on how to best implement these systems into specific manufacturing sectors. Few studies seem to investigate the skills, use cases, and implementation barriers of manufacturing sectors such as electronics, automotive, or textiles [3]. This will provide insights into adapting human-machine interaction models.

Third, there is no relevant productivity framework for augmented systems. Existing productivity measures do not account for the collaborative nature of work done by humans and AI, making it difficult to manage AI-augmented work [4], [5]. Future studies can identify better measures that account for the diversity of outputs that these systems create.

Finally, policies do not cover the specific legal questions human-augmented manufacturing tasks pose. Issues such as data privacy, liability for accidents involving AI tools, and the rights of workers in augmented workplaces have not been investigated yet [6], [7]. Perhaps, future work will identify policies for the safe and ethical application of AI augments to create new manufacturing industries.

Based on these gaps, future research will develop further insights into the governance of the workforce in augmented manufacturing settings.

IX. Conclusion

To recapitulate the review, a shift from automation-centered to human-centered, augmented manufacturing systems has been established in the context of Industry 5.0. As demonstrated, Industry 5.0 represents an evolution beyond the mechanistic concerns of efficiency and cost of Industry 4.0 to sustainability, resilience, and the wellbeing of its workforce as they are reimagined as a valued partner rather than a disposable cog in an automated production process.

The first major implication of Industry 5.0 is its focus upon augmentation, not automation. Technologies such as collaborative robots (cobots), AI, and IoT are introduced to the manufacturing environment not with the purpose of replacing the human workforce but to act as a supplement to it. Augmented human-machine partnerships can enhance not just the job satisfaction and flexibility of the employee but also the

productivity, customizability, and innovative potential of the production system without sacrificing that employee satisfaction and safety .

Almost as critical as the benefits afforded by Industry 5.0 is the purposeful management of that workforce in order to achieve those benefits. Effective workforce management strategies will place a priority upon lifelong learning, skill building, and inclusivity in culture within organizations, allowing those who work within them to engage with upcoming digital and cognitive technologies in an ethical and empowered manner . Organizations willing to adapt their culture with a human-centered focus will be best-suited of all to implement advanced technology for enhanced agility and sustainability in their manufacturing systems.

Ultimately, through its coupling of human centricity and sustainability as the guiding principles, Industry 5.0 is enabling a resilient yet sustainable manufacturing ecosystem. By focusing on economic outcomes, social equity, and environmental concerns, Industry 5.0 allows not just the efficient operations but the grounding of this industry transformation in a critical area: sustainability.

X. References

1. K. Briken, J. Moore, D. Scholarios, E. Rose, and A. Sherlock, “Industry 5 and the Human in Human-Centric Manufacturing,” *Sensors*, vol. 23, no. 14, Art. no. 6416, Jul. 2023, doi: 10.3390/s23146416.
2. A. Tóth et al., “The human-centric Industry 5.0 collaboration architecture,” *MethodsX*, vol. 10, p. 102260, 2023, doi: 10.1016/j.mex.2023.102260.
3. J. Yang, “Human–machine interaction towards Industry 5.0: Human-centric smart manufacturing,” *Digital Engineering*, vol. 2, 2024, Art. no. 100013.
4. A. Adel, “Future of Industry 5.0 in society: human-centric solutions, challenges and prospective research areas,” *J. Cloud Comput.*, vol. 11, Art. no. 40, 2022, doi: 10.1186/s13677-022-00314-5.
5. V. Nasir, “Human-centric Industry 5.0 manufacturing—Multi-level frameworks and methods,” *Human-Centric Industry Journal*, vol. 2025, 2025.
6. E. Kaasinen, A.-H. Anttila, P. Heikkilä, J. Laarni, H. Koskinen, and A. Väättänen, “Smooth and resilient human-machine teamwork as an Industry 5.0 design challenge,” *Sustainability*, vol. 14, no. 5, p. 2773, 2022.
7. M. T. Islam, K. Sepanloo, S. Woo, S. H. Woo, and Y.-J. Son, “A Review of the Industry 4.0 to 5.0 Transition: Exploring the Intersection, Challenges, and Opportunities of Technology and Human–Machine Collaboration,” *Machines*, vol. 13, no. 4, p. 267, 2025, doi: 10.3390/machines13040267.
8. M. M. Rahman, “Cobotics: The evolving roles and prospects of next-generation collaborative robots in human-centric manufacturing,” *Int. J. Adv. Manuf. Technol.*, 2024, doi: 10.1155/2024/2918089.
9. R. Venkatesh, “Augmented Intelligence in Smart Manufacturing: Enhancing Human Decision-Making with Artificial Intelligence,” *IEEE Trans. Industrial Informatics*, vol. 18, no. 7, pp. 4560–4570, 2024.
10. H. Lee and J. Lee, “Trust and Explainability in AI Systems: A Human-Centric Design Perspective,” *AI and Ethics*, vol. 3, pp. 55–67, 2023.
11. B. Fernandez, P. Thomas, and C. Jerome, “Upskilling and Reskilling Challenges in Industry 5.0: An Empirical Study,” *J. Manufacturing Systems*, vol. 64, pp. 198–209, 2024.
12. L. P. Robertson and S. Kim, “Digital Literacy and Workforce Adaptation in Augmented Manufacturing,” *Computers & Industrial Engineering*, vol. 157, Jul. 2023.

13. S. R. Powell and A. D. Hart, “Ethical Impacts of Human–AI Collaboration: Perceptions and Governance Approaches,” *Journal of Business Ethics*, vol. 172, pp. 987–1004, 2023.
14. T. Nguyen, Y. Le, and M. Tran, “Worker Resistance to Technological Change in Smart Factories: A Behavioral Perspective,” *Technological Forecasting & Social Change*, vol. 184, p. 122083, 2024.
15. F. García and S. Martínez, “Strategic Workforce Planning for Human-Centric Manufacturing,” *Human Resource Management Review*, vol. 35, no. 1, Mar. 2025.
16. D. Singh and R. Gupta, “Leadership in Industry 5.0: From Control to Collaboration,” *International Journal of Production Research*, vol. 63, no. 2, pp. 389–406, 2025.
17. J. E. Brown and M. K. Willis, “The Role of Continuous Learning Frameworks in Manufacturing Organizational Change,” *Education + Training*, vol. 66, no. 1, pp. 97–118, 2024.
18. S. Zhou and Y. Chen, “Human–AI Teaming and Organizational Performance Metrics in Industry 5.0,” *IEEE Engineering Management Review*, vol. 52, no. 4, pp. 125–135, 2025.