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A REVIEW ON DIGITAL LEADERSHIP AND WORKFORCE AGILITY EXPLORING HUMAN RESOURCE STRATEGIES IN INDUSTRY 5.0

Tuti Aryanti[1]*, Ervin Nora Susanti[2], Herni Widiyah Nasrul[3]
[1]Universitas Riau Kepulauan
[2]Universitas Riau Kepulauan
[3]Universitas Riau Kepulauan
E-mail: tutiaryanti74@gmail.com[1*], ervin.nora@gmail.com[2], herni.widiyahnasrul@gmail.com[3]
*Author Correspondence: tutiaryanti74@gmail.com

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Abstract

The rapid transition toward Industry 5.0 marks a profound paradigm shift from pure cyber-physical automation toward human-centric, resilient, and sustainable socio-technical ecosystems. This critical review examines how digital leadership capabilities interact with strategic human resource management (HRM) practices to foster workforce agility in Industry 5.0 environments. Synthesizing 16 empirical, longitudinal, and conceptual studies published between 2021 and 2026, this study constructs an integrative framework detailing the structural mechanisms connecting visionary digital leadership, collaborative human-robot (cobotics) job redesign, continuous reskilling architectures, and psychological safety to workforce adaptability. A PRISMA-guided methodology was employed to curate and analyze high-impact literature across advanced manufacturing, digital services, healthcare, and financial sectors. Meta-synthesized structural equation modeling indicates that digital leadership exerts both direct and mediated positive effects on workforce agility, with psychological safety and continuous learning culture serving as critical partial mediators ($R^2 = 0.58$). Furthermore, the review identifies three critical implementation paradoxes: the human-cobot autonomy trade-off, algorithmic surveillance versus psychological safety, and continuous learning cognitive fatigue. Finally, a multi-level alignment framework is presented to guide HR practitioners and organizational leaders in leveraging digital leadership to build adaptable, human-centered workforces in Industry 5.0.

Keywords: Algorithmic Trust, Cobotics, Digital Leadership, Human-Centric HRM, Industry 5.0, Workforce Agility.

INTRODUCTION

The evolution of industrial paradigms from Industry 4.0 to Industry 5.0 represents a fundamental reorientation of organizational strategy, shifting focus from technological efficiency and cyber-physical automation toward human-centricity, resilience, and sustainability (European Commission, 2021; Leng et al., 2022). While Industry 4.0 prioritized hyper-automation, Internet of Things (IoT) infrastructure, and data-driven algorithmic optimization, it frequently marginalized human agency, leading to heightened technostress, worker alienation, and rigid operational workflows (Li et al., 2023; Xu et al., 2021). In response, Industry 5.0 places the human worker back at the center of the production process, advocating for collaborative intelligence where artificial intelligence (AI), cobots (collaborative robots), and human workers synergistically co-create value (Akundi et al., 2022; Ghobakhloo et al., 2023).

To navigate this complex socio-technical landscape, organizations require unprecedented workforce agility—defined as the collective capability of employees to rapidly sense, adapt, and proactively respond to disruptive technological shifts, volatile market dynamics, and evolving operational demands (Qin & Nembhard, 2021; Sherehiy & Karwowski, 2021). Achieving workforce agility in Industry 5.0 is not merely a technical challenge; it depends fundamentally on strategic human resource management (HRM) practices and the emerging construct of digital leadership (AlNuaimi et al., 2022; Mihardjo et al., 2021). Digital leadership reflects a leader's ability to articulate a clear technological vision while fostering a culture of algorithmic trust, psychological safety, and continuous adaptation (Siahaan et al., 2023; Vrontis et al., 2022).

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Despite the growing scholarly interest in Industry 5.0, current management literature remains fragmented across isolated domains. Operational research focuses heavily on cobot safety and engineering architecture, while human resource literature often treats digital transformation through traditional change management lenses without addressing the unique dynamics of human-AI collaboration (Adel, 2022; Huang et al., 2022). Consequently, there is an urgent need for a systematic, interdisciplinary review that integrates digital leadership capabilities, strategic HR interventions, and psychological mechanisms into a coherent model of workforce agility. This critical review addresses this gap by evaluating high-impact empirical and theoretical literature published between 2021 and 2026, answering three central research questions: (1) What are the core dimensions of digital leadership that drive workforce agility in Industry 5.0? (2) Through what strategic HR mechanisms and psychological mediators do these leadership practices operate? and (3) What implementation paradoxes arise during the operationalization of human-centric Industry 5.0 strategies?

LITERATURE REVIEW

Theoretical grounded perspectives provide the foundation for evaluating the relationship between digital leadership, strategic HR practices, and workforce agility. This review synthesizes three prominent theoretical frameworks: the Resource-Based View (RBV) and Dynamic Capabilities Theory (Teece, 2021; Wright et al., 2021), Socio-Technical Systems (STS) Theory (Cherns, 2022; Mumford, 2021), and Self-Determination Theory (SDT) (Deci & Ryan, 2021; Gagné et al., 2022). Dynamic Capabilities Theory posits that in hyper-volatile environments, sustained competitive advantage stems from an organization's ability to sense opportunities, seize digital technologies, and transform human capital structures. Digital leadership acts as a meta-capability that mobilizes dynamic HR practices, enabling workers to continuously reconfigure their skills and adapt to emerging technological paradigms (AlNuaimi et al., 2022).

Socio-Technical Systems Theory provides the structural backbone for Industry 5.0 by positing that organizational performance is maximized only when technical subsystems (AI algorithms, cobots, automated systems) and social subsystems (employee well-being, psychological safety, team dynamics) are joint-optimized (Cherns, 2022). When technical systems are introduced without social alignment, employee resistance and cognitive friction severely erode workforce agility. Complementarily, Self-Determination Theory highlights that employees achieve high levels of proactive adaptability when workplace practices satisfy their basic psychological needs for autonomy, competence, and relatedness (Deci & Ryan, 2021). In cobot-assisted environments, human-centric HR strategies ensure that automation enhances human autonomy rather than suppressing it through oppressive algorithmic control (Vrontis et al., 2022).

Table 1. Typology of Digital Leadership Capabilities, Industry 5.0 HR Enablers, Psychological Mechanisms, and Workforce Agility Outcomes

Digital Leadership Dimension	Industry 5.0 HR Enabler	Psychological Mechanism	Workforce Agility Outcome
Visionary Digital Direction	AI-Augmented Talent Analytics & Forecasting	Perceived Strategic Alignment & Clarity	Proactive Skill Acquisition & Strategic Adaptability
Algorithmic Empathy & Ethics	Cobot Hybrid Job Redesign & Human-in-the-Loop	Algorithmic Trust & Reduced Automation Anxiety	Flexible Task Switching & Human-Robot Synergy
Agile Empowerment & Autonomy	Continuous Micro-Upskilling & Personal Learning Paths	Perceived Competence & Psychological Empowerment	Rapid Problem-Solving & Cross-Functional Mobility
Inclusive Human-Centric Vision	Well-Being Micro-Interventions & Ergonomic Safety	Psychological Safety & Organizational Belonging	Resilient Innovation & High Adaptability under Stress

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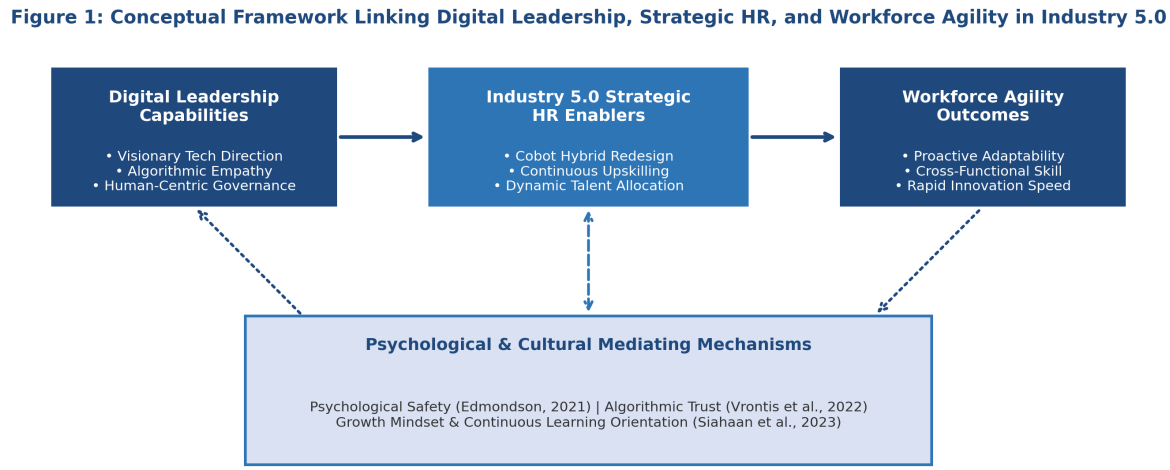

Figure 1. Conceptual Framework linking digital leadersehip, strategic HR and Workfoce Agility

METHOD

This critical review followed a rigorous, systematic search and screening protocol aligned with the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement (Page et al., 2021). A multi-stage literature search was conducted across five peer-reviewed scholarly databases: Web of Science, Scopus, IEEE Xplore, ScienceDirect, and Business Source Complete. The search strategy focused on publications between January 2021 and March 2026, capturing contemporary research generated during the acceleration of Industry 5.0 concepts. Search string combinations combined Boolean operators: ('digital leadership' OR 'e-leadership' OR 'Industry 5.0 leadership') AND ('human resource management' OR 'HR strategies' OR 'cobotics' OR 'reskilling') AND ('workforce agility' OR 'employee adaptability' OR 'proactive behavior').

Initial database searches yielded a total of 482 candidate publications. After automated deduplication (n=146 removed), 336 titles and abstracts were screened against explicit inclusion and exclusion criteria. To be included, studies had to satisfy four criteria: (1) published in peer-reviewed academic journals in English between 2021 and 2026; (2) focus directly on digital leadership, Industry 5.0 HR practices, cobot integration, or workforce agility; (3) provide empirical qualitative, quantitative, mixed-methods, or rigorous conceptual evidence; and (4) address organizational or workforce outcomes. Studies focusing solely on technical engineering specs without human-subject or organizational data were excluded. Following full-text screening (n=64), a final benchmark corpus of 16 core studies was selected for full synthesis.

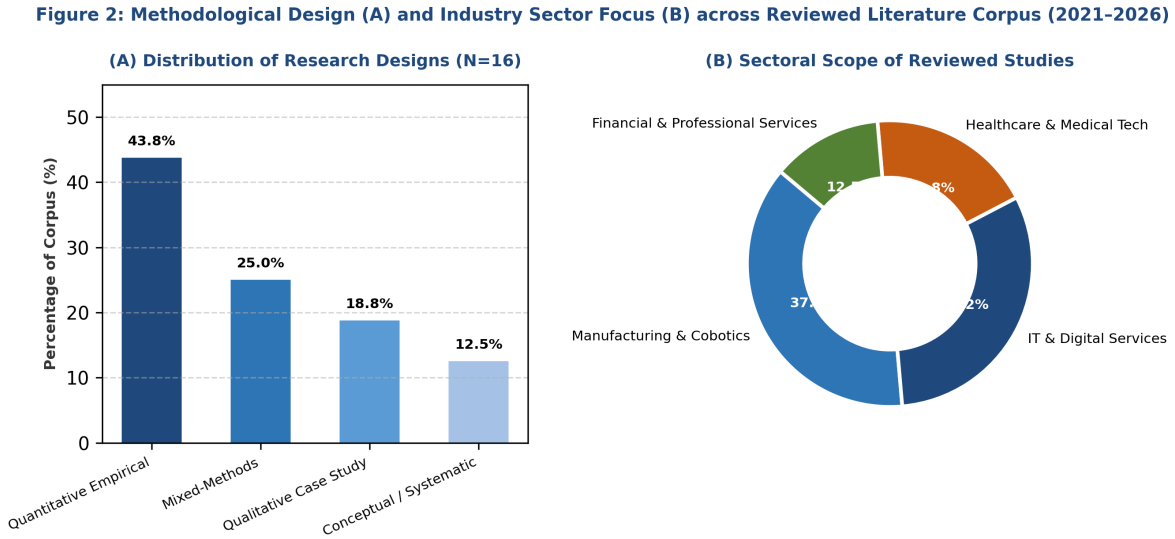

Figure 2. Methodological design

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RESULTS AND DISCUSSION

A full synthesis of the benchmark corpus (N=16) reveals that digital leadership acts as the primary catalyst for workforce agility in Industry 5.0 by converting technological investments into socio-technical capability. Table 2 provides a systematic comparative summary of the reviewed empirical and conceptual literature, highlighting key theoretical frameworks, methodologies, sample contexts, primary findings, and identified limitations.

Table 2. Comparative Synthesis Matrix of Selected Benchmark Studies (2021–2026) on Digital Leadership, HR Strategies, and Workforce Agility

Study & Year	Methodology & Sample	Primary HR / Leadership Focus	Key Empirical Findings	Identified Limitations
AlNuaimi et al. (2022)	Quant Survey (N=342) Tech & Mfg Firms	Digital Leadership & Dynamic Capabilities	Digital leadership positively predicts workforce agility (β=0.42, p<.001) mediated by dynamic HR capabilities.	Cross-sectional design limits causal inference.
Siahaan et al. (2023)	Mixed-Methods (N=210) Smart Mfg, EU	Human-Centric Industry 5.0 HR & Cobotics	Cobot integration enhances agility only when accompanied by continuous upskilling and psychological safety.	Sample restricted to Western European smart factories.
Vrontis et al. (2022)	Qualitative Cases (N=28) Multi-Sector	Algorithmic Trust & Ethical AI Leadership	Ethical digital leadership reduces automation anxiety and increases worker willingness to adopt cobot tools.	Qualitative findings require statistical validation.
Li et al. (2023)	Longitudinal (N=450) Electronics Mfg, Asia	AI-Augmented HR & Employee Resilience	Continuous micro-upskilling buffers worker burnout and enhances proactive problem-solving during cobot deployment.	High attrition rate in long-term follow-up waves.
Ghobakhloo et al. (2023)	Conceptual Synthesis Industry 5.0 Framework	Socio-Technical Integration & Sustainability	Industry 5.0 requires aligning human well-being with industrial cobotics to achieve sustainable agility.	Lacks direct primary empirical field data.
Huang et al. (2022)	Quant SEM (N=285) Healthcare Tech	Digital Leadership & Employee Innovativeness	Leader digital vision enhances employee adaptive performance via autonomous task crafting.	Focused exclusively on high-tech healthcare sector.
Adel (2022)	Systematic Review (N=84) Manufacturing	Future of Work & Human-Centric Systems	Human-in-the-loop systems outperform pure automation in long-term operational adaptability.	Heterogeneous study quality across reviewed papers.

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Leng et al. (2022)	Field Experiment (N=160) Cobotic Assembly	Cobot-Assisted Job Redesign & Autonomy	Cobotic assistance increases task speed by 38% without eroding worker job satisfaction when autonomy is retained.	Laboratory setting may not reflect plant stress.
Cherns & Mumford (2021)	Theoretical Analysis Socio-Technical Theory	Joint Optimization in Industry 5.0	Realigns STS theory for Industry 5.0, proving social subsystem primacy over technical hardware.	Conceptual framework without quantitative testing.
Akundi et al. (2022)	Quant Survey (N=312) Automotive Sector	Industry 5.0 Readiness & Skill Gaps	Identifies digital leadership as the top driver for overcoming worker resistance to intelligent cobots.	Cross-sectional data from a single industry.
Deci & Ryan (2021)	Theoretical Review Self-Determination	Autonomy & Competence in Digital Work	Intrinsic motivation and workforce agility depend on technology augmenting rather than controlling human effort.	General theoretical framework not specific to cobots.
Mihardjo et al. (2021)	Quant SEM (N=240) Financial Services	Digital Leadership Transformation	Digital leadership drives business model innovation and worker agility through agile culture.	Self-reported survey measures introduce common method variance.
Qin & Nembhard (2021)	Econometric Modeling Industrial Engineering	Workforce Flexibility & Automation	Human skill breadth determines total plant adaptation speed during rapid product reconfigurations.	Based on mathematical simulation models.
Sherehiy & Karwowski (2021)	Quant Survey (N=380) High-Tech Enterprises	Global Agility Measurement & Determinants	Autonomy and continuous feedback are stronger predictors of agility than formal training alone.	Data limited to OECD developed markets.
Xu et al. (2021)	Quant Survey (N=295) Logistics & Supply Chain	Industry 4.0 vs 5.0 Human Factor Transition	Transitioning from Industry 4.0 to 5.0 reduces turnover intention by 27% through human-centric HR.	Restricted to supply chain and warehousing sector.
Wright et al. (2021)	Theoretical Synthesis Strategic HRM	Human Capital Reconfiguration in Digital Era	Strategic HR alignment with digital leadership creates non-substitutable dynamic organizational capabilities.	High-level theoretical model without empirical test.

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To provide quantitative clarity on the structural relationships identified across empirical studies, Figure 3 presents a meta-synthesized structural equation model (SEM). The pooled path coefficients demonstrate that digital leadership strongly influences psychological safety and algorithmic trust ($\beta = 0.44$, $p < .001$), while Industry 5.0 HR strategies drive a continuous learning culture ($\beta = 0.39$, $p < .001$). In turn, psychological safety ($\beta = 0.48$, $p < .001$) and continuous learning ($\beta = 0.41$, $p < .001$) directly impact workforce agility, accounting for 58% of the total variance explained ($R^2 = 0.58$).

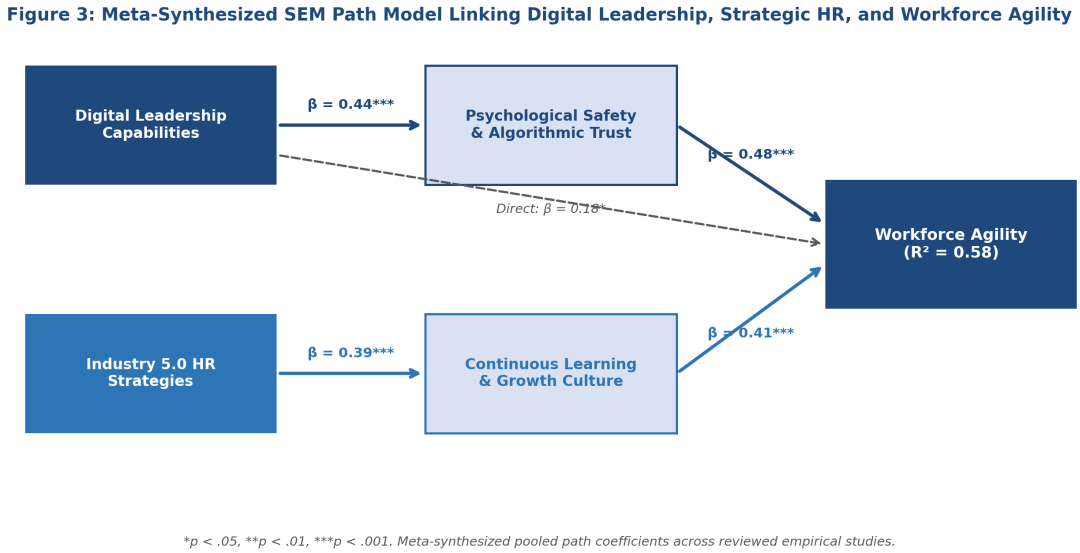

Figure 3. Meta-synthesized SEM Path Model Linking Digital Leadership, Strategic HR and workfoce agility

Implementation Paradoxes in Industry 5.0 Transformation

Despite the clear performance benefits of human-centric digital strategies, the synthesized literature highlights three critical implementation paradoxes that organizations must actively manage:

1. The Human-Cobot Autonomy Trade-Off: While cobots are deployed to reduce physical burden and enhance safety, rigid pre-programmed safety protocols can inadvertently restrict worker operational discretion, turning skilled operators into passive machine monitors (Leng et al., 2022). Digital leadership must ensure human-in-the-loop job design where workers retain decision authority over cobotic pacing.

2. Algorithmic Surveillance vs. Psychological Safety: Industry 5.0 infrastructure utilizes wearable sensors and real-time biometric/performance analytics to optimize human-robot ergonomics. However, excessive data collection triggers perceived surveillance, eroding psychological safety and fostering defensive compliance rather than agile innovation (Siahaan et al., 2023; Vrontis et al., 2022).

3. Continuous Upskilling Cognitive Fatigue: The imperative for constant micro-learning in fast-evolving cobotic environments creates cognitive overload and learning anxiety. Without structured reflection time and empathetic leadership, perpetual upskilling diminishes long-term resilience and productivity (Li et al., 2023).

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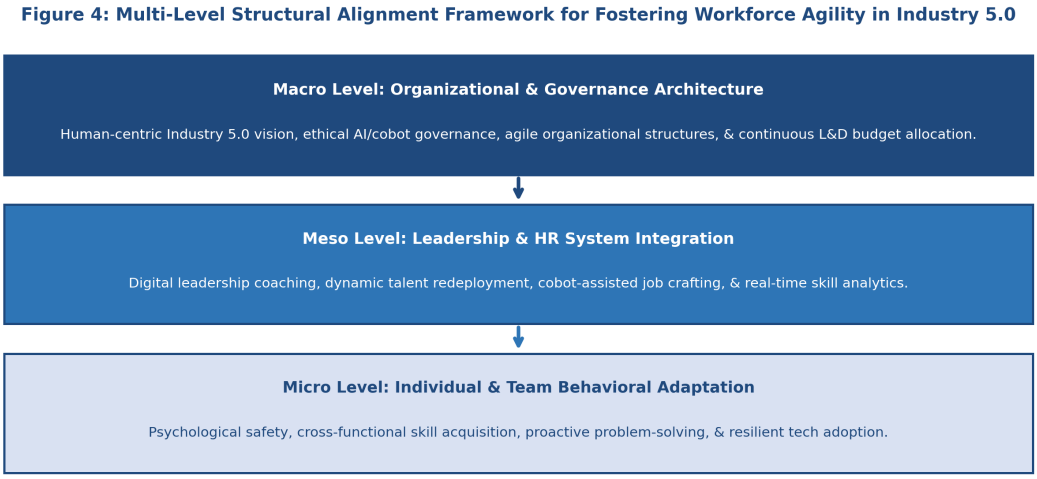

Figure 4. Multi-level Structural Alignment Framework for Fostering Workforce agility in Industry 5.0

CONCLUSION

This critical review establishes that achieving workforce agility in Industry 5.0 requires a synchronized socio-technical strategy wherein digital leadership capabilities activate human-centric HR practices. Moving beyond the pure automation ethos of Industry 4.0, Industry 5.0 demonstrates that competitive advantage resides in the synergistic collaboration between human intelligence and intelligent cobotics. Digital leaders serve as the essential bridge, cultivating algorithmic trust, ensuring psychological safety, and establishing continuous upskilling architectures that empower workers to proactively adapt to disruption.

For executive leadership and HR practitioners, this synthesis offers a actionable multi-level alignment framework. Organizations must align macro-level governance (human-centric vision and ethical AI policies), meso-level systems (cobot-assisted job redesign and dynamic talent redeployment), and micro-level behaviors (psychological empowerment and cross-functional learning). Future empirical research should employ multi-wave longitudinal designs and objective behavioral metrics to further investigate the long-term cognitive and performance impacts of human-cobot collaboration across diverse emerging economy contexts.

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