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Reforming Legal Frameworks for Human Capital: Digital Strategies Driving Industry 5.0 and Sustainability

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Abstract

The transition to Industry 5.0 necessitates a robust legal framework to regulate human capital investment, ensuring digital workforce development aligns with labor protections and Sustainable Development Goals (SDGs). This study examines the regulatory structures governing human capital investment in Indonesia, the European Union, and the United States, evaluating their effectiveness in addressing digital transformation challenges, AI-driven employment governance, and workforce adaptability. A mixed-methods approach integrates legal analysis with empirical assessments of policy effectiveness, workforce investment trends, and labor market outcomes. Findings reveal significant disparities in AI workforce governance, skill accreditation, and automation labor rights. Indonesia's fragmented legal framework hinders workforce reskilling and AI employment governance, while the European Union's AI Act provides a structured, albeit inconsistently implemented, model for digital employment regulation. The United States,

despite its technological leadership, lacks federal AI workforce policies, leading to state-level regulatory variations. The study underscores the necessity of harmonized legal frameworks to bridge workforce skill gaps, protect labor rights, and advance SDG-aligned workforce policies. Future legal reforms must prioritize AI governance, digital workforce training, and cross-border labor protections to ensure equitable workforce transitions. Strengthening public-private partnerships, standardizing AI employment regulations, and enhancing labor rights enforcement will be essential for fostering sustainable human capital investment in the industry 5.0 era. The contribution of research extends beyond theoretical frameworks, providing substantial implications for policy formulation, industry practices, educational advancements, and societal improvements.

Keywords
Legal Framework, Human Capital, Digital Strategies, Industry 5.0, SDGs.

Introduction

Human capital investment serves as a foundational pillar of economic resilience, technological advancement, and labor productivity in the digital era[1]. The transformation toward Industry 5.0, defined by the integration of artificial intelligence (AI), automation, and ethically conscious digital transformation, demands a comprehensive legal infrastructure to support sustainable human capital development[2]. Unlike the automation driven focus of Industry 4.0, the industry 5.0 paradigm introduces normative priorities such as human dignity, sustainability, and distributive justice into workforce policy[3]. Legal structures are no longer passive instruments of regulation but essential

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1 H. Wang, Y. Li, and J. Zhou, "The Role of Big Data Analytics in Human Capital Management: A Legal Perspective," *Digital Workforce Research Journal* 10, no. 3 (2023): 45–67.

2 W.D. Gerstlberger and G.K. Prause, "Introduction to the Special Issue 'The Twin Challenge of Sustainability and Digital Transformation,'" *Scientific Papers of the University of Pardubice, Series D: Faculty of Economics and Administration* 32, no. 2 (2024), https://doi.org/10.46585/sp32022137.

3 S. Xue, B. Zhang, and X. Zhao, "Brain Drain: The Impact of Air Pollution on Firm Performance," *Journal of Environmental Economics and Management* 110 (2021), https://doi.org/10.1016/j.jeem.2021.102546.

frameworks that shape access to digital education, ensure algorithmic fairness, and protect labor rights across diverse sectors[4]. From a juridical standpoint, Indonesia has enacted Law Number 6 of 2023 on the Enactment of Government Regulation in Lieu of Law Number 2 of 2022 on Job Creation into Law to streamline labor and vocational regulations.[5] However, this omnibus law remains narrowly investment-centric and omits key provisions on AI governance, digital labor contracts, and platform-based employment protections. Algorithmic recruitment, the ethical implications of automated decision-making, and protections for gig workers have not been explicitly addressed, resulting in regulatory lag. Similarly, Law No. 20 of 2003 on the National Education System has not yet mandated the integration of AI literacy, lifelong learning, or interdisciplinary digital competencies essential for Industry 5.0 transitions[6]. The decentralized nature of workforce planning under Law No. 23 of 2014 on Regional Government has further fragmented policy implementation[7]. Despite strategic documents such as RPJMN *[Rencana Pembangunan Jangka Menengah Nasional]* 2020–2024 and Presidential Regulation No. 68 of 2022 on vocational revitalization, Indonesia has yet to codify enforceable legal standards for AI ethics, digital inclusion, and equitable workforce transition[8].

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[4] J. Andersén, "Resource Orchestration of Firm-Specific Human Capital and Firm Performance—the Role of Collaborative Human Resource Management and Entrepreneurial Orientation," *International Journal of Human Resource Management* 32, no. 10 (2021): 2091–2123, https://doi.org/10.1080/09585192.2019.1579250.

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[7] Republic of Indonesia, "Law Number 23 of 2014 on the Regional Government," Pub. L. No. 23/2014, Lembaran Negara Tahun 2014 Nomor 244 (2014).

[8] Republic of Indonesia, "Presidential Regulation Number 18 of 2020 on the National Medium-Term Development Plan 2020–2024," Pub. L. No. 18/2020, Lembaran Negara Tahun 2020 Nomor 10 (2020); Republic of Indonesia, "Regulation of the Coordinating Minister for Human Development and Culture Number 1 of 2023 on the Amendment to Regulation Number 5 of 2022 on the Organization and Governance of the National Coordination Team for Vocational

Although the importance of human capital investment in digital transformation is increasingly recognized, existing legal frameworks often lag behind technological innovation[9]. Many countries have developed fragmented policies that fail to address emerging challenges such as AI governance, data privacy in workforce analytics, and the ethical implications of algorithmic decision-making in the hiring process[10]. Moreover, disparities in labor market regulations and access to digital skill training exacerbate inequalities in workforce development, further widening the global digital divide[11]. Brynjolfsson and McAfee have extensively examined the economic benefits of human capital investment[12] and the role of technology in reshaping labor markets, yet the juridical dimensions of this transformation remain underexplored and the role of technology in reshaping the labor market[13]. Research that explicitly connects legal frameworks, digital strategies, and sustainable workforce development in the context of Industry 5.0 remains limited. Addressing this scholarly gap is essential to formulate policy recommendations that bridge legal deficiencies and optimize national preparedness for ethical and inclusive digital economies. This study aims to explore how legal and policy frameworks can be reformed to ensure that human capital investment aligns with the complex demands of Industry 5.0. The guiding research question is: How can legal frameworks be adapted to support and expand human capital investment in the era of Industry 5.0?

Education and Vocational Training Revitalization.," Pub. L. No. 1/2023, Lembaran Negara Tahun 2023 Nomor 235 (2023).

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10 World Bank, "World Bank Economic Data and Human Resource Development," World Bank Economic data and human resource development, 2025, https://data.worldbank.org.

11 P. Thompson and M. Lewis, "Enhancing Public-Private Partnerships for Digital Skills Training and Workforce Reskilling," *Public Policy & Digital Economy* 17, no. 3 (2024): 199–215.

12 G.S. Becker, *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education* (University of Chicago Press, 1964).

13 E. Brynjolfsson and A. McAfee, *Machine, platform, crowd: Harnessing our digital future* (W. W. Norton & Company, 2017).

The theoretical foundation of human capital investment stems from Becker's classical theory, which emphasizes the role of education, training, and skill acquisition in enhancing labor productivity[14]. Hanushek and Woessmann expanded this framework by incorporating cognitive skills and digital literacy as essential factors influencing long-term economic development[15]. In the context of Industry 5.0, traditional human capital models must be reevaluated to reflect the need for human-machine collaboration and ethically sustainable work environments. Schwab argued that future economic systems must prioritize integrating technological innovation with workforce well-being[16]. This philosophical shift necessitates legal frameworks that not only facilitate digital upskilling but also protect labor rights in rapidly evolving technological environments.

The existing intersection of law, digital transformation, and human capital investment varies across different jurisdictions. Nelson proposed a governance model for enterprise-level data integration, emphasizing the importance of participatory legal structures in regulating digital labor practices[17]. Tu explored how the sharing economy influences the legal status of digital labor markets, highlighting the regulatory void in many jurisdictions[18]. Allouzi and Alomari contributed a hybrid legal framework to resolve disputes in the metaverse, illustrating the urgency for updated laws in managing virtual work environments[19]. Ștefoni investigated informal labor market

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[14] Becker *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*.

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[19] A.S. Allouzi and K.M. Alomari, "Adequate Legal Rules in Settling Metaverse Disputes: Hybrid Legal Framework for Metaverse Dispute Resolution (HLFMDR)," *International Journal of Data and Network Science* 7, no. 4 (2023): 1627–42, https://doi.org/10.5267/j.ijdns.2023.8.001.

regulation within underground economies, providing insights into the governance of non-standard employment[20]. Triana added a perspective from environmental law, analyzing alternative dispute resolution in marine labor contexts to support broader labor policy reform[21]. These studies reveal that existing legal systems are insufficiently responsive to the dynamics of digital employment and that jurisdictional reforms are urgently required.

Technological innovation in workforce management also presents significant legal implications for human capital investment. Wang examined the use of big data analytics in optimizing human resources[22], while Patel assessed blockchain technology as a means to ensure transparency in workforce qualifications[23]. Chen and Zhou addressed the critical issue of cybersecurity and legal compliance in digital employment governance[24]. Studies by Kim and Tanaka & Nakamura focused on AI-driven workforce analytics and cognitive computing, respectively, offering strategic frameworks for adaptive human resource management[25]. Zhang extended this analysis by studying cyber-physical systems in Industry 5.0, reinforcing the need for legal adaptation in tech-driven labor ecosystems[26]. These findings confirm that legal frameworks

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[20] M. Ștefoni, A. Popescu, and L. Ionescu, "Economic Development within Underground Economies: Implications for Informal Labor Market Regulations," *Economic Review Journal* 22, no. 1 (2024): 30–45.

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[26] P. Zhang, W. Lee, and H. Choi, "Cyber-Physical Systems for Human Capital Development in Industry 5.0: Legal and Policy Considerations," *Technology & Workforce Policy Review* 18, no. 1 (2024): 120–40.

must evolve alongside technological change to support secure, ethical, and inclusive workforce systems.

Despite growing interest in the digital economy, the integration of legal frameworks in human capital strategy remains underdeveloped in research and policy[27]. Gandhi examined how human capital investment supports digital transformation in Eastern European economies[28]. Al Amin and Baldacci emphasized the synergy between blockchain and Industry 5.0 in sustainable manufacturing systems[29]. Egbengwu proposed using extended reality in human-centric production, reaffirming the demand for proactive labor regulation[30]. However, most of these studies focus on technological design or economic outcomes without embedding the legal mechanisms necessary for labor protection and governance. This indicates a significant research gap at the convergence of law, digital workforce strategy, and human capital development.

The current study builds on these insights by bridging fragmented scholarships and proposing a reform-oriented legal approach. The contribution lies in formulating an integrative legal model that aligns human capital investment with the structural demands of Industry 5.0. Unlike prior research that isolates economic or technical factors, this research emphasizes juridical, philosophical, and sociological dimensions to ensure that future labor systems are efficient but also just, ethical, and inclusive. Addressing this gap is critical for policymakers seeking to

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[27] A. Gandhi et al., "Human Capital in Digital Economy: An Empirical Analysis of Central and Eastern European Countries from the European Union," *Sustainability (Switzerland)* 13, no. 4 (2021): 1–21, https://doi.org/10.3390/su13042020.

[28] Al Amin and Baldacci, "Blockchain Technology and Industry 5.0 Synergy for Sustainable Development in RMG Industries: An ISM and Fuzzy Dematel Approach."

[29] M. Al Amin and R. Baldacci, "Blockchain Technology and Industry 5.0 Synergy for Sustainable Development in RMG Industries: An ISM and Fuzzy Dematel Approach," *Discover Sustainability* 5, no. 1 (2024), https://doi.org/10.1007/s43621-024-00696-3.

[30] V. Egbengwu, W. Garn, and C.J. Turner, "Metaverse for Manufacturing: Leveraging Extended Reality Technology for Human-Centric Production Systems," *Sustainability (Switzerland)* 17, no. 1 (2025), https://doi.org/10.3390/su17010280.

harmonize legal infrastructure with digital transformation and sustainable development goals.

Methods

The study applies to a mixed method approach integrating qualitative legal analysis with quantitative data examination to evaluate the legal frameworks governing human capital investment in Industry 5.0 [31]. The research is designed to compare three jurisdictions, Indonesia, the European Union, and the United States, selected for their distinct regulatory approaches to digital workforce development, AI governance, and labor law modernization. Secondary data were collected from official reports, legislative texts, and international policy publications, including those from the OECD, World Bank, BPS Indonesia, and the European Commission. Quantitative data consists of statistics on human capital investment flows, labor market transition rates, and technology adoption trends from 2020 to 2024. These datasets were analyzed using descriptive statistics and comparative policy evaluation techniques to identify alignment or gaps between legal frameworks and labor outcomes.

Qualitative data were obtained through thematic document analysis of relevant statutes, national labor laws, strategic policy papers, and digital economy regulations. This method enables the identification of key legal principles, regulatory barriers, and reform patterns across jurisdictions. The qualitative analysis focuses on how current laws support or hinder digital skill development, worker protections, and equitable employment access in an AI-driven economy. While the study offers a comprehensive comparative perspective, limitations include regulatory fluidity across regions and differences in policy enforcement. Despite these challenges, the findings contribute to practical insights for legal reformers, institutional designers, and workforce policymakers in creating adaptive legal structures for human capital development in the industry 5.0 era.

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Result and Discussion

A. Human Capital Investment and Education Spending

The analysis of Human Capital Index (HCI) trends from 2022 to 2024 highlights significant regional variations in human capital development across Indonesia, the European Union, and the United States. While Indonesia's HCI gradually increased from 0.54 in 2022 to 0.56 in 2024, both the European Union and the United States maintained stable values at 0.74 and 0.70, respectively, over the same period. The steady rise in Indonesia suggests ongoing efforts in workforce transformation, whereas developed economies appear to have reached a level of maturity where additional growth in human capital requires strategies beyond financial investment.

Government investment in education remained stagnant at 3.6% of GDP in Indonesia, a level significantly lower than the European Union at 4.7% and the United States at 5.0%. Despite the absence of an increase in education funding, Indonesia experienced positive growth in HCI. This trend suggests that factors beyond direct government spending contributed to improvements in human capital. Possible explanations include policy reforms aimed at workforce development, greater involvement of private sector initiatives, expansion of targeted training programs, and international collaboration supporting skill development.

Stable HCI values in the European Union and the United States, despite consistent education expenditure, indicate that existing policies effectively sustain human capital development. However, further improvement may require innovative strategies such as AI-driven workforce training and reskilling programs designed for Industry 5.0. Increased financial investment alone may not be sufficient to drive substantial gains in workforce capabilities within highly developed economies.

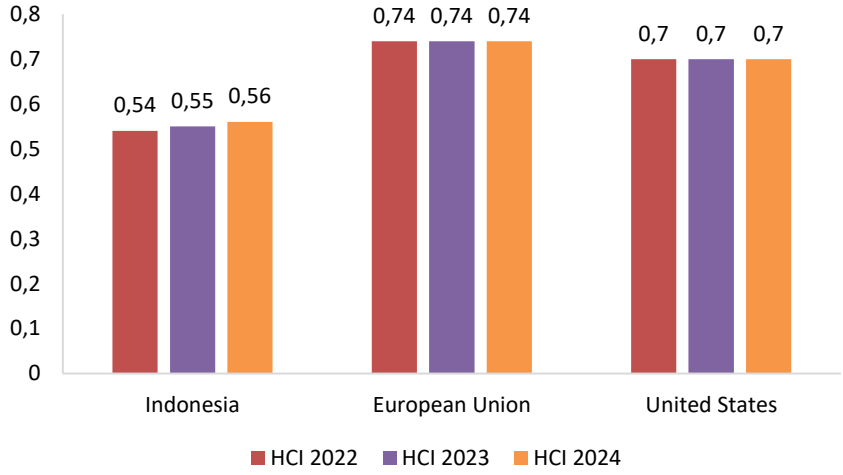

Figure 1. Human Capital Index 2022-2024. Source(s): Authors' own work

Figure 1 show comparative HCI trends across Indonesia, the European Union, and the United States illustrate distinct patterns in workforce development. Indonesia demonstrates a steady improvement, reflecting ongoing advancements in skill acquisition and workforce quality. In contrast, stable values in the European Union and the United States suggest that human capital in these regions has reached a point where further progress depends on structural and technological transformations in education and labor policies. Optimizing existing workforce strategies rather than increasing education funding may be a more effective approach for these economies.

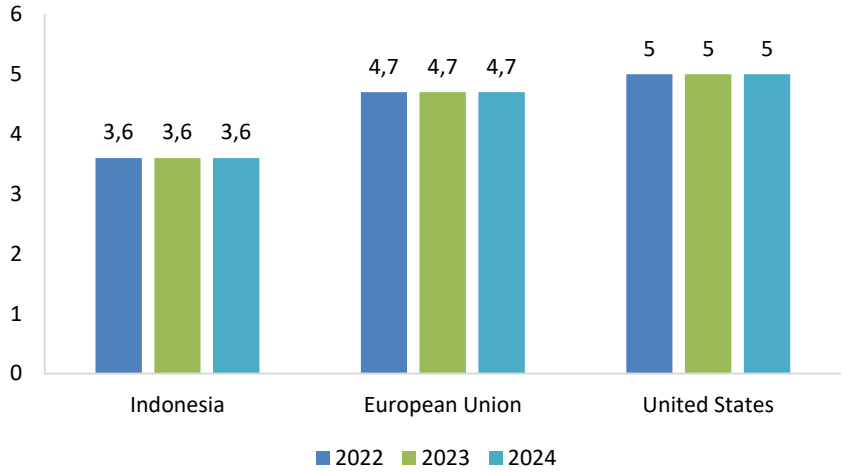

Figure 2. Government Investment in Education (%) of GDP 2022-2024
Source(s): Authors' own work

Government investment in education reflects differences in national priorities and policy approaches toward human capital development. Indonesia consistently allocated 3.6% of GDP to education, a figure lower than that of the European Union and the United States. Despite relatively low financial investment, HCI in Indonesia increased, implying that factors such as workforce training initiatives, partnerships with the private sector, and policy-driven improvements may have influenced human capital growth. Meanwhile, the European Union and the United States maintained stable levels of education investment alongside unchanged HCI values, reinforcing the argument that future human capital growth in these regions may require strategies beyond financial allocation.

Distinct approaches to human capital development in Indonesia, the European Union, and the United States highlight the necessity for tailored policy strategies. Indonesia may benefit from increased investment in vocational training, digital literacy programs, and Industry 5.0 skill development to accelerate HCI growth. Developed economies such as the European Union and the United States may achieve greater advancements by refining existing workforce programs through AI-powered learning models and digital skill improvement initiatives. Maintaining competitiveness in the future labor market requires

adaptation to technological advancements and continuous improvements in workforce development strategies.

B. Labor Market Trends and Workforce Readiness

Labor market trends from 2022 to 2024 demonstrate distinct regional differences in unemployment rates and labor force participation across Indonesia, the European Union, and the United States. Variations in workforce engagement highlight the impact of economic stability, government policies, and digital transformation on employment conditions. Regional disparities reflect structural changes, workforce adaptability, and evolving labor market demands in response to technological advancements.

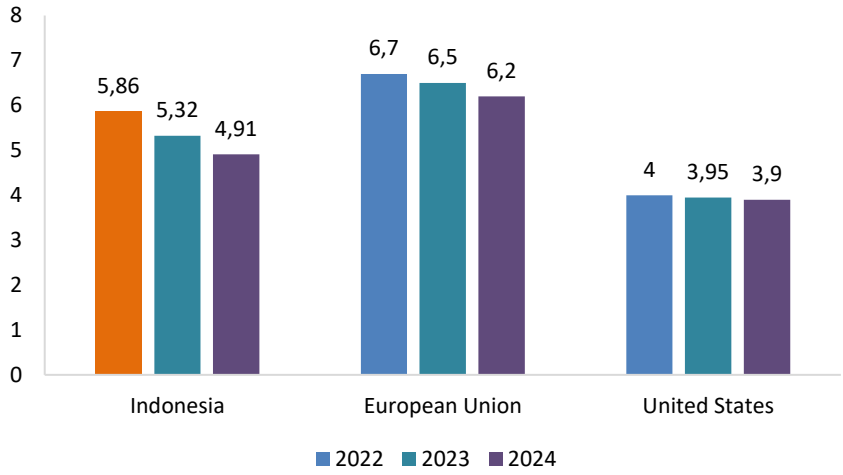

Figure 3. Unemployment Rate Trends (2022-2024). Source(s): Authors' own work

Figure 3 show unemployment rates serve as a fundamental measure of labor market performance, providing insights into job availability, workforce demand, and economic stability. Between 2022 and 2024, Indonesia recorded a continuous decline in unemployment, decreasing from 5.86% in 2022 to 4.91% in 2024. The reduction suggests an expanding labor market with greater employment opportunities, supported by economic recovery, private sector growth, and workforce development initiatives. Policies promoting entrepreneurship, vocational education, and digital workforce integration may have contributed to sustained employment gains.

The European Union exhibited a moderate decline in unemployment, from 6.7% in 2022 to 6.2% in 2024. The gradual reduction indicates a stable labor market with consistent workforce demand, though economic conditions vary across member states. Some economies experienced rapid labor market improvements, while others continued to face challenges related to labor mobility, automation, and sector-specific skill shortages. Workforce policies emphasizing reskilling programs and digital economy expansion played a crucial role in sustaining employment levels.

The United States recorded the lowest unemployment rate among the three regions, with a marginal decline from 4.0% in 2022 to 3.9% in 2024. The slight decrease reflects a highly competitive labor market with strong employment prospects, particularly in sectors aligned with technological advancements, healthcare, and remote work industries. High levels of job mobility, flexible employment structures, and continuous digital skill development contributed to maintaining a low unemployment rate.

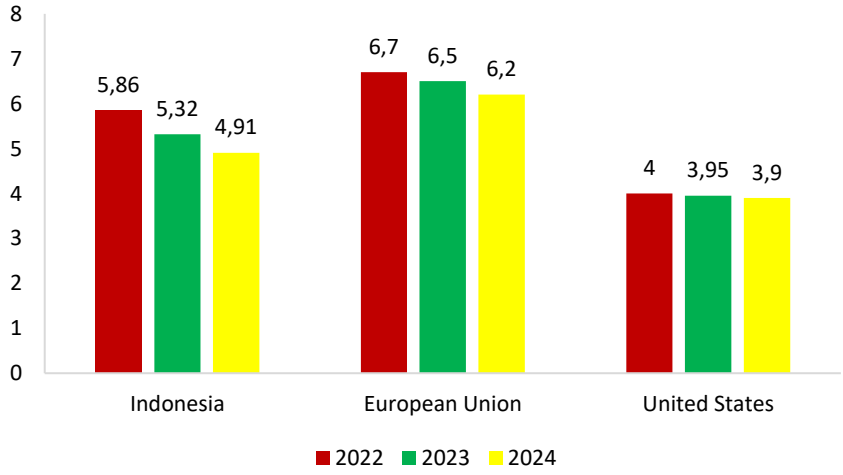

Figure 4. Labor Force Participation Trends (2022-2024). Source(s): Authors' own work

Figure 4 show labor force participation measures the proportion of the working-age population engaged in economic activities, either through employment or active job-seeking efforts. Between 2022 and 2024, Indonesia experienced a steady increase in workforce participation, rising from 68.06% to 69.78%. The growth suggests greater economic

engagement and expanding job opportunities, influenced by improvements in workforce policies, skill development programs, and digital job integration. The upward trend reflects increasing confidence in employment prospects and stronger participation from younger workers and skilled professionals.

The European Union maintained a stable labor force participation rate, increasing slightly from 72.0% in 2022 to 72.5% in 2024. The high and consistent rate suggests effective labor market policies and economic resilience, though demographic challenges such as an aging workforce and mismatches between skills and industry needs have limited further growth.

The United States recorded a modest increase in labor force participation, rising from 63.5% in 2022 to 64.0% in 2024. The steady increase reflects a labor market capable of attracting and retaining workers despite economic fluctuations. Growth in flexible employment, digital workforce integration, and sectoral diversification has supported the upward trend. Expansion in industries such as technology, renewable energy, and healthcare has contributed to sustained labor force engagement.

C. Adoption of Digital Technologies in Industry 5.0

The adoption of digital technologies in Indonesia increased from 30% in 2022 to 40% in 2024, demonstrating gradual progress toward Industry 5.0 transformation. The moderate growth suggests increasing awareness of digitalization benefits, government-led initiatives, and incremental infrastructure development. Despite improvements, challenges such as limited access to advanced digital infrastructure, slow regulatory adaptation, and digital literacy deficiencies continue to restrict large-scale implementation.

In comparison, the European Union and the United States achieved significantly higher digital adoption rates, reaching 75% and 78% in 2024, respectively. The accelerated adoption reflects strong government incentives, well-developed industrial ecosystems, and widespread technology integration. The European Union prioritized sustainability-driven digital innovation, integrating smart manufacturing, AI-based automation, and data-driven decision-making

into production processes. The United States leveraged early adoption strategies, utilizing artificial intelligence, cloud computing, and real-time analytics to improve operational efficiency and industrial competitiveness.

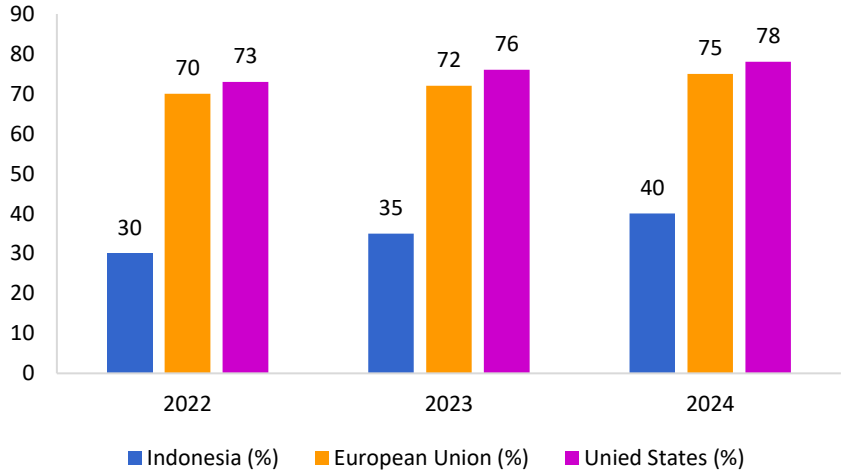

Figure 5. Digital Adoption Trends Data. Source(s): Authors' own work

Figure 5 illustrates the comparative trends in digital adoption across the three regions. The data indicate that Indonesia's digital transformation remains in the early stages, while the European Union and the United States have progressed toward full Industry 5.0 integration. The significant gap in adoption rates highlights the impact of early-stage investment, infrastructure readiness, and regulatory support in shaping digital transformation.

Investment in digital transformation in Indonesia grew from 10% of total industrial investment in 2022 to 15% in 2024. Despite progress, investment levels remained substantially lower than those in the European Union (24%) and the United States (30%). The disparity in investment underscores differences in economic capacity, policy-driven incentives, and private-sector engagement in digital transformation. Lower investment levels in Indonesia suggest continued reliance on conventional production models, slower adoption of automation, and insufficient research and development funding.

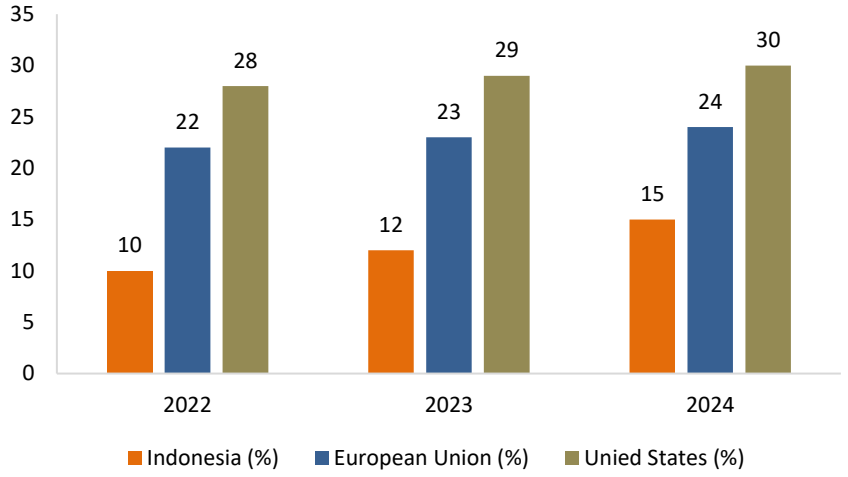

Figure 6. Digital Investment Trends Data. Source(s): Authors' own work

As shown in Figure 6, digital investment as a percentage of total industry investment in Indonesia remains significantly lower than in the European Union and the United States. The gradual increase in Indonesia's investment share reflects growing interest in digitalization, yet the gap in investment suggests the need for stronger financial support mechanisms, technology transfer policies, and strategic workforce reskilling initiatives.

Despite ongoing policy efforts to improve Industry 5.0 readiness, Indonesia continues to face challenges in digital workforce development. The absence of structured digital upskilling programs, slow automation adoption in traditional industries, and fragmented digital training initiatives restricts the development of a competitive digital economy. By contrast, the European Union and the United States have systematically integrated digital workforce training into economic strategies, ensuring a smooth transition to Industry 5.0-driven employment models.

D. Legal And Policy Challenges in Human Capital Investment

Legal and policy challenges significantly impact Industry 5.0 workforce transformation, influencing human capital investment and digital workforce integration. Findings reveal distinct regulatory and policy barriers in Indonesia, the European Union, and the United States,

shaping the pace of digital workforce adaptation and economic competitiveness.

Table 1. Legal and Policy Challenges in Human Capital Investment

Region	Legal Challenge	Policy Challenge
Indonesia	Unclear AI employment regulations, slow Industry 5.0 legal adoption.	Limited infrastructure and uneven access to digital training.
European Union	Fragmented digital workforce policies among member states.	High digital skill gaps despite strong policy frameworks.
United States	Lack of unified federal AI employment regulations.	Variations in state policies affecting workforce digitalization.

Sources: Authors' own work

Table 1 presents an overview of legal and policy challenges in human capital investment across the three regions. Indonesia faces unclear AI employment regulations and slow Industry 5.0 legal adoption, creating uncertainty for businesses and limiting workforce digitalization efforts. Additionally, limited infrastructure and unequal access to digital training programs hinder the development of a digitally competent workforce, restricting participation in an increasingly technology-driven economy. Despite initiatives promoting digital literacy and upskilling programs, gaps in policy execution and uneven resource distribution continue to slow progress.

The European Union faces a different challenge, as digital workforce policies remain fragmented among member states. As indicated in Table 1, despite strong government initiatives to advance digital skill development, differences in regulatory approaches across nations create disparities in workforce transformation efforts. A high digital skill gap persists, reflecting a mismatch between industry demands and workforce training programs. The lack of a centralized digital workforce governance system complicates labor mobility and the standardization of AI employment regulations, affecting Industry 5.0 readiness.

The United States encounters legal and policy challenges stemming from the absence of a unified federal AI employment regulation. Table 1 highlights the regulatory inconsistencies across different states, leading to variations in workforce digitalization policies. The lack of federal oversight affects AI-driven hiring practices, job automation policies, and digital employment protections, creating state-level disparities in Industry 5.0 adoption. Workforce mobility and digital skill certification vary between states, resulting in uneven access to AI-integrated labor markets and potential labor market inefficiencies.

The transformation of legal infrastructures governing human capital investment in the Industry 5.0 era reveals a deepening convergence between regulatory systems, technological advancement, and evolving labor dynamics. Recent policy efforts have sought to reconcile protective labor norms with the imperatives of digital skill development and employment regulations amid AI proliferation and automation[32]. Findings from this research highlight the indispensable role of juridical clarity in facilitating equitable digital workforce transitions while exposing structural gaps, inconsistencies in statutory interpretation, and policy divergences across jurisdictions such as Indonesia, the European Union, and the United States. Although prior scholarships have largely concentrated on macroeconomic factors influencing labor force expansion, there remains a notable deficiency in the literature addressing how legal regimes configure the rights, obligations, and protections within digital employment ecosystems[33].

Public expenditure on education is a foundational determinant of workforce readiness; however, the legal frameworks that govern resource allocation, access to educational services, and vocational training benchmarks remain heterogeneous across national contexts. This study identifies significant disparities in education-related statutory

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[32] A.H. Nelson et al., "A Governance and Legal Framework for Getting to 'Yes' with Enterprise-Level Data Integration," *Data and Policy* 6 (2024), https://doi.org/10.1017/dap.2024.23; Patel, Sharma, and Lewis, "Blockchain Technologies for Secure and Transparent Workforce Management."

[33] Triana, Turistiati, and Monk, "Alternative Dispute Resolution in Marine Pollution: Advancing Ecological Justice through the Polluter Pays Principle"; Allouzi and Alomari, "Adequate Legal Rules in Settling Metaverse Disputes: Hybrid Legal Framework for Metaverse Dispute Resolution (HLFMDR)."

instruments and their impact on digital skill development. In Indonesia, where only 3.6% of GDP is allocated to education, compared to 4.7% in the European Union and 5.0% in the United States, there exists a juridical tension between formal commitments to SDG 4 (Quality Education) and the practical limitations of underfunded legal mandates[34]. Indonesia's Human Capital Index (HCI) has shown incremental improvement, indicating the influence of non-budgetary drivers such as legislative frameworks, public-private cooperation, and foreign-led workforce initiatives[35]. Nevertheless, persistent legal fragmentation in vocational education policy and the absence of a standardized national accreditation mechanism obstructs the scalability and credibility of workforce development programs, ultimately curtailing labor mobility in digitally intensive sectors[36].

In contrast, the European Union and the United States have operationalized more cohesive legal infrastructures supporting skills accreditation, vocational standardization, and institutionalized lifelong learning to enhance workforce agility[37]. The EU's Digital Education Action Plan (2021–2027) functions as a juridically structured roadmap for comprehensive reskilling, while the United States Workforce

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[34] J.O. Arowosegbe, "Before We Forget Its Horrors: When Does Human Genome Editing Not Become Eugenics?," *Mizan Law Review* 18, no. 2 (2024): 241–70, https://doi.org/10.4314/mlr.v18i2.1.

[35] E.I. Eroshenkova et al., "Formation of human capital and pro-social attitudes of future teachers and university students," *Perspectives of Science and Imagery* 49, no. 1 (2021): 66–79, https://doi.org/10.32744/PSE.2021.1.5.

[36] C.M. Jackson et al., "An Assessment of Kenya's Forest Policy and Law on Participatory Forest Management for Sustainable Forest Management: Insights from Mt. Kenya Forest Reserve," *Trees, Forests and People* 19 (2025), https://doi.org/10.1016/j.tfp.2024.100770; I. Dia and H.A. Ondoa, "Does Economic Freedom Improve FDI Inflows in Sub-Saharan Africa?," *Journal of Economic Integration* 38, no. 3 (2023): 383–410, https://doi.org/10.11130/jei.2023.38.3.383.

[37] M.N.U. Milon et al., "An In-Depth PRISMA Based Review of Cybercrime in a Developing Economy: Examining Sector-Wide Impacts, Legal Frameworks, and Emerging Trends in the Digital Era," *Edelweiss Applied Science and Technology* 8, no. 4 (2024): 2072–93, https://doi.org/10.55214/25768484.v8i4.1583; H. Han and J. Wang, "Determinants on the Selection of Rural Households' Financial Assets in China: Marketization or Financial Literacy?," *Journal of the Asia Pacific Economy*, 2024, https://doi.org/10.1080/13547860.2024.2424661.

Innovation and Opportunity Act (WIOA) mandates federal alignment with digital workforce training benchmarks[38]. While necessary, these frameworks illustrate that financial investment is insufficient in the absence of coherent legal governance that operationalizes education policies into enforceable labor outcomes. Findings from this study affirm the argument that emerging economies must go beyond fiscal interventions and embed legal protections into education reform efforts to narrow the digital divide and advance progress toward SDG 9 (Industry, Innovation, and Infrastructure) [39].

The continuing transformation of labor markets under the influence of Industry 5.0 necessitates robust legal safeguards to uphold employment stability, regulate fair wages, and ensure non-discriminatory access to job opportunities. Empirical data indicate a downward trend in unemployment across Indonesia, the European Union, and the United States between 2022 and 2024, suggesting increased labor market absorption[40]. However, a closer analysis reveals that Indonesia's labor force participation remains suboptimal due to structural skill mismatches, high rates of informal employment, and limited enforcement of labor rights. Juridically, the current statutory framework inadequately protects vulnerable labor segments, particularly gig workers, remote employees, and individuals displaced by automation. From a philosophical standpoint, this reflects a normative deficit in ensuring labor dignity and equity within technologically mediated

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[38] S.L. Náñez Alonso et al., "Cryptocurrency Mining from an Economic and Environmental Perspective. Analysis of the Most and Least Sustainable Countries," *Energies* 14, no. 14 (2021), https://doi.org/10.3390/en14144254; M. Festing, "Germany: Talent Development in Complex and Dynamic Environments: New Approaches in the Context of the German Business System," in *The Global Hum. Resource Management Casebook, Third Edition* (Taylor and Francis, 2023), 21–30, https://doi.org/10.4324/9781003307099-4.

[39] A.H. Jakiyudin and M. Cahyani, "Can Islamic Philanthrophic Institutions in Indonesia Achieve Sdgs? An Emipirical Legal Research," *Jurisdictie: Journal of Law and Sharia* 15, no. 2 (2024): 446–76, https://doi.org/10.18860/j.v15i2.29019.

[40] Jakiyudin and Cahyani, "Can Islamic Philanthrophic Institutions in Indonesia Achieve Sdgs?: An Emipirical Legal Research"; C. Mansour, N. Márquez-Grant, and M. Benito Sánchez, "Current Status of Forensic Anthropology in the Middle East and North Africa (MENA) Region," *Egyptian Journal of Forensic Sciences* 15, no. 1 (2025), https://doi.org/10.1186/s41935-025-00423-7.

employment structures. Sociologically, the persistence of legal inattention toward emerging forms of work perpetuates socio-economic inequality and institutional exclusion from the benefits of digital transformation[41].

In comparative terms, the European Union and the United States maintain stronger statutory protections for labor, underpinned by codified legal instruments that secure fair compensation, employment continuity, and structured reskilling frameworks. The European Pillar of Social Rights imposes enforceable mandates on equal remuneration and occupational safety for automation-impacted employees. At the same time, the Fair Labor Standards Act (FLSA) in the United States outlines wage standards, benefits entitlements, and unionization rights for digitally employed labor[42]. Nonetheless, both regions exhibit legal deficiencies in regulating AI-powered employment systems, including gaps in oversight of automated recruitment, predictive workforce analytics, and algorithmic job assignments[43]. Juridically, these lacunae points to the need for second-generation labor reforms that can encompass technologically augmented employment realities. Philosophically, this lag reflects a tension between innovation and ethical governance, while sociologically, it implies that even advanced economies

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41 R.P. Reveco, "Legal-Economic Incentives for Mining and Local Processing of Rare Earths," *Environmental Law Journal (Chile)* 1, no. 17 (2022): 129–56, https://doi.org/10.5354/0719-4633.2022.66408; N. Angrist et al., "Measuring Human Capital Using Global Learning Data," *Nature* 592, no. 7854 (2021): 403–8, https://doi.org/10.1038/s41586-021-03323-7; M.A. Esquivias et al., "Nexus between Technological Innovation, Renewable Energy, and Human Capital on the Environmental Sustainability in Emerging Asian Economies: A Panel Quantile Regression Approach," *Energies* 15, no. 7 (2022), https://doi.org/10.3390/en15072451.

42 O. Zyhrii et al., "Law and Technology: The Impact of Innovations on the Legal System and Its Regulation," *Social and Legal Studios* 6, no. 4 (2023): 267–75, https://doi.org/10.32518/sals4.2023.267; Reveco, "Legal-Economic Incentives for Mining and Local Processing of Rare Earths."

43 Milon et al., "An In-Depth PRISMA Based Review of Cybercrime in a Developing Economy: Examining Sector-Wide Impacts, Legal Frameworks, and Emerging Trends in the Digital Era".

remain vulnerable to uneven digital labor protections, particularly in marginalized labor segments[44].

The rapid integration of digital technologies under Industry 5.0 imperatives necessitates adaptive legal frameworks capable of managing workforce automation, safeguarding labor rights, and ensuring ethical deployment of AI in employment governance. According to current data, Indonesia's digital adoption rose from 30% to 40% between 2022 and 2024, while the European Union and the United States reached 75% and 78%, respectively[45]. Although this positive trend, Indonesia's legal infrastructure remains underdeveloped, with significant regulatory constraints, insufficient automation incentives, and infrastructural limitations that hinder deeper digital integration[46]. Juridically, the absence of a consolidated statutory framework for transitioning labor into AI-intensive industries exacerbates workers' vulnerability to wage suppression, occupational displacement, and structural exclusion. From a philosophical perspective, this reflects a broader failure to anchor innovation within a rights-based governance model. Sociologically, such legal deficiencies foster stratified labor markets where access to digital

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[44] Náñez Alonso et al., "Cryptocurrency Mining from an Economic and Environmental Perspective. Analysis of the Most and Least Sustainable Countries"; Festing, "Germany: Talent Development in Complex and Dynamic Environments: New Approaches in the Context of the German Business System."

[45] E.P. Alvarado and E. Kauffer, "Climate Policy in the Usumacinta River Basin (1992–2018)," *Regions and Cohesion* 13, no. 2 (2023): 79–104, https://doi.org/10.3167/reco.2023.130205; A. Ohonba and G.W. Akinola, "The Effect of Governance on Capital Flows in Sub-Saharan African Countries," *Journal of Infrastructure, Policy and Development* 7, no. 3 (2023), https://doi.org/10.24294/jipd.v7i3.2122.

[46] H.O. Goktas and N. Yumusak, "Applying the Delphi Method to Assess Critical Success Factors of Digitalization While Sustaining Lean at a Lean Automaker," *Sustainability (Switzerland)* 16, no. 19 (2024), https://doi.org/10.3390/su16198424; S. Zhang, X. Ma, and Q. Cui, "Assessing the Impact of the Digital Economy on Green Total Factor Energy Efficiency in the Post-COVID-19 Era," *Frontiers in Energy Research* 9 (2021), https://doi.org/10.3389/fenrg.2021.798922; M. Müller et al., "Citizen Science for the Sustainable Development Goals? The Perspective of German Citizen Science Practitioners on the Relationship between Citizen Science and the Sustainable Development Goals," *Citizen Science: Theory and Practice* 8, no. 1 (2023), https://doi.org/10.5334/cstp.583.

employment remains conditional upon privileged access to technology and protected legal status[47].

Contrastingly, the European Union has institutionalized digital labor governance through regulatory instruments such as the AI Act and the Digital Markets Act, which mandate compliance with human-centered oversight mechanisms in algorithmic hiring and performance evaluation[48]. Juridically, these measures establish enforceable obligations that reinforce accountability in technology-driven employment systems. The United States demonstrates leadership in AI workforce applications; nonetheless, it lacks cohesive federal statutes on AI employment practices, leaving a fragmented regulatory landscape at the state level[49]. This divergence illustrates that effective legal oversight remains essential for technological legitimacy and for preserving labor rights amid accelerated automation. From a sociological perspective, these regulatory

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47 A.A. Lashitew, M.L. Ross, and E. Werker, "What Drives Successful Economic Diversification in Resource-Rich Countries?," *World Bank Research Observer* 36, no. 2 (2021): 164–96, https://doi.org/10.1093/wbro/lkaa001; W.M. Al-ahdal et al., "Unveiling the Impact of Firm-Characteristics on Sustainable Development Goals Disclosure: A Cross-Country Study on Non-Financial Companies in Asia," *Borsa Istanbul Review* 24, no. 5 (2024): 916–33, https://doi.org/10.1016/j.bir.2024.05.003; M.T. Bahri, "Navigating Indonesia's Golden Visa Scheme Through Comparative Legal Policy Analysis," *International Comparative Jurisprudence* 9, no. 1 (2023): 92–110, https://doi.org/10.13165/j.icj.2023.06.007.

48 V. Sima et al., "Influences of the Industry 4.0 Revolution on the Human Capital Development and Consumer Behavior: A Systematic Review," *Sustainability (Switzerland)* 12, no. 10 (2020), https://doi.org/10.3390/SU12104035; Zyhrii et al., "Law and Technology: The Impact of Innovations on the Legal System and Its Regulation"; P. De Giovanni, "Sustainability of the Metaverse: A Transition to Industry 5.0," *Sustainability (Switzerland)* 15, no. 7 (2023), https://doi.org/10.3390/su15076079.

49 E.W. Ziemba et al., "Leveraging Artificial Intelligence to Meet the Sustainable Development Goals," *Journal of Economics and Management (Poland)* 46, no. 1 (2024), https://doi.org/10.22367/jem.2024.46.19; Y. Tsikalo et al., "Using Artificial Intelligence to Improve Tax Security and Control Over Tax Avoidance Schemes," *Journal of Theoretical and Applied Information Technology* 102, no. 23 (2024): 8530–42.

inconsistencies perpetuate geographic inequities in labor protection and weaken institutional trust in AI deployment[50].

This study underscores that legal frameworks regulating human capital investment must be recalibrated to explicitly align with the Sustainable Development Goals (SDGs), particularly in advancing inclusive workforce development, labor equity, and access to digital competency pathways[51]. The absence of harmonized AI labor governance and enforceable digital labor protections in Indonesia necessitates targeted statutory reform to enhance preparedness for Industry 5.0 transitions. The European Union's alignment with SDG 8 (Decent Work) and SDG 9 (Industry and Innovation) is embedded in its legislative infrastructure, demonstrating an integrated approach to digital workforce planning[52]. Conversely, the United States must reconcile its policy inconsistencies at the federal level to safeguard equitable employment practices in algorithmic contexts. Strengthening regulatory clarity, procedural transparency, and inter-sectoral legal coordination will be pivotal in fostering sustainable and ethically grounded labor transitions under digital capitalism.

The findings of this research reveal significant gaps in legal and policy structures related to human capital investment and labor protection in the context of Industry 5.0. Key deficiencies include the absence of standardized AI employment regulation, disjointed digital workforce policies, and limited institutional capacity for legal

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[50] M. Ahmad et al., "Financial Development and Environmental Degradation: Do Human Capital and Institutional Quality Make a Difference?" *Gondwana Research* 105 (2022): 299–310, https://doi.org/10.1016/j.gr.2021.09.012; Festing, "Germany: Talent Development in Complex and Dynamic Environments: New Approaches in the Context of the German Business System."

[51] De Giovanni, "Sustainability of the Metaverse: A Transition to Industry 5.0"; Zhang, Lee, and Choi, "Cyber-Physical Systems for Human Capital Development in Industry 5.0: Legal and Policy Considerations."

[52] R.L. Hannah, "Post-Employment Covenants in the United States: Legal Framework and Market Behaviours," *International Labour Review* 149, no. 1 (2010): 107–19, https://doi.org/10.1111/j.1564-913X.2010.00078.x; K.L. Whittingham et al., "The Impact of the United Nations Sustainable Development Goals on Corporate Sustainability Reporting," *BRQ Business Research Quarterly* 26, no. 1 (2023): 45–61, https://doi.org/10.1177/23409444221085585.

enforcement[53]. Juridically, these deficiencies represent a misalignment between existing labor law and the operational realities of a rapidly digitizing employment environment. While advanced economies such as the European Union and the United States have initiated partial reforms, emerging jurisdictions like Indonesia remain without a cohesive statutory model capable of managing the complexities of digital labor transformation[54]. From a philosophical standpoint, the challenge lies in ensuring that innovation does not outpace justice; sociologically, it is essential to protect labor inclusivity by safeguarding against technology-induced dislocation and ensuring equitable pathways for digital skill acquisition[55].

Regulatory institutions are pivotal in safeguarding employment stability amid the structural disruptions brought about by automation, algorithmic recruitment, and platform-mediated labor models[56]. Empirical findings indicate that Indonesia's legal infrastructure lacks cohesion in addressing the digital labor economy, resulting in statutory ambiguities and rising informality in employment relations[57]. Juridically, the absence of explicit legal definitions concerning gig work, AI-mediated workforce analytics, and enforceable digital labor contracts exacerbates income insecurity, precarious employment conditions, and

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53 L. Alfonsi et al., "Tackling Youth Unemployment: Evidence from a Labor Market Experiment in Uganda," *Econometrica* 88, no. 6 (2020): 2369–2414, https://doi.org/10.3982/ECTA15959; Andersén, "Resource Orchestration of Firm-Specific Human Capital and Firm Performance—the Role of Collaborative Human Resource Management and Entrepreneurial Orientation."

54 M.P.A. Crespillo and O.K. Antonova, "Interactive Didactics of Translation and Interpreting: Emotive Approach Applied to Migrant Care in German, Spanish, Arabic and Russian Languages," *European Public and Social Innovation Review* 10 (2025), https://doi.org/10.31637/epsir-2025-1187.

55 World Bank, *The Future of Work and Digital Transformation: Legal Frameworks for Sustainable Workforce Development* (World Bank Group, 2023).

56 A. Ali and M. Rahman, "Strengthening Labor Rights Protections in Automation-Driven Industries," *Journal of Labor Policy* 18, no. 2 (2024): 112–30.

57 K.K. Aggarwal and D. Taneja, "Impact of Organizational Culture on Employee Satisfaction, Motivation, Performance, Commitment, and Engagement in Educational Institutions," in *Build. Sustain. Human Resources Manag. Pract. for Bus.* (IGI Global, 2024), 204–15, https://doi.org/10.4018/979-8-3693-1994-9.ch012.

limited avenues for legal remediation[58]. Although Indonesia's National Medium-Term Development Plan (RPJMN) articulates a vision for digital workforce expansion, it remains aspirational, mainly without corresponding legal enforcement instruments or clearly delineated labor protections for technology-intensive occupations[59].

In contrast, the European Union has enacted progressive legal instruments through the European Pillar of Social Rights, which institutionalizes mandates on equal pay, algorithmic oversight in hiring, and labor protections in AI-based recruitment environments[60]. Complementing this, the Directive on Transparent and Predictable Working Conditions codifies specific guarantees for platform workers, including contract clarity and minimum labor standards, particularly relevant for gig-based and remote labor models[61]. Juridically, these frameworks embody a structured and enforceable approach to managing digital labor transformations[62]. The United States, while at the forefront of technological innovation, remains without a unified federal legal apparatus for AI employment governance, resulting in fragmented regulatory oversight at the state level[63]. Disparities in labor protections surrounding automated recruitment, digital identity protocols, and the taxation of remote labor generate systemic inconsistencies that compromise the security and cohesion of digital employment.

The proliferation of AI-enhanced workforce management systems, including automated hiring decisions and predictive labor

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58 Ali and Rahman, "Strengthening Labor Rights Protections in Automation-Driven Industries."

59 H.N. Feuer, "Geographical Indications out of Context and in Vogue: The Awkward Embrace of European Heritage Agricultural Protections in Asia," in *Geographical Indication and Global Agri-Food: Development and Democratization* (Taylor and Francis, 2019), 39–53, https://doi.org/10.4324/9780429470905-5.

60 Ziemba et al., "Leveraging Artificial Intelligence to Meet the Sustainable Development Goals."

61 K. Fahmi et al., "The Role of the Law in Safeguarding Electoral Democracy in Indonesia," *Journal of Legal, Ethical and Regulatory Issues* 22, no. 2 (2019).

62 Zyhrii et al., "Law and Technology: The Impact of Innovations on the Legal System and Its Regulation."

63 A.D. Ali et al., "Factors Affecting Remote Workers' Job Satisfaction in Utah: An Exploratory Study," *International Journal of Environmental Research and Public Health* 20, no. 9 (2023), https://doi.org/10.3390/ijerph20095736.

analytics, demands rigorous legal scrutiny to mitigate bias, ensure procedural fairness, and safeguard against involuntary job displacement[64]. Findings reveal persistent regulatory vacuums surrounding ethical AI use in employment, particularly in developing economies where labor protections remain fragile or under-enforced[65]. In Indonesia, juridical deficiencies include the absence of codified statutes on algorithmic bias detection, fairness audits for automated recruitment processes, and statutory labor rights within AI-mediated performance evaluation frameworks. These legislative omissions foster an environment of legal ambiguity, amplifying risks of data misuse, wage compression in gig-based employment, and systemic exclusion of digitally unskilled labor from formal workforce participation[66].

The European Union's AI Act constitutes one of the most advanced regulatory frameworks for AI employment governance, incorporating a risk-based classification model, mandatory human oversight in algorithmic decision-making, and enforceable fairness provisions for labor systems[67]. The Digital Services Act imposes legal obligations on corporate actors, reinforcing transparency and accountability in deploying AI for recruitment and workforce management[68]. Juridically, these measures represent proactive regulatory architecture aimed at curbing exploitation and ensuring algorithmic

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64 M. Faizin and W.A. Jafar, "Protecting Child Labor Rights: Maqasid Sharia Framework and Policy Recommendations," *Samarah* 8, no. 2 (2024): 1187–1215, https://doi.org/10.22373/sjhk.v8i2.24559.

65 Balachandran and Rabbiraj, "Artificial Intelligence: A Support System in Inclusive Education."

66 C.-E. Bănescu, E. Țițan, and D. Manea, "The Impact of E-Commerce on the Labor Market," *Sustainability (Switzerland)* 14, no. 9 (2022), https://doi.org/10.3390/su14095086.

67 I. Van Heerden and A. Bas, "Viewpoint: Ai as Author - Bridging the Gap between Machine Learning and Literary Theory," *Journal of Artificial Intelligence Research* 71 (2021): 175–89, https://doi.org/10.1613/JAIR.1.12593.

68 A. Ette, B. Heß, and L. Sauer, "Tackling Germany's Demographic Skills Shortage: Permanent Settlement Intentions of the Recent Wave of Labour Migrants from Non-European Countries," *Journal of International Migration and Integration* 17, no. 2 (2015): 429–48, https://doi.org/10.1007/s12134-015-0424-2.

integrity[69]. Nonetheless, the lack of full legal harmonization across EU member states leads to regulatory discrepancies that hinder seamless cross-border labor integration[70]. In contrast, the United States continues to operate without a comprehensive federal statute governing AI employment, granting private corporations' significant latitude in algorithmic governance. Although certain states, such as California, Illinois, and New York, have enacted partial AI compliance laws, a cohesive national legal framework remains conspicuously absent[71].

Integrating human capital investment legislation with the Sustainable Development Goals (SDGs) remains a strategic imperative for achieving inclusive and equitable workforce expansion. Research findings point to persistent regulatory inefficiencies, particularly in digital labor law, education policy alignment, and wage protections, obstructing meaningful progress toward SDG 8 (Decent Work) and SDG 9 (Industry, Innovation, and Infrastructure)[72]. In Indonesia, delays in codifying AI labor legislation, the absence of structured programs for automation reskilling, and weak statutory enforcement of digital wage standards perpetuate labor market fragmentation[73]. While the European Union has advanced significantly in embedding SDG principles into workforce policy, it continues to face challenges in resolving intra-regional skill disparities and harmonizing regulatory frameworks[74]. In the United States, legal fragmentation across states in regulating AI

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[69] S.A. Aljudaibi and Y.J. Amuda, "Legal Framework Governing Consumers' Protection in Digital Banking in Saudi Arabia," *Journal of Infrastructure, Policy and Development* 8, no. 8 (2024), https://doi.org/10.24294/jipd.v8i8.5453.

[70] Ziemba et al., "Leveraging Artificial Intelligence to Meet the Sustainable Development Goals."

[71] Hannah, "Post-Employment Covenants in the United States: Legal Framework and Market Behaviours."

[72] V. Denhere, "Does Board Gender Diversity Influence SDGs Disclosure? Insight from Top 15 JSE-Listed Mining Companies," *Journal of Risk and Financial Management* 17, no. 10 (2024), https://doi.org/10.3390/jrfm17100429.

[73] Bănescu, Țițan, and Manea, "The Impact of E-Commerce on the Labor Market."

[74] Arowosegbe, "Before We Forget Its Horrors: When Does Human Genome Editing Not Become Eugenics?"

employment undermines the universality of labor protections and jeopardizes access to fair and inclusive digital work environments[75].

The sustainability of workforce development strategies in Industry 5.0 hinges on the ability of legal frameworks to embed AI ethics, promote digital skills acquisition, and uphold equitable labor protections through cohesive regulatory governance[76]. Juridically, this entails codifying principles of algorithmic transparency, non-discrimination, and employee consent into enforceable law. In addition, fostering robust public–private partnerships, enhancing legal transparency, and harmonizing cross-sector workforce regulations are crucial to facilitating socially just digital transitions[77]. Looking ahead, legal reform agendas must prioritize the institutionalization of AI risk mitigation mechanisms, the advancement of transnational regulatory cooperation, and the strengthening of statutory labor rights in digital employment ecosystems that increasingly transcend national boundaries[78].

The legal architecture underpinning human capital investment and workforce sustainability in the Industry 5.0 era presents a dual reality of systemic challenges and transformative opportunities[79]. Empirical evidence indicates that inconsistent regulatory enforcement, the absence of comprehensive AI employment legislation, and limited support for labor transition mechanisms obstruct effective digital integration[80].

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75 Milon et al., "An In-Depth PRISMA Based Review of Cybercrime in a Developing Economy: Examining Sector-Wide Impacts, Legal Frameworks, and Emerging Trends in the Digital Era"; Han and Wang, "Determinants on the Selection of Rural Households' Financial Assets in China: Marketization or Financial Literacy?"

76 Gusliana et al., "Garantizar La Equidad y La Transparencia En El Deporte Mediante El Respeto de Los Principios Jurídicos y Las Normas Éticas."

77 G. Murewanhema et al., "Commercial Sexual Exploitation of Children in Zimbabwe: A Threat to Human and Social Development," *Child Abuse Review* 32, no. 2 (2023), https://doi.org/10.1002/car.2794; Alvarado and Kauffer, "La Politique Climatique Dans Le Bassin Versant Du Fl Euve Usumacinta (1992-2018)."

78 Ali and Rahman, "Strengthening Labor Rights Protections in Automation-Driven Industries."

79 Aljudaibi and Amuda, "Legal Framework Governing Consumers' Protection in Digital Banking in Saudi Arabia."

80 E. Aydin et al., "Technological Advancements and Organizational Discrimination: The Dual Impact of Industry 5.0 on Migrant Workers," *Administrative Sciences* 14, no. 10 (2024): 5, https://doi.org/10.3390/admsci14100240.

Juridically, existing legal frameworks must evolve to accommodate algorithmically mediated employment systems, enable digital reskilling infrastructure, and safeguard rights during automation-induced job shifts. While the European Union and the United States have advanced AI governance through incremental legal reforms, Indonesia's statutory underdevelopment remains a critical barrier to building a resilient and inclusive digital labor force[81].

Artificial intelligence redefines employment structure and governance by automating recruitment processes, monitoring employee performance, and shaping wage-setting practices[82]. Findings suggest that Indonesia remains without a dedicated legislative framework for AI employment, producing regulatory ambiguity, heightened exposure to algorithmic bias, and fragmented oversight in workforce management systems. Juridically, this lacuna permits employers to exercise unchecked discretion over AI-powered analytics without legal obligations for transparency or worker protection[83]. The absence of statutory controls opens space for potential labor rights violations, algorithm-driven wage compression, and discriminatory hiring patterns. Sociologically, such regulatory insufficiency disproportionately affects gig and platform-based workers, reinforcing job insecurity and exacerbating labor market inequalities in digitally mediated sectors[84].

The European Union has emerged as a regulatory frontrunner in AI employment governance by enacting the AI Act, which imposes stringent compliance obligations on employers deploying algorithmic

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[81] B. Baqai et al., "Religious Identity Discrimination in the Physician Workforce: Insights from Two National Studies of Muslim Clinicians in the US," *Journal of General Internal Medicine* 38, no. 5 (2023): 1167–74, https://doi.org/10.1007/s11606-022-07923-5.

[82] Aljudaibi and Amuda, "Legal Framework Governing Consumers' Protection in Digital Banking in Saudi Arabia."

[83] Aydin et al., "Technological Advancements and Organizational Discrimination: The Dual Impact of Industry 5.0 on Migrant Workers."

[84] S. Dwiono, A.K. Ja'far, and S. Haryadi, "An Analysis on the Omnibus Law and Its Challenges in Indonesia: The Perspectives of the Constitutional and the Islamic Law," *Samarah* 8, no. 2 (2024): 706–25, https://doi.org/10.22373/sjhk.v8i2.22720.

systems[85]. This legislative framework mandates algorithmic explainability, human oversight in high-risk AI applications, and periodic risk assessments to ensure procedural integrity and labor accountability[86]. Juridically, the AI Act institutionalizes safeguards that operationalize ethical standards in digital labor practices[87]. However, uneven implementation across EU member states continues to generate regulatory inconsistencies, particularly in the context of cross-border labor mobility and corporate compliance. In comparison, despite its technological prowess, the United States still lacks a centralized federal AI employment regime, leading to a patchwork of state-level laws that provide fragmented and uneven protection for digital workers[88].

Workforce automation is a core attribute of Industry 5.0, compelling legal systems to balance labor protection with the imperative of digital skill adaptation[89]. Research findings highlight Indonesia's acute digital skills gap, compounded by insufficient legal incentives for private sector engagement in reskilling efforts. The National Digital Talent Development Framework, while conceptually aligned with future labor needs, remains under-resourced and lacks statutory enforceability[90]. Juridically, the fragmented legal foundation supporting AI-related workforce development fails to mandate automation training or provide structured assistance to displaced labor. Sociologically, the absence of a state-backed transition mechanism intensifies skill-based inequality,

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85 Ziemba et al., "Leveraging Artificial Intelligence to Meet the Sustainable Development Goals."

86 Aggarwal and Taneja, "Impact of Organizational Culture on Employee Satisfaction, Motivation, Performance, Commitment, and Engagement in Educational Institutions."

87 G. Masik, I. Sagan, and J.W. Scott, "Smart City Strategies and New Urban Development Policies in the Polish Context," *Cities* 108 (2021), https://doi.org/10.1016/j.cities.2020.102970.

88 A. Calabrò et al., "The Role of Human Capital on Family Firm Innovativeness: The Strategic Leadership Role of Family Board Members," *International Entrepreneurship and Management Journal* 17, no. 1 (2021): 261–87, https://doi.org/10.1007/s11365-020-00657-y.

89 L. Li, "Reskilling and Upskilling the Future-Ready Workforce for Industry 4.0 and Beyond," *Information Systems Frontiers* 26, no. 5 (2024): 1697–1712, https://doi.org/10.1007/s10796-022-10308-y.

90 Ziemba et al., "Leveraging Artificial Intelligence to Meet the Sustainable Development Goals."

limiting upward mobility for workers marginalized by technological restructuring[91].

The European Union has reinforced its legal infrastructure for managing workforce automation through instruments such as the Just Transition Mechanism, which allocates financial support for retraining employees displaced by AI-driven transformations[92]. The Digital Skills and Jobs Coalition also advances systematic upskilling initiatives bolstered by legal mandates obligating corporate participation in workforce automation preparedness[93]. Juridically, this reflects a rights-based approach to labor adaptation that places public and private actors under defined legal duties[94]. Nevertheless, persistent digital skill disparities, particularly within lower-income member states, highlight the sociological challenge of policy uniformity across a heterogeneous labor market. In contrast, the United States relies heavily on market-led digital training programs, lacking federal legislative backing, yield inconsistent and often inequitable outcomes across state jurisdictions[95].

Equitable integration into the Industry 5.0 workforce necessitates legal regimes prioritizing digital skill development, governing AI-based employment systems, and institutionalizing universal labor protections[96]. The findings underscore the urgent need for Indonesia to reform its statutory frameworks to align with SDG 8 (Decent Work) and SDG 9 (Industry, Innovation, and Infrastructure), particularly through enforceable automation reskilling mandates, transparent algorithmic employment regulations, and labor rights guarantees[97]. The European

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91 De Giovanni, "Sustainability of the Metaverse: A Transition to Industry 5.0."

92 Thompson and Lewis, "Enhancing Public-Private Partnerships for Digital Skills Training and Workforce Reskilling."

93 Y. Kim, J. Park, and S. Lee, "AI-Driven Workforce Analytics and Legal Considerations for Human Capital Investment," *AI & Society* 39, no. 1 (2024): 55–72.

94 Zhang, Lee, and Choi, "Cyber-Physical Systems for Human Capital Development in Industry 5.0: Legal and Policy Considerations," 5.

95 Whittingham et al., "The Impact of the United Nations Sustainable Development Goals on Corporate Sustainability Reporting."

96 Li, "Reskilling and Upskilling the Future-Ready Workforce for Industry 4.0 and Beyond," 5.

97 Ștefoni, Popescu, and Ionescu, "Economic Development within Underground Economies: Implications for Informal Labor Market Regulations."

Union's AI Act and Digital Services Act exemplify legislative alignment between digital transformation and social protection imperatives[98]. Meanwhile, the United States must address critical federal AI workforce governance gaps to forestall deepening inequalities and ensure equitable access to digital employment across demographic and geographic divisions[99].

The analysis reinforces the imperative that labor law reform must be integrally connected with digital governance strategies to establish a sustainable, equitable, and inclusive Industry 5.0 workforce[100]. Juridically, this entails aligning national legal systems with emerging global standards on algorithmic fairness, data accountability, and digital labor rights. Advancing multistakeholder regulatory partnerships, adopting internationally recognized AI employment protocols, and institutionalizing ethical labor principles will be central to accelerating coherent legal transformation. Looking ahead, reform agendas should emphasize cross-border interoperability in AI workforce governance, synchronized automation training mandates, and robust compliance mechanisms to safeguard worker welfare within globalized digital employment systems[101].

The transition to Industry 5.0 necessitates the development of forward-looking legal innovations, stringent regulatory enforcement, and the harmonization of transnational labor policies to protect employment rights, advance inclusive participation, and ensure resilient human capital formation[102]. The study finds that fragmented legal

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98 G. Chehbouni, "Assessing the Alignment and Implementation Challenges of The Sustainable Development Goals (Sdgs) 2030 In Morocco: A Relevant Inquiry," *Journal of Sustainable Development Law and Policy* 15, no. 2 (2024): 186–223, https://doi.org/10.4314/jsdlp.v15i2.8.

99 Ziemba et al., "Leveraging Artificial Intelligence to Meet the Sustainable Development Goals."

100 F. Alfawaire and T. Atan, "The Effect of Strategic Human Resource and Knowledge Management on Sustainable Competitive Advantages at Jordanian Universities: The Mediating Role of Organizational Innovation," *Sustainability (Switzerland)* 13, no. 15 (2021), https://doi.org/10.3390/su13158445.

101 Alfonsi et al., "Tackling Youth Unemployment: Evidence From a Labor Market Experiment in Uganda."

102 Tu, Zhang, and Liu, "Sustainable Development through the Sharing Economy: Legal Implications of Digital Labor Markets."

strategies toward AI-based employment, the absence of centralized workforce legislation, and unequal digital skills infrastructure pose substantive threats to labor market coherence, wage equity, and job security. While the European Union offers a relatively mature governance model through its AI and digital labor directives, Indonesia and the United States must expand their legal frameworks to comprehensively address the multidimensional challenges of labor transformation in the age of intelligent automation[103].

As AI-driven automation reshapes the contours of labor markets, legal innovation must incorporate comprehensive safeguards for algorithmic accountability, transparent wage regulation, and ethical oversight in machine-learning-based recruitment systems[104]. Findings indicate that Indonesia's absence of national legislation governing AI labor practices enables the unregulated deployment of algorithmic tools in employment decision-making. Juridically, this void permits unchecked private-sector discretion, undermining the protective function of labor law. Without legally mandated AI audit protocols or anti-discrimination mechanisms, the risks of opaque hiring, predictive wage suppression, and algorithmic exclusion escalate, particularly within automation-intensive sectors, thereby intensifying structural labor inequalities and weakening social cohesion[105].

The European Union's AI Act establishes groundbreaking regulatory standards by obligating organizations to perform algorithmic fairness assessments, conduct bias audits, and classify AI systems based on employment-related risk levels[106]. Juridically, these requirements formalize the integration of ethical labor principles into algorithmic governance, thereby reducing the likelihood of automated exclusion

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[103] Kim, Park, and Lee, "AI-Driven Workforce Analytics and Legal Considerations for Human Capital Investment."

[104] B. Helaudho, S. Mukhtar, and I. Pahala, "Optimizing Performance: The Role of Job Rotation in Employee Motivation and Satisfaction," *Pakistan Journal of Life and Social Sciences* 22, no. 1 (2024): 5532–42, https://doi.org/10.57239/PJLSS-2024-22.1.00408.

[105] Aydin et al., "Technological Advancements and Organizational Discrimination: The Dual Impact of Industry 5.0 on Migrant Workers."

[106] Brynjolfsson and McAfee, *Machine, platform, crowd: Harnessing our digital future*.

from employment[107]. However, persistent disparities in implementing AI regulations across EU member states create coordination challenges, especially for multinational corporations managing transnational digital workforces. In contrast, although the United States remains at the frontier of AI development, the absence of a unified federal AI workforce statute generates significant variations in digital labor protections and leaves many workers without consistent legal safeguards[108].

Digitalizing labor processes raises complex regulatory issues related to AI-augmented employment contracts, transparency in algorithmically determined remuneration, and ethical frameworks for automated labor management[109]. Findings reveal that Indonesia's current labor legislation inadequately aligns with the demands of Industry 5.0, particularly in recognizing the legality of remote digital employment and AI-mediated contractual relationships[110]. Juridically, the absence of statutory instruments mandating employer responsibilities in funding workforce reskilling and supporting intersectoral mobility hinders effective labor adaptation[111]. As a result, workers face limited opportunities for structured career transitions, reducing their resilience against technology-induced disruptions and undermining the state's obligation to ensure decent work[112].

In contrast, the European Union has enacted binding obligations requiring employer compliance with AI-oriented workforce transition strategies, including mandates for digital retraining, proactive labor inclusion measures, and facilitation of mobility into emerging

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[107] Zyhrii et al., "Law and Technology: The Impact of Innovations on the Legal System and Its Regulation."

[108] Aydin et al., "Technological Advancements and Organizational Discrimination: The Dual Impact of Industry 5.0 on Migrant Workers."

[109] Ziemba et al., "Leveraging Artificial Intelligence to Meet the Sustainable Development Goals."

[110] Kim, Park, and Lee, "AI-Driven Workforce Analytics and Legal Considerations for Human Capital Investment."

[111] Aljudaibi and Amuda, "Legal Framework Governing Consumers' Protection in Digital Banking in Saudi Arabia."

[112] Ali and Rahman, "Strengthening Labor Rights Protections in Automation-Driven Industries."

technological roles[113]. The EU's Digital Skills Framework is a juridical foundation for lifelong learning policies, institutionalizing AI-focused training across industrial sectors[114]. Nonetheless, persistent mismatches in digital competencies, especially in under-resourced regions, constrain equitable readiness for Industry 5.0 participation. Meanwhile, the United States lacks a federal legislative mandate on workforce digital transition, delegating training responsibilities to private-sector actors. This regulatory gap results in inconsistent adaptation efforts across states and sectors, thereby reinforcing unequal access to digital career pathways[115].

Equitable integration into the Industry 5.0 workforce necessitates legal frameworks that center on digital skill development, transparent algorithmic governance, and enforceable universal labor protections[116]. Research indicates that Indonesia must undertake substantive legal reform to operationalize its commitments to SDG 8 (Decent Work) and SDG 9 (Industry, Innovation, and Infrastructure), particularly by enacting statutes for structured reskilling, AI employment transparency, and protection of worker rights across digital sectors[117]. The European Union's legislative instruments, including the AI Act and Digital Services Act, serve as significant advancements in aligning digital labor transitions with social protection mandates[118]. The absence of a federal AI workforce

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[113] Wang, Li, and Zhou, "The Role of Big Data Analytics in Human Capital Management: A Legal Perspective."

[114] Li, "Reskilling and Upskilling the Future-Ready Workforce for Industry 4.0 and Beyond."

[115] Tu, Zhang, and Liu, "Sustainable Development through the Sharing Economy: Legal Implications of Digital Labor Markets."

[116] Balachandran and Rabbiraj, "Artificial Intelligence: A Support System in Inclusive Education."

[117] L.E. Valdez-Juárez and D. García Pérez-de-Lema, "Creativity and the Family Environment, Facilitators of Self-Efficacy for Entrepreneurial Intentions in University Students: Case ITSON Mexico," *International Journal of Management Education* 21, no. 1 (2023), https://doi.org/10.1016/j.ijme.2023.100764.

[118] Thompson and Lewis, "Enhancing Public-Private Partnerships for Digital Skills Training and Workforce Reskilling."

statute in the United States continues to widen gaps in digital labor equity, making comprehensive national reform increasingly urgent[119].

Findings from this study reinforce the conclusion that sustainable, inclusive, and ethically sound workforce integration into Industry 5.0 can only be achieved through the deliberate convergence of labor law reform and digital governance policies. Juridically, cross-sector collaboration must be formalized through legal instruments that codify shared responsibilities between governments, private enterprises, and educational institutions. The adoption of internationally consistent AI employment standards and robust ethical frameworks can serve as accelerators for legislative innovation. Future legal reforms should prioritize interoperable AI labor governance, synchronized transnational automation training, and multilateral agreements on fair digital labor practices to ensure global coherence[120].

The broader transition into the Industry 5.0 paradigm necessitates the formulation of comprehensive legal innovations, enhanced regulatory enforcement mechanisms, and cross-border harmonization of workforce policies to protect employment rights and foster inclusive participation in technologically advanced labor markets. Findings underscore that fragmented regulatory responses, particularly the lack of national AI labor statutes and unbalanced digital skills frameworks, contribute to vulnerability in distribution, labor market stability, and long-term job security. The European Union's integrated digital labor governance offers a robust comparative model, while both Indonesia and the United States are called upon to expand and deepen their legislative architectures to adequately address the multifaceted labor challenges emerging from Industry 5.0 transformations[121].

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[119] G. Murewanhema et al., "Commercial Sexual Exploitation of Children in Zimbabwe: A Threat to Human and Social Development," *Child Abuse Review* 32, no. 2 (2023), https://doi.org/10.1002/car.2794; Alvarado and Kauffer, "Climate Policy in the Flu Euve Usumacinta Watershed (1992-2018)."

[120] Nelson et al., "A Governance and Legal Framework for Getting to 'Yes' with Enterprise-Level Data Integration," 2024; Patel, Sharma, and Lewis, "Blockchain Technologies for Secure and Transparent Workforce Management."

[121] Triana, Turistiati, and Monk, "Alternative Dispute Resolution in Marine Pollution: Advancing Ecological Justice through the Polluter Pays Principle"; Allouzi and Alomari, "Adequate Legal Rules in Settling Metaverse Disputes: Hybrid Legal Framework for Metaverse Dispute Resolution (HLFMDR)."

As AI-driven automation continues to reshape employment ecosystems, regulatory innovation must institutionalize mechanisms for algorithmic accountability, safeguard against wage manipulation through predictive systems, and enforce ethical oversight in AI-based recruitment processes. Evidence suggests that Indonesia lacks a coherent national legal framework governing AI in labor relations, which enables private firms to deploy algorithmic hiring tools without external audit or compliance obligations. Juridically, this legal void fosters unregulated practices that risk exacerbating discrimination, opaque wage-setting, and exclusion from digital employment pathways. Such systemic vulnerabilities are particularly acute in automation-intensive sectors, where the absence of statutory protections amplifies socio-economic disparities[122].

The European Union's AI Act exemplifies a regulatory breakthrough by mandating algorithmic fairness evaluations, bias detection audits, and classification protocols for AI systems used in employment decisions. These juridical safeguards help align technological advancement and labor ethics, reinforcing human oversight and preventing algorithmic exclusion from job opportunities. However, practical implementation remains uneven across EU member states, creating inconsistencies in governance and complicating compliance for multinational employers managing distributed digital labor. In contrast, despite its leadership in AI innovation, the United States continues to lack a national AI labor statute, resulting in state-by-state variability that leaves many digital workers without uniform legal protection[123].

The widespread digitalization of work introduces novel legal challenges, including regulating AI-mediated labor contracts, ensuring

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[122] S.E. Ştefoni, I.V. GoodȘoveanu, and N. Cristache, "Advances in Economic Development through Control of the Underground Economy," *Sustainability (Switzerland)* 16, no. 19 (2024), https://doi.org/10.3390/su16198286; Arowosegbe, "Before We Forget Its Horrors: When Does Human Genome Editing Not Become Eugenics?"

[123] Milon et al., "An In-Depth PRISMA Based Review of Cybercrime in a Developing Economy: Examining Sector-Wide Impacts, Legal Frameworks, and Emerging Trends in the Digital Era"; Han and Wang, "Determinants on the Selection of Rural Households' Financial Assets in China: Marketization or Financial Literacy?"

wage transparency in algorithmic pay structures, and constructing ethical oversight frameworks for automated workforce management. Current findings reveal that Indonesia's labor legislation remains inadequately attuned to these Industry 5.0 imperatives. Juridical gaps persist in recognizing remote digital employment as formal labor, codifying AI-mediated contractual obligations, and incentivizing cross-sector upskilling. Moreover, the absence of legally mandated provisions for employer-supported reskilling severely hampers the capacity of workers to navigate career transitions, thereby diminishing national labor adaptability in the face of ongoing digital disruptions[124].

The European Union has taken a proactive stance by mandating employer compliance with AI-driven workforce transition strategies, including obligations to facilitate digital retraining, prevent exclusion from emerging job sectors, and enable structured mobility into AI-integrated roles. The Digital Skills Framework provides a legal scaffold for continuous, industry-aligned workforce education. Nevertheless, persistent mismatches between vocational curricula and AI-driven labor demands continue to impede equitable workforce preparedness across EU member states. Conversely, the United States lacks a cohesive federal framework for workforce transition in the context of automation, placing the onus on private-sector entities to develop retraining programs. This decentralized approach has produced uneven levels of digital labor adaptation and contributed to structural inequities in Industry 5.0 participation[125].

Equity in the Industry 5.0 workforce can only be achieved through legal frameworks that embed digital skills development, comprehensive regulation of AI-mediated employment models, and universal guarantees of labor protection. Based on the study's findings, Indonesia must reform its regulatory architecture to fulfill its commitments to SDG 8 and SDG 9 through legally structured automation reskilling mandates, transparent algorithmic employment provisions, and the enforceability of labor

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[124] A. Froehlich, D.A. Amante Soria, and E. De Marchi, "Argentina," in *Stud. Space Policy*, vol. 25 (Springer, 2020), 145–84, https://doi.org/10.1007/978-3-030-38520-0_6.

[125] Murewanhema et al., "Commercial Sexual Exploitation of Children in Zimbabwe: A Threat to Human and Social Development"; Alvarado and Kauffer, "La Politique Climatique Dans Le Bassin Versant Du Fl Euve Usumacinta (1992-2018)."

rights in digital sectors. The European Union's AI and Digital Services Act offers an integration model between technology regulation and social protection policies. Meanwhile, the United States must confront its fragmented approach to AI employment governance to mitigate the growing risk of digital labor stratification and exclusion[126].

The findings underscore that future legal and policy reforms must explicitly integrate SDG-oriented workforce protections to establish ethical, inclusive, and resilient labor systems in the Industry 5.0 era. The absence of formalized SDG-aligned transition laws in Indonesia compromises labor resilience and hampers the regulatory response to automation-induced employment restructuring. The European Union, while relatively advanced in this domain, must continue refining policy implementation across regional labor markets to address intra-EU disparities. The United States, in turn, must strengthen its legal infrastructure for workforce sustainability, ensuring that AI employment governance adheres to principles of equity, transparency, and accountability as envisioned in SDG 10 (Reduced Inequalities). These multi-scalar challenges reaffirm the urgency of legal transformation as a precondition for human-centered digital development.

Conclusion

The study concludes while the European Union has established comprehensive AI workforce policies, regulatory inconsistencies among member states complicate uniform implementation. Indonesia and the United States lack structured federal legal frameworks to regulate AI-driven employment models and facilitate digital workforce adaptation, creating vulnerabilities in labor protections and widening skill gaps. The study advances theoretical discourse by integrating AI employment law, workforce digitalization policies, and SDG-aligned labor governance, offering empirical insights that inform policymakers and industry leaders on equitable workforce transitions. The broader implications emphasize

[126] Milon et al., "An In-Depth PRISMA Based Review of Cybercrime in a Developing Economy: Examining Sector-Wide Impacts, Legal Frameworks, and Emerging Trends in the Digital Era"; Balachandran and Rabbiraj, "Artificial Intelligence: A Support System in Inclusive Education."

the necessity of cross-border legal harmonization, ethical AI workforce regulation, and SDG-driven labor protections to mitigate automation-induced job displacement and structural unemployment. Future research should expand on global AI workforce governance models, analyze the long-term socioeconomic effects of Industry 5.0 labor transformations, and develop standardized policy frameworks that ensure inclusive and sustainable digital employment ecosystems.

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