

Shaping Human Capital Standards: Exploring the Intersections of the Future of Work and Artificial Intelligence



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Founded in 2017 by Professor Tania Saba, BMO Chair in Diversity and Governance at the University of Montreal is an interdisciplinary center of excellence for research and training on the theme of "living together." The objective of the Chair is to stimulate reflection on issues of equity and governance by studying the effects of changes in a constantly evolving world on work relations, individuals and organizations. The Chair's publications and media interventions reflect its commitment to improving working conditions and organizational practices and to influencing public policy. The Chair is associated with research centers such as Obvia, CRIMT, CERUM, the Diversity Institute at Toronto Metropolitan University and the Future Skills Centre. It represents the Quebec pole and Francophone communities in the federal government's Women Entrepreneurship Knowledge Hub (WEKH) project.



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Background

This report explores the evolving landscape of sustainable finance, shaped by the growing integration of social considerations into global financial systems. Central banks are increasingly prioritizing climate-related risks and biodiversity loss in their decision-making processes, aligning with international agreements such as the Paris Agreement (2015) and the Kunming-Montreal Accord (2022). At the same time, investors demand reliable and comprehensive financial and non-financial information to effectively assess sustainability risks and opportunities. Central to this ecosystem is the IFRS Foundation, tasked with establishing international accounting and sustainability standards to support transparent and decision-useful reporting. Collectively, these efforts aim to create a sustainable financial system capable of addressing global challenges while meeting the evolving needs of financial stakeholders.

The report highlights the critical intersections between sustainable jobs, technological advancements, and a fair economy, emphasizing the need to integrate social dimensions into financial systems. It anticipates the challenges and opportunities organizations will face as they align with global sustainability standards, particularly those set by the International Sustainability Standards Board (ISSB). These standards prioritize transparency and the disclosure of relevant information to guide decision-making, providing a framework for organizations to remain competitive while pursuing global sustainability goals. However, social dimensions continue to lag in terms of well-defined frameworks and indicators, unlike environmental standards, which are more clearly established.

The evolving role of human capital amid technological advances, particularly artificial intelligence (AI), is a central focus of this report. The transformative potential of AI offers opportunities to boost productivity and innovation, while reshaping how organizations leverage skills and talent. To capitalize on these benefits, organizations must invest in skills development, retraining, and workforce adaptability to meet the demands of AI-driven processes. Such efforts are essential for fostering sustainable jobs that promote long-term resilience and inclusivity.

This report seeks to identify and analyze critical dimensions relevant to policymakers and investors at the intersection of work, sustainability, and AI. It examines how human capital elements—such as skills, knowledge, access to resources, diversity, and collective capabilities—can be integrated into sustainability frameworks. It also addresses the risks and uncertainties posed by AI, particularly its potential to transform the use of skills within organizations, creating both opportunities and challenges.

As part of a broader project, this report represents the initial stage of a reflection on defining global disclosure standards for sustainability. It emphasizes the inclusion of workforce-related measures, including skills, diversity, and job quality. Additionally, it aims to develop frameworks for assessing employee engagement, well-being, and collective capabilities, while accounting for the risks and opportunities associated with automation and AI-driven transformations.

Aligning Financial Systems with Sustainability: Central Banks, Investors, and IFRS Standards



Methodological Approach

This report aims to identify and analyze the key dimensions most relevant to policymakers and investors in the interconnected areas of labor, sustainability, and artificial intelligence (AI). To do so, we consulted databases of international, Canadian and European institutions known for influential research in these fields. Specifically, we examined the resources of the Organisation for Economic Co-operation and Development (OECD), the International Labour Organization (ILO), the International Monetary Fund (IMF) and the World Economic Forum (WEF). Canadian institutions such as the Diversity Institute and the Future Skills Centre were also included, alongside European entities such as Eurofound, the European Commission, the European Parliament and the *Confédération française de l'encadrement - Confédération générale des cadres* (CFE-CGC). These organizations were selected on the basis of their established credibility and the relevance of their research to policy formulation and investment strategy.

Our analysis began by identifying the dimensions explicitly associated with human capital in the selected reports. These dimensions encompass key areas such as skills, knowledge, access to resources, inequalities, diversity and collective capabilities. Once these core elements identified, we carried out an in-depth assessment of each dimension to evaluate its implications in terms of risks, opportunities and uncertainties. This framework enabled us not only to uncover sector-specific insights, but also to examine broader trends at the intersection of AI, sustainability and workforce development. The findings were then categorized and aggregated to highlight recurring patterns, ensuring that the results are directly aligned with the priorities of policymakers and investors as they face complex global challenges.

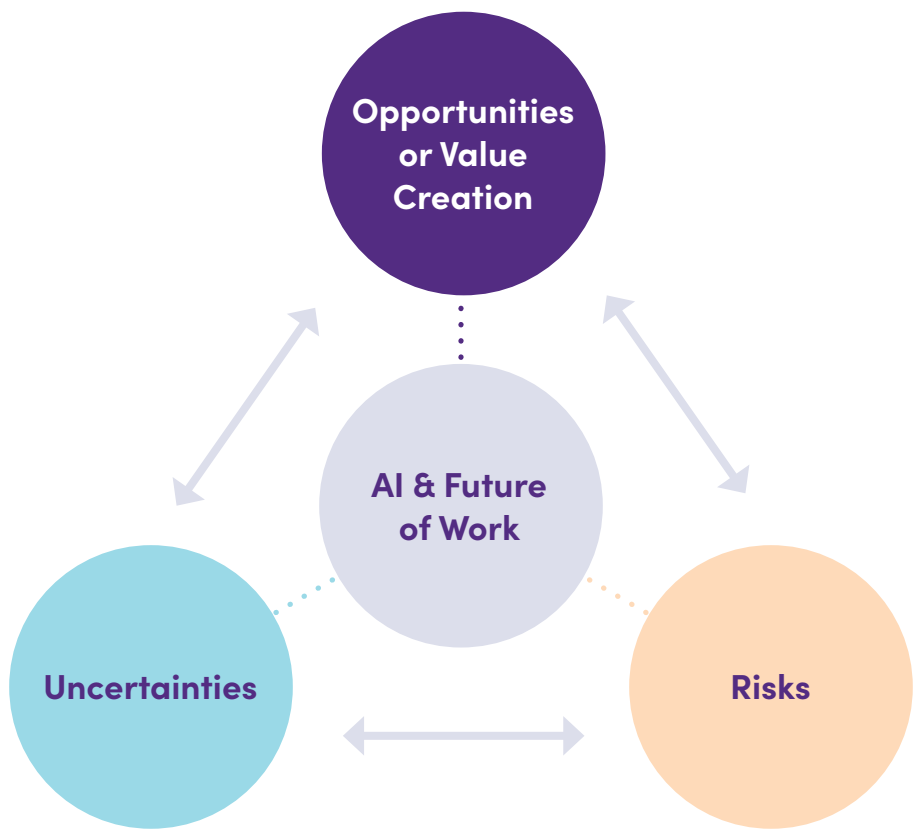
To facilitate data collection, we used the search engines provided on these institutions' websites to locate relevant reports and publications. Our systematic search used targeted English keywords, including "work", "future of work", "artificial intelligence", "technology", "human capital", "sustainability", "workers' rights", "diversity", "green transition", "environment" and "policy". This all-encompassing approach enabled us to gather a wide range of viewpoints and trends relevant to our objectives.

Given the rapid evolution of AI, sustainability and workforce issues, we focused on the most recent reports to ensure their currency and relevance. The analysis was limited to publications from 2022 to 2024, with the majority of reports published in 2024. Our final dataset consists of 31 reports: 17 from the OECD (including four co-authored reports - two with UNESCO, one with the Inter-American Development Bank and one with the International Trade Centre), five from the ILO, two from the IMF, two from the Future Skills Centre, and one from each of the WEF, Eurofound, the European Commission, the European Parliament and CFE-CGC.

AI and the Future of Work: Challenges in Human Capital Development

The analysis of human capital components involves considering opportunities, risks, and uncertainties that come with technological advancements, particularly artificial intelligence (AI). AI has the potential to reshape how skills and talents are utilized in organizations, creating opportunities such as the increase of productivity and the development of new skill sets. At the same time, it introduces risks like job polarization and challenges related to inclusivity. The uncertainties tied to the rapid pace of technological change and shifting market demands add further complexity. By examining these factors, organizations can better understand the evolving role of human capital in an increasingly AI-driven environment.

AI and the Future of Work: Balancing Opportunities, Risks, and Uncertainties



How is Human Capital Being Redefined in the Age of Artificial Intelligence?

In his 1964 seminal work, Becker defined human capital as the skills, knowledge, experience, and abilities that enhance individual productivity and economic potential. He emphasized that investments in education, training, health, and mobility are as critical as investments in physical capital for fostering innovation and driving economic growth.

Over time, the concept of human capital has evolved, as identified through our analysis, to encompass a range of dimensions that reflect the diverse needs of modern economies. Foundational elements like skills and knowledge, acquired through formal education, professional training, and experiential learning, remain central to productivity. Health and well-being, both physical and mental, are increasingly recognized as essential for maintaining a capable and resilient workforce. Social and emotional skills, such as adaptability, teamwork, and emotional intelligence, have gained prominence, highlighting their value in dynamic and collaborative work environments. Additionally, diversity and inclusion have become strategic aspects of human capital, emphasizing the importance of leveraging varied perspectives to drive innovation and competitiveness. Emerging dimensions further underscore the growing importance of AI-specific skills, interdisciplinary competencies for green jobs, and the role of education systems in fostering lifelong learning. Workforce autonomy and well-being, along with ethical and inclusive practices, ensure that human capital development remains aligned with broader societal and sustainability goals, positioning it as a cornerstone of future economic resilience and growth.

AI and the Future of Work: What Are the Main Challenges in Human Capital Development?

The following figure illustrates how artificial intelligence and the evolving nature of work influence the development of human capital on a global scale, highlighting both AI's broader impact and the specific challenges tied to human capital in this context.

AI & Future of Work: Main Challenges in Human Capital Development					
Skill Gaps and Workforce Development	Educational Challenges	Workforce Diversity and Inclusivity	Challenges in Workforce Autonomy and Well-Being	Human Capital in Public Policy	Global Disparities in Human Capital Development
AI-Specific Skill Demands	STEM Education Deficits	Gender Gaps	AI-Driven Monitoring and Stress	Government Role in Workforce Development	AI Compute Divide:
Green Economy Transition	Pandemic-Induced Inequities	Leadership and Inclusivity	Ethical Concerns	Ethics and Sustainability	Digital and Educational Inequalities
Lifelong Learning		Representation of Marginalized Groups			

Our analysis reveals several critical themes shaping the challenges and opportunities surrounding human capital today. Skill gaps and workforce development are particularly significant in the context of AI and the transition to a green economy (European Commission, 2024; Future Skills Centre, 2024; Krämer and Cazes, 2022; OECD, 2022b; OECD, 2024a, 2024c, 2024f, 2024h; OECD/UNESCO, 2024). AI-specific roles, requiring expertise in machine learning and data science, are growing faster than the available talent pool can supply (Future Skills Centre/Diversity Institute/Smart Prosperity Institute, 2024; OECD, 2022b; OECD, 2024f). At the same time, green jobs demand interdisciplinary skills that many workers currently do not possess (European Commission, 2024; Future Skills Centre, 2024; Gancheva et al., 2024; ILO, 2024a). Education systems, often slow to adapt, face difficulties integrating green and digital skills into curricula, highlighting the crucial role of lifelong learning in preparing workers for rapidly evolving job roles (Butera, 2024; Future Skills Centre, 2024).

Educational challenges further complicate the landscape. Deficits in STEM education hinder the development of talent for high-growth sectors like AI and green technology (Alexander et al., 2024), while systemic barriers limit access for women and underrepresented groups (Alexander et al., 2024; André and Gal, 2024; European Commission, 2024; OECD, 2024d, 2024e; UNESCO/OECD/IDB, 2022). The COVID-19 pandemic exacerbated these disparities, exposing gaps in digital infrastructure and reducing lifetime earning potential for students, thereby affecting long-term human capital development (OECD, 2022a).

Workforce diversity and inclusion remain significant concerns. Gender gaps persist, with women underrepresented in AI-related fields and leadership positions, while systemic barriers continue to exclude marginalized groups (Alexander et al., 2024; European Commission, 2024; Future Skills Centre/Diversity Institute/Smart Prosperity Institute, 2024; OECD, 2024d, 2024e, 2024g; UNESCO/OECD/IDB, 2022). Geographic disparities, such as the concentration of opportunities in urban areas, further marginalize rural populations (Butera, 2024; OECD, 2024b).

Workforce autonomy and well-being are also under strain due to AI-driven monitoring tools that erode privacy and autonomy, contributing to stress and dissatisfaction (Krämer and Cazes, 2022; UNESCO/OECD/IDB, 2022). Bias in AI hiring algorithms perpetuates inequities, while task automation risks deskilling workers, reducing engagement and career growth opportunities (Cappelli and Rogovsky, 2023; Krämer and Cazes, 2022).

Public policy plays a pivotal role in shaping the future of human capital. Governments face challenges in recruiting AI talent due to competition with the private sector and must foster cross-sector collaboration to improve governance and institutional efficiency (Gancheva et al., 2024; OECD, 2024c; 2024g; WEF, 2024). Ethical considerations, such as fairness and inclusivity, are increasingly important in AI-related policies, while aligning workforce training with sustainability goals requires targeted investments in education, technology, and infrastructure (OECD, 2024b; OECD/UNESCO, 2024).

Finally, global disparities in human capital development underscore the inequalities between developed and emerging economies. Many developing nations lack access to AI resources, limiting their ability to build talent and participate in global advancements (OECD, 2022a, 2022b). Digital and educational inequalities further exacerbate skill gaps, with vulnerable populations such as women and rural communities facing additional barriers to digital literacy and workforce participation (Alexander et al., 2024; European Commission, 2024; Future Skills Centre/Diversity Institute/Smart Prosperity Institute, 2024; OECD, 2024d, 2024e, 2024g; UNESCO/OECD/IDB, 2022). Addressing these contemporary dimensions is crucial for building resilient, inclusive, and future-ready human capital systems worldwide.

Artificial Intelligence: An Overview of Opportunities and Value Creation for the Future of Work

Artificial intelligence (AI) represents a transformative force across sectors, with the potential to drive significant advancements in efficiency, innovation, and sustainability. Through our analysis, we identified six key opportunities for AI to shape the future of work.

AI enhances resource optimization through applications such as predictive climate modeling and advanced energy systems, contributing to sustainable development and improved resilience against environmental changes through technologies like digital twins (OECD, 2022b; OECD, 2024b; 2024d). It improves decision-making processes by mitigating biases and fostering fairness across organizational and industrial settings, while human-AI collaboration enhances the precision and ethical alignment of decisions (Krämer and Cazes, 2022; UNESCO/OECD/IDB, 2022).

In the workforce transformation domain, AI-driven automation mitigates risks in repetitive tasks, enhancing occupational safety and enabling workers to focus on higher-value activities (Cappelli and Rogovsky, 2023; Chagny et al., 2023). Generative AI democratizes access to sophisticated tools, empowering individuals with limited formal training or experience (OECD, 2024c, 2024e; WEF, 2024).

Furthermore, AI accelerates scientific innovation, reconfigures value chains, and catalyzes new business models through interdisciplinary collaborations spanning academia, industry, and policymaking (WEF, 2024). AI also supports social equity by facilitating reskilling programs that address workforce disparities, such as gender gaps in technology-intensive roles, and by promoting algorithmic transparency to reduce bias and enhance inclusivity in employment practices (Butera, 2024; OECD, 2024d, 2024e; UNESCO/OECD/IDB, 2022).

Moreover, AI underpins sustainability efforts through its contributions to renewable energy systems, green hydrogen production, and climate-adaptive technologies, offering scalable solutions to mitigate climate change and advance the attainment of Sustainable Development Goals (European Commission, 2024; OECD, 2022b).

AI & Future of Work: Value Creation & Opportunities					
Efficiency Gains	Enhanced Decision-Making	Job Quality and Workplace Transformation	Innovation and Productivity	Social Inclusion and Gender Equity	Sustainability and Climate Action
Optimizing resource usage through applications like predictive climate modeling and advanced energy systems, contributing to sustainable development. Digital twin technology allows for the simulation of systems, fostering improved policy-making and resilience against environmental changes.	Reducing biases in decision-making, promoting fairness across workplaces and industries. Human-AI collaboration improves decision accuracy, driving sustainable and ethical practices.	Automation of repetitive tasks enhances worker safety and allows for more engaging roles. Generative AI democratizes access to advanced tools, empowering workers with less experience or formal training.	AI accelerates scientific breakthroughs, reshapes value chains, and introduces new business models. Fostering interdisciplinary collaboration, bridging academia, industry, and policymaking to drive innovation.	Allowing for reskilling opportunities, narrowing the gender gap in high-demand tech roles. Algorithmic transparency initiatives address biases, creating equitable employment opportunities.	Supporting renewable energy systems, green hydrogen production, and climate-resilient practices. Scaling solutions for mitigating climate change and achieving sustainability.

Identifying the Vulnerabilities of Artificial Intelligence: Risks and Strategic Considerations for the Future of Work

Our analysis reveals eight core areas of vulnerabilities associated with artificial intelligence (AI), highlighting critical risks that require careful consideration to ensure ethical, sustainable, and equitable implementation. Among these risks, the environmental impact of AI is substantial, as its high computational power demands lead to considerable energy consumption, often outpacing the efficiency gains achieved through hardware improvements (OECD, 2022b; OECD, 2024d). This issue is further exacerbated in resource-intensive sectors like mining and manufacturing (Krämer and Cazes, 2022; OECD, 2022b).

Algorithmic bias poses another significant challenge, as biases embedded in training datasets can result in discriminatory outcomes, particularly in sensitive areas such as recruitment, lending, and law enforcement, thereby perpetuating systemic inequalities (Cappelli and Rogovsky, 2023; Chagny et al., 2023; Krämer and Cazes, 2022; OECD, 2024a, 2024b, 2024e; OECD/UNESCO, 2024; UNESCO/OECD/IDB, 2022).

AI's reliance on vast amounts of data increases vulnerabilities to breaches and adversarial attacks, raising significant privacy and security concerns (Krämer and Cazes, 2022; OECD, 2024c, 2024d; OECD/UNESCO, 2024; WEF, 2024). The use of monitoring systems further amplifies ethical issues related to surveillance and the erosion of individual privacy (Krämer and Cazes, 2022; OECD, 2024b; OECD/UNESCO, 2024).

Automation driven by AI is displacing jobs, particularly those involving repetitive tasks, disproportionately affecting low- and medium-skilled workers and contributing to job inequalities (Future Skills Centre/Diversity Institute/Smart Prosperity Institute, 2024; Krämer and Cazes, 2022; OECD, 2024d, 2024e, 2024i; UNESCO/OECD/IDB, 2022). At the same time, the specialized skill sets required for AI roles create a talent gap, widening disparities across regions and sectors (OECD, 2022a, 2022b; OECD, 2024e).

Accountability and transparency challenges arise from the opaque nature of AI decision-making processes, particularly in critical sectors like healthcare and finance, where the lack of explainability can lead to ethical dilemmas and potential legal liabilities (Cappelli and Rogovsky, 2023; Krämer and Cazes, 2022; OECD, 2024a, 2024b; OECD/UNESCO, 2024).

The spread of generative AI tools introduces risks related to manipulation and misinformation, as these technologies facilitate the creation of synthetic content, deepfakes, and false narratives, eroding social trust and stability (OECD, 2024b, 2024c, 2024i). Additionally, the concentration of AI resources and expertise within a few dominant tech entities restricts equitable access and stifles competition and innovation (Chagny et al., 2023; OECD, 2024b).

Governance and ethical gaps further compound these risks, as the rapid evolution of AI technologies often outpaces the development of adequate regulatory frameworks (OECD, 2024b; OECD/ITC, 2024; WEF, 2024). Fragmented governance across jurisdictions leads to non-interoperable systems, creating challenges for innovation and compliance (Butera, 2024; European Commission, 2024; WEF, 2024).

AI & Future of Work: Risks

Environmental Impact	Algorithmic Bias and Discrimination	Privacy and Security	Job Displacement and Inequalities	Accountability and Transparency Challenges	Manipulation and Misinformation	Power Concentration	Governance and Ethical Gaps
Vast computational power, leading to high energy consumption that often outpaces gains from improved hardware efficiency. Specific sectors, such as mining and manufacturing, amplify this impact through resource-intensive AI applications.	AI systems depend on data quality, and biases in training datasets can result in discriminatory outcomes. Applications in recruitment, lending, and law enforcement risk perpetuating systemic inequalities.	The data-intensive nature of AI increases vulnerabilities to data breaches and adversarial attacks. Monitoring systems raise ethical concerns about surveillance and the erosion of individual privacy.	Automation enabled by AI is displacing jobs, particularly in sectors with repetitive tasks, disproportionately affecting low- and medium-skilled workers. Specialized skills for AI roles create a talent gap, exacerbating global and sectoral disparities.	The opacity of AI decision-making In critical sectors such as healthcare and finance, this lack of explainability could lead to ethical dilemmas and legal liabilities.	Generative AI tools contribute to the spread of synthetic content, deepfakes, and misinformation, undermining social trust and stability.	Centralization of AI resources and expertise within a few dominant tech entities restricts equitable access, curbing competition and innovation.	Rapid evolution of AI technologies often outpaces the development of regulatory frameworks. Fragmented governance structures across jurisdictions risk creating non-interoperable systems and stifling innovation.



Navigating the Uncertainties of Artificial Intelligence: Technological, Economic, and Social Dimensions

Our analysis identifies seven core uncertainties surrounding artificial intelligence (AI), highlighting areas that demand careful consideration to navigate its complexities and potential impacts. Among the key technological challenges is the difficulty in accurately measuring AI-specific environmental impacts, as they are often intertwined with broader information and communication technology (ICT) systems, complicating assessments of AI’s full environmental footprint (Cappelli and Rogovsky, 2023; ILO, 2024b; OECD, 2022b; OECD, 2024i). Additionally, large-scale AI systems exhibit emergent capabilities, such as unexpected autonomous decision-making, which introduces new layers of unpredictability and complicate governance (Krämer and Cazes, 2022; WEF, 2024). The convergence of AI with other advanced fields, such as synthetic biology and quantum computing, raises novel ethical and safety concerns that remain largely unaddressed (OECD, 2024d; WEF, 2024). The rapid pace of AI advancements further outstrips the capacity of existing regulatory frameworks, creating governance gaps and challenges in adaptation (Chagny et al., 2023; OECD, 2024h; OECD/UNESCO, 2024; WEF, 2024).

Economic and social dynamics also contribute significantly to AI’s uncertainties. The impact of AI on the job market remains ambiguous, with its potential to create jobs balanced against risks of displacement, which vary across demographics and sectors (Alexander et al., 2024; André and Gal, 2024; Cappelli and Rogovsky, 2023; Future Skills Centre/ Diversity Institute/Smart Prosperity Institute, 2024; ILO, 2024b; OECD, 2024b, 2024d, 2024e; 2024g). Equitable access to AI advancements is another critical concern, as emerging economies face significant barriers, exacerbating global inequalities in technology adoption and utilization (ILO, 2024b; OECD, 2022a, 2022b; OECD, 2024a). Reskilling efforts are further complicated by the continuous evolution of AI technologies, which challenge workforce planning and the ability to develop adaptive educational and training strategies (ILO, 2024a; Pechansky and Lioussis, 2024; UNESCO/ OECD/IDB, 2022).

AI & Future of Work: Uncertainties						
Technological Challenges	Economic and Social Dynamics	Ethical and Regulatory Issues	Labor Market Dynamics	Environmental Considerations	Technological Feasibility and Risks	Equity in Access
Measurement Complexity – Emergent Capabilities – Convergence with Other Technologies – Rapid Advancements.	Job Market Impacts – Equitable Access & Reskilling Challenges.	Trustworthiness – Legal Frameworks – Cultural Variability.	Ambiguity in job creation versus job displacement from AI adoption – Potential erosion of worker autonomy and job satisfaction due to automation – Uncertainty in defining and acquiring the skills needed for emerging AI roles.	Sustainability – Advancements in green technologies like hydrogen energy.	Integration of AI with emerging technologies (e.g., quantum computing, synthetic biology) raises new ethical and safety concerns – Generative AI models exhibit unpredictable behaviors, complicating governance and regulation.	Disparities between economies in accessing AI infrastructure and benefits.

AI Integration Across Sectors: Transforming Work

Artificial intelligence (AI) is revolutionizing industries by driving innovation, enhancing operational efficiency, and addressing critical sustainability challenges. However, its integration comes with complex opportunities and risks that vary significantly across sectors. Our analysis explores these dynamics, focusing on how AI is shaping the future of work through sector-specific applications and challenges.

Our analysis also reveals that these industry sectors—**Healthcare, Energy and Environment, Agriculture, Manufacturing and Industrial Production, Financial Services, Logistics and Transportation, and Education**—have garnered the most attention in examining the opportunities, risks, and challenges associated with AI integration. This highlights the critical importance of sector-based analysis in understanding how AI is transforming the nature of work and in developing tailored strategies to address these changes effectively.



AI’s Role in Driving Sector-Specific Innovation and Sustainability

Our analysis identified how artificial intelligence (AI) is transforming industries by driving innovation, enhancing efficiency, and enabling sustainable practices. Its sector-specific applications illustrate its profound potential to revolutionize diverse fields and address pressing challenges. In healthcare, AI is reshaping diagnostics through personalized medicine and predictive analytics while reducing administrative burdens, allowing healthcare professionals to dedicate more time to patient care (Krämer and Cazes, 2022; OECD, 2022a; OECD, 2024a, 2024b; OECD/UNESCO, 2024). In energy and environmental sectors, AI integrates renewable energy systems, optimizes smart grid efficiency, and supports decarbonization efforts. Advanced technologies, such as digital twins and green hydrogen production, provide pathways toward achieving a net-zero economy (OECD, 2022b; OECD, 2024d, 2024g).

In agriculture, AI-driven predictive analytics improve crop resilience and resource optimization, fostering sustainable farming practices. Emerging innovations, like cellular agriculture, open new opportunities for sustainable food production (OECD, 2022a, 2022b). In manufacturing and industrial production, automation enhances workplace safety and productivity, while machine vision and AI-driven lean practices improve operational efficiency (Cappelli and Rogovsky, 2023; Krämer and Cazes, 2022; OECD/UNESCO, 2024).

The financial services sector benefits from AI through improved fraud detection, enhanced operational efficiency, and personalized customer service (Krämer and Cazes, 2022). In logistics and transportation, AI optimizes routing, reduces traffic congestion, and accelerates the development of autonomous vehicles (Krämer and Cazes, 2022). Education systems are leveraging AI to personalize learning experiences, improve accessibility, and foster digital literacy, equipping future generations for increasingly technology-driven economies (OECD, 2022a; OECD, 2024b, 2024c).

Retail and trade are also being transformed by AI, with predictive analytics optimizing inventory management and enhancing customer experiences (Krämer and Cazes, 2022; OECD, 2024c). Additionally, AI plays a pivotal role in the clean technology and green economy sectors, supporting the green transition by creating jobs in renewable energy and cleantech while driving costefficiency and scalability in climate-resilient technologies (OECD, 2022a).

AI’s Key Sector Specific Benefits in shaping the future of work	
Healthcare	Personalized medicine, predictive analytics, reduced administrative burdens
Energy and Environment	Renewable energy integration, smart grid efficiency, decarbonization
Agriculture	Crop resilience, resource optimization, cellular agriculture
Manufacturing and Industrial Production	Workplace safety, productivity, lean practices
Financial Services	Fraud detection, operational efficiency, personalized service
Logistics and Transportation	Routing optimization, traffic reduction, autonomous vehicles
Education	Personalized learning, accessibility, digital literacy
Retail and Trade	Inventory management, customer experience optimization
Clean Technology and Green Economy	Jobs in renewables, cost efficiency, climate-resilient technologies

Addressing AI Risks Across Industries

Our analysis highlights significant sector-specific concerns regarding the integration of artificial intelligence (AI), emphasizing the unique risks and challenges across various domains. In manufacturing and industrial production, increased automation risks job displacement and safety hazards from AI-operated machinery, compounded by delays in workforce retraining and skill development (Cappelli and Rogovsky, 2023; Krämer and Cazes, 2022; OECD/UNESCO, 2024). While AI-enabled efficiencies improve productivity, they often drive higher resource extraction and emissions, exacerbating environmental impacts (OECD, 2022b; OECD, 2024d). In healthcare and life sciences, privacy concerns surrounding sensitive patient data are paramount, as are the risks of biases in diagnostics and treatment recommendations (Krämer and Cazes, 2022; OECD, 2022a, 2022b; OECD, 2024a, 2024b, 2024c; WEF, 2024). Ethical dilemmas arise from over-reliance on AI systems, which can undermine clinical decision-making and diminish the autonomy of healthcare professionals (OECD, 2024a).

In financial services, AI-driven decisions in risk assessment and lending introduce liability and bias risks, while algorithmic trading amplifies market volatility and systemic vulnerabilities (OECD, 2024b). The sector is also highly susceptible to cyberattacks and sophisticated AI-driven fraud schemes (OECD, 2024b). In logistics and transportation, the proliferation of autonomous vehicles and AI optimization systems threatens job displacement in driving and warehousing roles, while fleet monitoring systems raise concerns about worker privacy (Krämer and Cazes, 2022). Retail and e-commerce face challenges such as AI-driven recommendation systems that promotes unsustainable consumption patterns and retail automation operations that degrades job quality in low-skill positions (Krämer and Cazes, 2022; OECD, 2022b).

Public services and smart cities grapple with extensive data collection, raising the risk of privacy violations and mass surveillance (Krämer and Cazes, 2022; OECD, 2024i; OECD/UNESCO, 2024). The integration of AI in critical infrastructure also poses cybersecurity threats and operational vulnerabilities (European Commission, 2024; OECD, 2024c, 2024d, 2024i; OECD/UNESCO, 2024). In education, over-reliance on AI risks widening digital divides in low-income regions where access to technology is limited, while automation in learning tools may reduce teacher-student interaction and exacerbate inequities (OECD, 2022a; OECD, 2024b, 2024d).

The energy and environmental sectors face hurdles such as the immature state of green technologies, carbon lock-in from fossil-fuel-dependent AI systems, and high costs associated with renewable infrastructure (European Commission, 2024; OECD, 2024a). In the gig economy and platform work, the fragmented nature of gig roles diminishes job security and collective bargaining power, while algorithmic scheduling perpetuates inequalities and fails to adapt to worker's needs (Krämer and Cazes, 2022). Critical infrastructure, including energy grids, transport systems, and communication networks, is vulnerable to cascading failures from AI malfunctions, adversarial attacks, and misinformation (e.g., hallucinations), which undermine trust and reliability (OECD, 2024b, 2024c).

AI Sector-Specific Risks and Challenges in shaping the future of work	
Manufacturing & Industrial Production	Job displacement, safety hazards, environmental impacts
Healthcare & Life Sciences	Privacy, bias in diagnostics, ethical dilemmas
Financial Services	Liability, bias, cyberattacks, market vulnerabilities
Logistics & Transportation	Job displacement, worker privacy
Retail & E-Commerce	Unsustainable consumption, degraded job quality
Public Services & Smart Cities	Privacy violations, cybersecurity threats
Education	Digital divides, reduced teacher-student interactions
Energy & Environmental Sectors	Immature technologies, high costs, carbon lock-in
Gig Economy & Platform Work	Job insecurity, algorithmic inequalities
Critical Infrastructure (i.e. energy grids, transport systems, and communication networks)	Cascading failures, adversarial attacks, misinformation

Key Challenges in AI Integration Across Sectors: Shaping the Future of Work

Our analysis identifies key challenges associated with the integration of artificial intelligence (AI) across the nine sectors, highlighting critical areas of concern that require attention for responsible and effective adoption. These findings underscore the multifaceted impacts of AI, spanning labor market dynamics, policy evolution, technological and market volatility, and sustainability.

Artificial intelligence (AI) is reshaping the labor market and industry landscapes, presenting both opportunities and challenges. Uneven impacts on job creation and displacement, particularly in caregiving and service roles, highlight gendered disparities and the need for equitable workforce strategies. Policy and regulatory misalignments, coupled with the absence of global AI governance standards, further complicate integration efforts. Rapid technological advancements introduce volatility, disrupting industries reliant on stable innovation cycles. Moreover, transitioning to sustainable AI practices remains fraught with economic uncertainties and inconsistent regulatory frameworks, underscoring the urgency for coordinated approaches to address these sector-specific challenges.

Labor Market Impacts

AI affects job creation and displacement unevenly across sectors and demographics.

Gendered impacts of AI on jobs in caregiving and service roles warrant attention.

Policy and Regulatory Evolution

Misalignment of federal and regional policies complicates AI adoption.

Lack of global standards for AI governance introduces compliance risks.

Sustainability and Adaptation

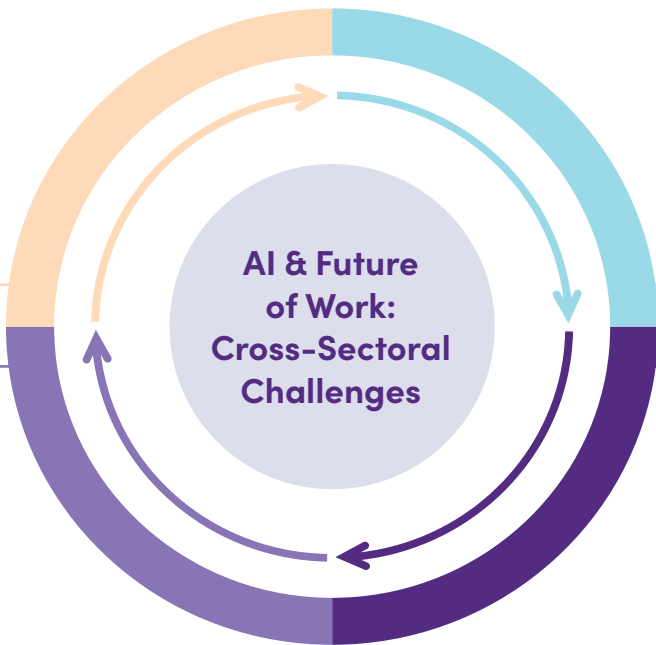
Transitioning to sustainable practices requires significant investment and regulatory clarity.

Economic costs of reducing emissions and scaling green technologies remain uncertain.

Technological and Market Volatility

The pace of technological change introduces risks for sectors reliant on stable innovation cycles.

Market acceptance of new AI-driven solutions varies significantly across industries.



Labor Market Impacts emerge as a significant challenge, with AI affecting job creation and displacement unevenly across sectors and demographics (Krämer and Cazes, 2022; OECD, 2024b; OECD/UNESCO, 2024; UNESCO/OECD/IDB, 2022). Our analysis reveals gendered impacts, particularly in caregiving and service roles, where automation and AI-driven solutions may disproportionately affect women, exacerbating existing inequalities (OECD, 2024e; UNESCO/OECD/IDB, 2022).

In terms of policy and regulatory evolution, our findings highlight that the misalignment of federal and regional policies complicates the effective integration of AI technologies (OECD, 2024b, 2024d, 2024g, 2024h). Furthermore, the absence of global standards for AI governance introduces compliance risks, creating barriers for organizations navigating inconsistent and often conflicting regulations across the nine sectors (European Commission, 2024; OECD, 2024b, 2024h).

The pace of technological and market volatility is another critical challenge. The rapid evolution of AI technologies poses risks for industries dependent on stable innovation cycles, leaving some sectors vulnerable to disruption (Chagny et al., 2023; OECD, 2024b, 2024h; OECD/UNESCO, 2024; WEF, 2024). Additionally, market acceptance of AI-driven solutions varies significantly, reflecting the uneven readiness of industries to adopt these innovations effectively (Krämer and Cazes, 2022; OECD, 2024b).

Finally, sustainability and adaptation present ongoing hurdles. Transitioning to sustainable practices in AI development and deployment requires substantial investment and regulatory clarity, both of which remain inconsistent across sectors (OECD, 2024g; WEF, 2024). Moreover, our findings emphasize the economic uncertainties associated with reducing emissions and scaling green technologies, which continue to challenge progress in aligning AI with environmental goals (Alexander et al., 2024; Black, Parry, and Zhunussova, 2024; Future Skills Centre, 2024; Gancheva et al., 2024; ILO, 2024b; OECD, 2022a, 2022b; OECD, 2024f; OECD/ITC, 2024).

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