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## THE GOVERNMENTAL HAND IN THE ALGORITHMIC AGE: POLICY LEVERS, CHALLENGES, AND IMPLICATIONS IN SHAPING ARTIFICIAL INTELLIGENCE SKILLS

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### ABSTRACT

**Purpose:** *This paper examines how national governments use policy levers to shape the supply of AI-related competences, distinguishing clearly between skills for AI development (advanced R&D, engineering) and skills for AI adoption (work-force and citizen literacy). It synthesises theory and practice to propose a multi-level framework that links human-capital investment, innovation-ecosystem coordination and inclusion goals to concrete skill outcomes.*

**Need for the study:** *Global surveys show acute shortages of AI specialists and low baseline AI literacy among workers; yet most national strategies still treat “AI skills” as a single policy target. Little academic work has analysed how different policy mixes map onto these two distinct gaps or what constitutes a balanced, equitable skill strategy.*

**Methodology:** *The study conducts a structured review of recent research, international guidelines and national AI strategies. It integrates insights through comparative thematic coding and builds a conceptual model—the Nested AI-Skill Ecosystem—that explicates causal links between policy instruments (education reform, R&D subsidies, PPPs, immigration, ethics standards) and the twin skill domains.*

**Findings:** *The “AI skills gap” is dual: specialist shortages impede frontier innovation, while weak adoption skills limit productivity diffusion. Policy effectiveness hinges on coherent bundles: regulation or funding alone is insufficient without ecosystem coordination. Three archetypal government approaches emerge—development-led, adoption-led and balanced—each traceable to different strategic narratives and institutional capacities. Public–private partnerships and lifelong-learning infrastructures are critical cross-cutting enablers; ethical-AI guidelines indirectly create new training demand.*

**Practical Implications:** *Policymakers should set dual, measurable targets for developer talent and broad AI literacy; embed AI ethics across all curricula; align R&D grants with mandatory up-/re-skilling components; and establish governance bodies that integrate education, labour and innovation portfolios. The proposed typology offers a diagnostic tool for auditing existing national strategies and designing adaptive, inclusive skill ecosystems for the algorithmic age.*

**Keywords:** artificial intelligence skills, human capital development, public policy & governance, AI adoption vs. AI development, workforce upskilling and reskilling, skills gap, digital inclusion

**JEL codes:** J24; O33; O38; I28; H52

## 1. INTRODUCTION: THE NEXUS OF GOVERNMENT POLICY AND AI SKILLS

Artificial intelligence (AI) is a key tool for accelerating civilization development, affecting employment, society, and the economy. Its proper implementation requires strategies and regulations from governments and international organizations that should invest in education and user protection. In today's world, artificial intelligence and its development are becoming the main tools for gaining an advantage and obtaining a dominant position in international competition. Systematically and intensively developing on a global scale, artificial intelligence significantly impacts employment, society, and the economy. More fields of science, such as medicine, industry, logistics, transport, finance, education, entertainment, and work, are opening to new AI solutions (Szpilko et al., 2023a, 2023b). Progress in the field of artificial intelligence is continuous, leading to groundbreaking technological and innovative achievements. Spending by governments and companies on the development of Industry 4.0 is growing rapidly.

A properly constructed strategy for artificial intelligence modernizes the economy and elevates citizens' lives. States and international organizations are increasingly taking action to develop strategies for AI advancement. They are involved in creating specific recommendations and guidelines for implementing AI solutions. Artificial intelligence is a tool that can bring great benefits, but it requires understanding and a proper approach. It is impossible to stop technological progress; therefore, the application and implementation of AI must be approached responsibly. It is the responsibility of governments and international organizations to develop specific practices in the field of AI development. Work on appropriate regulations should aim to both invest in educating society about artificial intelligence and create conditions for developing new skills in its use, while also protecting users and preventing abuse. Technology companies should consider ethical principles in their AI projects, act transparently, and safeguard user privacy. In the current phase of continuous implementation of intelligent solutions across various sectors, primarily in the private industry, the burden of educating society falls on both state institutions and enterprises.

### *1.1. Defining the Core Research Problem*

The rapid integration of Artificial Intelligence – broadly defined as machines imitating human intelligence functions like perception, learning, reasoning, and problem-solving – into nearly every facet of society presents profound opportunities and complex challenges. As AI technologies evolve at an unprecedented pace, governments worldwide grapple with how to steer their development and deployment towards societal benefit while mitigating inherent risks (Taeihagh, 2021). Central to this endeavor is the cultivation of AI-related skills within the populace and workforce. This research investigates the multifaceted ways in which national and regional governments, through deliberate policy interventions and strategic frameworks, influence the development, diffusion, and equitable distribution of AI skills.

Artificial Intelligence is transforming economies and job markets at an unprecedented pace, creating an urgent need for new skills across societies. A significant skills gap has emerged: many organizations report that shortages of AI-related talent are a major barrier to adopting AI technologies. Governments around the world recognize that without deliberate policy intervention, the workforce may lack the competencies required to develop and to effectively use AI, risking lost economic opportunities and widened inequalities (European Commission, 2021). The problem is twofold – we need highly skilled experts to create AI systems, and a broader base of users and managers who can adopt and leverage AI responsibly in all sectors. This research is relevant because closing these skill gaps is critical for innovation, productivity, and inclusive growth in the age of AI.

The core problem lies in understanding the effectiveness, efficiency, and equity implications of diverse governmental approaches in navigating these AI-driven technological shifts. Governments are increasingly formulating national AI strategies and policies, recognizing AI's potential to enhance economic competitiveness and transform societal structures (UNESCO IESALC 2025). However, these policies operate within a context of significant uncertainty regarding AI's trajectory and impact. A critical aspect of this challenge is bridging the perceived and growing gap between the accelerating demand for AI competencies in the labor market and the current supply within the workforce.

This study addresses the fundamental question: *To what extent and through which mechanisms can government policy effectively shape a nation's AI skills landscape to foster economic growth, ensure*

*social equity, and prepare the workforce for the future of work?* It moves beyond simply documenting policy initiatives to critically analyze the interplay between government actions and the complex ecosystem of AI skill formation. The way this "problem" is diagnosed – whether primarily as an economic competitiveness race, a workforce transition imperative, or an ethical governance challenge – significantly influences the types of policies governments prioritize. An economic framing might focus on elite talent and R&D, a workforce framing towards broad reskilling, and an ethical framing towards regulation and safeguards. A truly comprehensive approach likely requires integrating all three perspectives.

### *1.2. Relevance and Significance*

The role of government policy in shaping AI skills is critically relevant for several interconnected reasons. Firstly, AI holds transformative potential across economic, social, and geopolitical domains. AI skills are increasingly viewed as central determinants of national competitiveness, innovation capacity, productivity growth, and even military superiority. Governments perceive AI development as crucial for economic prosperity and strategic positioning in the global order.

Secondly, the rapid advancement and deployment of AI systems pose significant risks that necessitate proactive governance. These include the potential exacerbation of social and economic inequalities (National Institute of Standards and Technology, 2023), the displacement of workers in specific sectors as tasks become automated, and a host of ethical dilemmas concerning bias, fairness, privacy, transparency, and accountability. AI systems can amplify existing societal biases present in training data, leading to discriminatory outcomes. Furthermore, the potential for AI misuse, such as the spread of misinformation or the development of autonomous weapons, raises profound security and societal concerns (Taeiagh, 2021). Effective government policy is therefore crucial not only to harness AI's benefits but also to navigate these complex challenges and ensure AI development aligns with societal values and human rights (UNESCO IESALC, 2025).

Thirdly, understanding the effectiveness of different policy interventions is vital for evidence-based decision-making. Governments, educational institutions, industry stakeholders, and civil society require insights into which policies are most likely to succeed in fostering the necessary skills, promoting equitable access, and adapting to the dynamic nature of AI. Evaluating policy impact, however challenging, is essential for optimizing resource allocation and achieving desired outcomes.

### *1.3. Research Objectives and Scope*

This research pursues to critically review and synthesize existing frameworks for defining and categorizing AI skills relevant to policy intervention, identifying commonalities, divergences, and gaps; to identify and analyze the primary policy instruments (levers) employed by governments globally to influence AI skill development across education, R&D, labor markets, and collaborative initiatives; to comparatively evaluate the AI skills strategies of key nations and regions, assessing their distinct approaches, underlying rationales, and last but not the least to synthesize findings and propose actionable policy recommendations for fostering effective, equitable, and adaptable AI skill ecosystems that support both economic prosperity and social well-being.

This paper contributes to the existing literature by providing a structured analysis that explicitly differentiates between policy approaches for AI development skills and AI adoption skills. While many studies address digital skills or national AI strategies broadly, few delve into the specific policy mechanisms targeting these distinct skill sets and critically assess their effectiveness (Hong, Wang, Fu, & Li, 2024). Often, policy discussions tend to conflate different types of AI skills or lack rigorous evaluation of intervention impacts. By offering a comparative framework and synthesizing characteristics of potentially effective policies, this research aims to provide valuable insights for policymakers, researchers, and educators grappling with the challenge of preparing society for the AI revolution.

## **2. LITERATURE REVIEW**

To ground this study, we review three relevant bodies of literature: digital transformation, public policy in skill formation, and emerging work on AI skills. This situates our inquiry in a broader theoretical context.

The digital transformation era has repeatedly shown that technology adoption goes hand-in-hand with workforce skills. Research on digital innovation highlights that lacking the right skills is a major obstacle to successful transformation in organizations and the public sector (Mettler, Miscione, Jacobs, & Guenduez, 2024). Governments increasingly view digital skills as a foundation for economic competitiveness and public service delivery in the 21st century. For instance, Mettler *et al.* (2024) note that governments, as strategic actors, actively shape digital transformation by investing in infrastructure and skills, framing a national vision for change. High failure rates of IT modernization projects have been attributed in part to insufficient understanding of technology and inadequate skill preparedness within organizations. Thus, a consensus in the literature is that continuous upskilling and reskilling are required to keep pace with rapid technological change (often summarized in concepts like the need for “lifelong learning” in the digital age). AI represents the latest, and perhaps most profound, wave of this digital disruption, intensifying the spotlight on skill formation.

There is a rich tradition of scholarship on the role of the state in developing human capital. Classic human capital theory holds that education and training yield broad social benefits beyond the private gains to individuals, justifying government investment in skills. Public policy in many countries has long encompassed education systems, vocational training programs, and labor market interventions to develop workforce skills and enhance employability. Modern skill formation literature (including studies in political economy and labor economics) emphasizes how governments can correct market failures in training: for example, firms may under-invest in employee training because some benefits “spill over” to other firms or to society (Organisation for Economic Co-operation and Development, 2023). Indeed, OECD analyses find that employers often do not provide enough AI-related training on their own – partly due to information gaps about AI and partly because the returns on training may extend beyond the individual firm. This gap opens space for government action. Additionally, policy scholars discuss how different institutional models (e.g. education systems, apprenticeship schemes, public-private partnerships) affect skill development outcomes. The notion of “skills ecosystems” has emerged, viewing skill formation as a coordinated effort among government, industry, and educational institutions. In summary, the literature suggests that proactive public policies are crucial to build the skills base needed for new technologies, especially when the pace of change is too rapid for traditional education alone to keep up (Organisation for Economic Co-operation and Development).

Specific research on AI and skills is relatively nascent but growing quickly since around 2018. Early studies and policy reports identify AI as a general-purpose technology that will significantly alter skill demands. One key finding is that AI does not only affect technical occupations – its impact is broad-based, requiring adaptations across many roles. AI skills discourse often highlights a dual need: cultivating AI specialists and promoting AI literacy for all. For example, the OECD Employment Outlook 2023 finds that as AI adoption expands, there will be growing demand for both advanced AI expertise and basic digital/AI literacy, along with higher demand for cognitive skills that complement AI. At the same time, skills that AI can automate (routine cognitive or manual tasks) may decline in importance. This aligns with broader future-of-work literature (e.g. World Economic Forum’s Future of Jobs reports) which project increasing importance of complex problem-solving, creativity, and social intelligence skills by 2025 as automation spreads. Recent policy analyses by institutions like the European Union and OECD consistently flag the ‘AI skills gap’ as a strategic challenge. The EU’s Coordinated Plan on AI (2021) explicitly calls out the persistent ICT and AI specialist shortage as a key hurdle to AI development in Europe and equally stresses the need for ‘AI for all’ through broad digital skill initiatives to avoid societal inequalities (European Commission, 2021). In sum, current literature converges on the view that AI is reshaping skill needs on two fronts – deep technical expertise and widespread user capabilities – and that public policy must evolve to foster both.

### *2.1. The Strategic Imperative of AI Skills*

Artificial Intelligence (AI) stands as a transformative general-purpose technology (GPT), fundamentally reshaping economies and societies across the globe. Its potential extends far beyond incremental improvements, offering pathways to tackle complex global challenges. The capacity of AI to automate tasks, augment human capabilities, and drive innovation positions it as a critical engine for productivity growth. Consequently, national capabilities in AI are increasingly viewed as central determinants of international competitiveness, economic prosperity, and overall societal well-being. However, realizing the profound benefits of AI requires more than technological advancement alone; it necessitates a

population equipped with the requisite skills to develop, deploy, and interact with these powerful systems effectively.

Governments worldwide play an indispensable role in navigating the complexities of digital transformation. This role becomes even more critical in the context of AI, where strategic policy interventions are needed to cultivate the human capital essential for the AI era. Recognizing this imperative, numerous nations are formulating and implementing comprehensive national AI strategies, often placing skills development at the core of their agendas.

These strategies acknowledge that fostering an AI-ready populace is not merely an economic goal but also a societal necessity. The urgency for government action is amplified by the dual nature of AI: while it presents immense opportunities, it also introduces significant risks, including potential job displacement, the amplification of bias and inequality, and threats to privacy and security. Skills gaps exacerbate these risks; a workforce unable to adapt may face heightened insecurity, and a society lacking critical AI literacy may struggle to ensure responsible and ethical deployment. Therefore, government policies focused narrowly on cultivating elite AI development talent, while neglecting the broader societal adjustments and skills needed for widespread, responsible adoption, may inadvertently widen societal divides even as they pursue technological leadership.

### 2.2. *The Dual Nature of the AI Skills Gap (Development vs. Adoption)*

The central challenge hindering the full realization of AI's potential is a significant and multifaceted skills gap (Wu & Lin, 2025). This gap manifests in two distinct but interconnected domains, a distinction crucial for effective policy formulation:

- AI Development Skills,
- AI Adoption Skills.

*AI Development Skills* encompass the specialized expertise required to design, build, train, test, and advance AI systems. It includes deep knowledge in areas such as machine learning (ML) engineering, data science, AI research, algorithm development, and related technical fields. Shortages in these high-level skills directly constrain a nation's capacity for innovation, limiting its ability to create novel AI solutions and compete at the technological frontier.

*AI Adoption Skills* is a broader set of competencies is required by the wider workforce and citizenry to effectively and responsibly utilize AI tools, interpret AI-generated outputs, collaborate with AI systems, and navigate the ethical considerations inherent in their use. Key skills include AI literacy (a basic understanding of AI), data interpretation, critical evaluation of AI outputs, ethical reasoning, effective human-AI collaboration, and prompt engineering. Deficiencies in these adoption skills limit the diffusion of AI benefits across the economy, hindering productivity gains and increasing the risk of misuse or unintended negative consequences.

A fundamental premise of this paper is that government policies must strategically address *both* the AI development skills gap and the AI adoption skills gap. These two challenges often necessitate different policy instruments, target populations, and timelines, requiring a nuanced and differentiated approach from policymakers.

## 3. ARTIFICIAL INTELLIGENCE

We are currently in the era of the fourth industrial revolution, also known as Industry 4.0. Its foundations were laid during the third revolution, which occurred in the 1960s. At that time, technology and information began to determine the development of the economy, leading to the creation of the information society. The first IT systems appeared, enabling production planning and control, which in turn contributed to the increase in automation. The rapid development of technology at the beginning of the 21st century initiated the fourth industrial revolution. It is associated with the development and dissemination of information and communication technologies, intelligent network technologies, mutually communicating objects, and artificial intelligence. As a result of these changes, the modern physical world began to intermingle with the digital world rapidly. A swift pace of change, considerable force, and significant impact on all sectors of the economy characterize the fourth revolution. A key element of the current and future era of civilization development is artificial intelligence, which has permeated various areas of our lives. Despite the widespread use of the term artificial intelligence, it is not easy to define this concept clearly. There are currently many different approaches to this term.

One of the most frequently cited definitions is that used by J. McCarthy, the creator of this term: “the science and engineering of creating intelligent machines”, a fundamental and still relevant concept that emphasizes the creation of machines capable of intelligent action. Kaplan and Haenlein (2019) define artificial intelligence as the ability of a system to correctly interpret external data, learn from it, and use this knowledge to perform specific tasks and achieve goals through flexible adaptation. Definitions of artificial intelligence usually assert that it is an area of computer science dealing with the construction of machines and algorithms that exhibit characteristics of intelligent action. As a field of science, artificial intelligence analyzes and defines the principles underlying human intelligent behavior and then implements these principles in the form of computer programs and algorithms. Artificial intelligence uses computational methods to analyze and perform intelligent actions (Duch, 1997, after Gałat, 2019). In the context of artificial intelligence, two approaches are often mentioned. The first one, strong artificial intelligence, refers to a system with intelligence comparable to human intelligence that is capable of independent thinking and reasoning. It assumes that a properly programmed computer can reach the level of human intelligence or even surpass it. In this context, creating self-learning programs, such as neural networks, that can solve abstract and conceptual problems through machine learning is considered. The goal is to create a system with intelligence comparable to or higher than human intelligence, capable of independent thinking and development.

Currently, scientists strive to construct machines and programs that imitate the functions of the human mind and senses, going beyond the possibilities of algorithmization. The second approach, referred to as weak artificial intelligence, emphasizes its various limitations and lower position in relation to the human mind (Rózanowski, 2007). According to its proponents, the greatest achievement of artificial intelligence is imitating the human brain, creating advanced mathematical models, and implementing them in computer programs for specific applications. Weak AI systems operate intelligently in the real world, but only to a limited extent, focusing on individual tasks that they perform efficiently. Today, narrow AI is widely present in our environment. We encounter it in chatbots that help us online, in voice assistants on our mobile devices, and in systems that recognize faces on social media. It is also used to analyze city traffic, allowing for better management of taxis. In turn, the essence of strong AI is to perceive a properly programmed computer as having elements of human intelligence, in some way equivalent to the brain. On this basis, it is considered possible to create self-learning programs and structures – models of neural networks – and develop procedures for solving conceptual and even abstract problems by teaching machines and obtaining answers to questions posed to them (Rózanowski, 2007).

To sum up the considerations in this area, it should be stated that for over 60 years of research devoted to this issue, a uniform, coherent, and complementary definition of artificial intelligence has not yet been developed. This is primarily due to its interdisciplinary nature and the multitude of diverse issues discussed within it. Nevertheless, as part of the conducted research, attempts are made to define its essence descriptively. In general, artificial intelligence is understood as a field of knowledge that includes, in particular, neural networks, the creation of models of intelligent behavior, and computer programs capable of simulating these behaviors.

The continual modeling and development of algorithms facilitate their autonomous self-improvement, enabling predictions of future behaviors through data analysis and inter-system interactions. Artificial intelligence, as a subfield of computer science, focuses on developing algorithms and systems endowed with intelligent attributes, such as adaptability, learning (including machine learning and reinforcement learning), and the capacity for abstract reasoning and decision-making. A prevailing consensus in defining AI adopts a systemic perspective, recognizing it as a system capable of influencing its environment by generating recommendations, predictions, or decisions based on specific objectives. Thus, AI uses input data—whether from machines or humans—to interpret the environment, constructing models based on these observations and subsequently deriving actionable outcomes such as decisions, behaviors, or recommendations. In advancing intelligent solutions for machines and systems, AI research aims to identify and implement rules governing human-like intelligent behavior into computer programs and algorithms. A prerequisite for the effective and responsible advancement of AI innovations is education, which involves elucidating AI mechanisms, addressing ambiguous issues, and objectively presenting both the potential and challenges associated with AI, thereby demystifying it as knowledge traditionally regarded as arcane or accessible to a select few.

#### 4. THE ROLE OF POLICIES AND GOVERNMENTS IN SHAPING ARTIFICIAL INTELLIGENCE

Overarching national and supranational AI strategies serve as crucial high-level policy levers. These documents articulate a government's vision, priorities, and commitment regarding AI development and adoption. They often include specific goals and action plans related to talent cultivation and skills development, such as targets for AI researchers, plans for educational reform, priorities for R&D investment in AI, and strategies for managing workforce transitions. These strategies play a signaling role, indicating government priorities to industry, academia, and the public, and aim to coordinate actions across different ministries and agencies. However, the level of detail, specific targets, timeframes, and implementation frameworks vary considerably across countries. Some strategies may lack concrete outcome measures or detailed implementation plans, potentially limiting their effectiveness as coordination tools (National Audit Office, 2024).

##### *4.1. International Initiatives on Artificial Intelligence*

To initiate a meaningful discourse on the topic, it is essential to examine various examples of global or supranational strategies. The United Nations, through its specialized agencies, including the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Development Programme (UNDP), and the International Telecommunication Union (ITU), actively engages in numerous initiatives that address the ethical, social, and legal dimensions associated with the development and implementation of artificial intelligence (AI). A noteworthy example of this commitment is the UNESCO Recommendation on the Ethics of AI, which was formally adopted in November 2021. This landmark document represents the first comprehensive global framework dedicated to the promotion of human rights, social equality, and sustainable development in the context of AI applications. Such initiatives highlight the necessity for collaborative approaches in navigating the complexities and challenges posed by AI technologies globally. The UNDP also uses AI to enhance the Rapid Integrated Assessment (RIA), enabling governments to evaluate their national development plans against the 169 Sustainable Development Goals (SDGs), assessing readiness for the global development agenda. Meanwhile, the ITU focuses on responsible AI development with the AI for Good platform, aimed at identifying and scaling practical AI applications aligned with the SDGs through a year-long program and an annual Global Summit.

The Organisation for Economic Co-operation and Development (OECD) has launched various initiatives to facilitate responsible AI development, including conferences, standards publication, and the establishment of the AI Policy Observatory and the ONE AI Advisory Group. These efforts aim to enhance technological trust and promote international cooperation. Since initiating its AI work at the Technology Foresight Forum in 2016 and the Intelligent Machines, Smart Policies conference in 2017, the OECD has published numerous reports assessing modern technologies' impacts on economies and societies at both national and international levels.

In May 2019, OECD released its first intergovernmental standards for AI development, emphasizing responsible management aligned with human rights and democratic values. The guidelines target all stakeholders in AI design and implementation, divided into two sections: one for developers and the other for policymakers (Organisation for Economic Co-operation and Development, 2019). The former outlines five principles for responsible AI management: fostering prosperity and sustainable development; prioritizing values and human consideration; ensuring transparency; guaranteeing user safety; and maintaining responsibility. The second section addresses policymakers, advocating for principles such as investing in AI R&D, nurturing the AI ecosystem, shaping conducive political environments, enhancing workforce competencies, and fostering international collaboration for ethical AI development.

Established in 2020, the AI Policy Observatory provides a framework to assist countries in leveraging AI benefits while mitigating associated risks. The OECD AI platform offers guidelines for effective AI tool development. The informal ONE AI Advisory Group advises the OECD on AI-related policy and technical issues, comprising diverse experts from government, civil society, and academia. It reports to the Digital Economy Policy Committee, which formulates recommendations on digital policies, including those related to AI, privacy, and digital security. The OECD also established the Digital Policy Committee (CDEP) to support sustainable development and technological innovation in

partnership with organizations like UNESCO and the Council of Europe, aligning its initiatives with European Parliament and European Commission activities.

The European Commission's Digital Decade is an initiative. The Commission has developed this program to accelerate Europe's digital transformation by 2030, setting specific goals and actions in areas such as digital skills, the digital transformation of enterprises, digital infrastructure and the digitalisation of public services. Artificial intelligence is a key element of this transformation. One of the programme's goals is for 75% of EU businesses to use cloud technologies, artificial intelligence or big data by 2030. AI is seen as a tool that can significantly improve the operational efficiency and innovation of enterprises. The program envisages increased investment in AI research and development, so that Europe can become a leader in this field.

The European Parliament is taking several actions regarding artificial intelligence, including publishing draft regulations, establishing special committees, adopting the AI Act, and working on the protection of citizens' rights as well as the application of AI in various sectors. In 2020, the European Parliament's Legal Affairs Committee published a draft report with recommendations to the Commission on a civil liability regime for artificial intelligence containing a draft resolution regulating liability for the operation of AI systems (European Parliament, 2020). In February 2024 EU Artificial Intelligence Act (AI Act) was adopted. It is considered the first legislative text concerning artificial intelligence in the world.

The European strategy for artificial intelligence development posits that AI can positively transform modern society by enhancing daily life and supporting sustainable development. It aims to improve healthcare, reduce energy consumption, increase communication and transport safety, and optimize the use of natural resources. Furthermore, AI can aid in environmental forecasting, financial risk management, fraud detection, and law enforcement. It is anticipated that AI will significantly advance public service digitization, ensuring that by 2030, all major public services are accessible online, promoting effective management and citizen accessibility (European Commission, 2018).

#### *4.2. Implementation of AI Strategies Across Countries*

The development and application of AI extend beyond international organizations and technology corporations; many countries are now formulating national AI strategies, reflecting a growing interest in AI within the public sector. Governments and local authorities are persuading citizens that technological advancements, particularly AI, will offer new opportunities for development. However, it is crucial to acknowledge the accompanying threats. Key components of an effective AI development strategy include: a thorough assessment of the current landscape, identifying the primary drivers for AI development, setting goals with a timeline, outlining key industries and applications, creating an implementation plan, delineating the strategy's role in government functions, designating a leading research center for national AI efforts, planning research sector development, recognizing barriers and challenges, fostering collaboration between business and science, establishing principles for international cooperation, and defining funding and support mechanisms alongside progress indicators.

The analysis of AI implementation strategies in OECD countries shows that most of them recognize the strategic importance of AI for economic growth and innovation. They emphasize ethical development, investment in R&D, education, and international cooperation. Regulative approaches and priorities vary depending on the specifics of the economy and challenges of the individual countries.

The analysis of AI implementation strategies in OECD countries reveals several common themes and differences in the approaches used. Almost all countries recognize the strategic importance of AI for future economic growth, innovation, and social well-being. The need for ethical and responsible AI development is widely emphasized, often with references to the OECD Ethical Principles and, in the case of European countries, to the upcoming European Union AI Act. Most strategies highlight investment in AI research and development, as well as fostering talents and skills in this area through education and training programs.

At the same time, strategic priorities and goals vary based on the specifics of each economy and the individual challenges faced by countries. For example, South Korea and Japan are setting ambitious goals for their positions in global AI rankings and AI-driven economic growth. In contrast, countries such as New Zealand and Canada seem to focus on responsibly implementing AI in the public sector and building public trust in the technology.

Approaches to AI regulation also vary. Some countries, such as Australia and Japan, prefer light regulation and the use of existing legal frameworks, intervening only when serious risks arise. Others, particularly in Europe, are actively involved in the development and implementation of more comprehensive regulations, such as the EU AI Act, seeking to ensure safety and protect fundamental rights while supporting innovation. Ethics is widely recognized as an integral part of AI strategies, and many countries have adopted or are developing their own AI ethics principles, often based on OECD recommendations.

Talent development and infrastructure are regarded as essential for successful AI implementation. Most strategies encompass initiatives to enhance AI education at all levels, from primary schools to universities, along with training and retraining programs for the current workforce. Investment in digital infrastructure, which includes computing power, data centers, and high-speed telecommunications networks, is also considered crucial for supporting the development and deployment of advanced AI systems. International cooperation is another vital aspect of many OECD countries' AI strategies. AI is perceived as a global challenge and opportunity, emphasizing the importance of knowledge exchange, best practice sharing, and participation in international initiatives such as the Global Partnership for Artificial Intelligence (GPAI) and the OECD's work on AI.

## 5. THE NATURE AND CATEGORIZATION OF AI SKILLS

Artificial intelligence and the development of information and communication technologies accelerate civilizational progress, requiring society to acquire new digital competences that are necessary for the effective use of AI in work and everyday life. In today's world, artificial intelligence is becoming the main tool for accelerating civilization, gaining an advantage, and obtaining a position in international competition. A properly constructed strategy regarding artificial intelligence makes the economy more modern and the lives of citizens reach a higher level.

Contemporary society is subject to constant change. Technological intensity is accompanied by an accelerated pace of life and exceptionally rapid changes. Among the many consequences of these ongoing processes, acquiring new skills and deepening existing ones, especially in the realm of ICT, is of particular importance. Achieving an appropriate level of competence is essential, both in the micro dimension – the spheres of work and everyday life of individuals – and in the macro dimension, as it conditions stable and systematic socio-economic development.

In the information society, an important role, in addition to access to ICT, is also played by using modern technologies, which is inextricably linked to establishing and enhancing appropriate competencies referred to as digital. The rapid development of technology and artificial intelligence is transforming the way we learn and work. In contrast, the need to interact with technology and collaborate with AI necessitates unique skills that are essential in the realm of modern technologies. These skills encompass not only basic knowledge of digital tools but also a deeper understanding of the operational principles of AI and other advanced technologies. Employees must be able to cooperate effectively with AI systems and comprehend their capabilities and limitations. Skills related to data analysis, programming, and management of technological projects are increasingly crucial. In the context of AI, the ability to interpret results generated by algorithms and make business decisions based on these results is invaluable. Nowadays, everyone should possess a foundational understanding of artificial intelligence to consciously and safely utilize its potential. (Luckin, George, & Cukurova, 2022).

### *5.1. Skills and Competences as a Key Element of AI Strategy*

The lack of appropriate digital competencies in society is a significant barrier to the effective implementation and use of artificial intelligence. This is why OECD countries emphasize education and raising awareness of AI at all levels of education and through continuing education programs.

The lack of appropriate competences is becoming a serious obstacle to using AI tools. In the strategies for implementing artificial intelligence in OECD countries, the issue of society's digital competences is treated as a key element enabling the effective use of AI's potential and adaptation to changes in the labor market. Many countries emphasize the need to raise awareness and understanding of AI among citizens at all levels of education, from primary schools to universities, as well as through continuing education programs and vocational training. For example, in Poland, the AI strategy assumes actions aimed at making the country one of the primary beneficiaries of the data-based economy and

increasing the digital competences of Polish society. Similar goals for raising awareness and digital competences can be found in the strategies of Lithuania, Luxembourg, the Czech Republic, Finland, Germany, Sweden, Slovenia, Latvia, and Denmark. The strategies often include specific educational initiatives, such as integrating AI topics into curricula at various levels, creating specialized AI-related courses and study programmes, and supporting training and retraining for people whose jobs may change due to AI developments.

An example is Finland, which promotes initiatives such as free online courses 'Elements of AI' to raise general awareness of AI, a free online course created by the University of Helsinki, aimed at introducing the subject of artificial intelligence to a broad audience. The course does not require advanced mathematical knowledge or programming skills, making it accessible to anyone who wants to understand what AI is, what its capabilities and limitations are, and how it affects our lives. The main goal of the initiative is to increase awareness and understanding of AI among the public. It has gained tremendous popularity, with over a million registered users from over 110 countries. It is worth adding that the Finnish government actively supports and promotes "Elements of AI" as part of its AI development strategy in the country, aiming to raise the level of digital competence of citizens. The course has been translated into many languages.

AI. Estonia plans to develop a similar online course based on the Finnish model. OECD countries recognize that raising the level of digital literacy in society is essential not only for economic development and innovation but also to ensure that AI is used ethically and responsibly, respecting human rights and democratic values. As such, investment in education and digital literacy is an essential element of many national AI strategies.

### 5.2. Frameworks of AI Skills

Defining and categorizing the skills required in the age of AI is a complex and evolving task, crucial for designing effective educational programs and policies. The discourse has moved beyond simple digital literacy towards a more nuanced understanding of AI-specific competencies. AI literacy involves a basic understanding of AI concepts, capabilities, limitations, and societal implications, enabling individuals to interact critically and effectively with AI systems. Competencies represent a broader set of skills, knowledge, attitudes, and abilities needed to perform specific tasks or roles in an AI-influenced environment.

Several frameworks attempt to structure the diverse range of AI-related skills. UNESCO has developed separate competency frameworks for students (UNESCO, 2024) and teachers (UNESCO, 2025). The student framework emphasizes four interlinked aspects: human-centred mindset, ethics of AI, AI techniques and applications, and AI system design, each with progression levels (understand, apply, create). The teacher framework outlines 15 competencies across five dimensions: human-centred mindset, ethics of AI, AI foundations and applications, AI pedagogy, and AI for professional learning, also with progression levels (acquire, deepen, create).

WEF (World Economic Forum, 2025a) global skills taxonomy aims to provide a structured, shared language for skills to align businesses, governments, and education providers. It categorizes skills broadly into Skills/Knowledge/Abilities and Attitudes. While not exclusively focused on AI, it explicitly includes "Artificial intelligence and big data" as a key skill area, alongside related competencies like technological literacy. Its value lies in facilitating communication and alignment across different sectors regarding skill requirements.

US Office of Personnel Management (OPM) AI Competency Model, developed specifically for US federal government AI roles, distinguishes between 43 general competencies (e.g., critical thinking, problem-solving, accountability, teamwork, ethical reasoning) and 14 technical competencies (e.g., AI/ML, data analysis, modeling and simulation, software engineering). It emphasizes a shift towards skills-based hiring, prioritizing demonstrated proficiency over traditional credentials.

The OECD has developed frameworks for classifying AI *systems* based on dimensions like context, data, model, and task, which indirectly inform the skills needed to develop, deploy, and govern such systems. Academic and library-specific frameworks also exist, often categorizing skills into areas like knowledge and understanding, analysis and evaluation, use and application, and ethical considerations. The NIST AI Risk Management Framework, while focused on risk, outlines characteristics of trustworthy AI (e.g., valid, reliable, safe, fair, transparent, accountable) that imply necessary skills for

developers and users (National Institute of Standards and Technology, 2023). Table 1 provides the overview of selected frameworks.

**Table 1.** Comparative analysis of major AI skill/competency frameworks

Framework	Primary Target Audience	Key Skill Categories/Dimensions	Emphasis
UNESCO Student Framework	Students (K-12/Higher Ed)	Human-centred mindset, Ethics of AI, AI techniques & applications, AI system design	Foundational Literacy, Ethical Use, Human-Centricity, Progression Levels
UNESCO Teacher Framework	Teachers	Human-centred mindset, Ethics of AI, AI foundations & applications, AI pedagogy, AI for professional learning	Teacher Training, Ethical Pedagogy, Classroom Integration
WEF Skills Taxonomy	Global Businesses, Govts, Education	Skills/Knowledge/Abilities (incl. AI & Big Data, Tech Literacy), Attitudes	Workforce Readiness, Shared Language, Alignment Across Sectors
US OPM AI Competency Model	US Federal Workforce	General Competencies (Cognitive, Soft, Foundational), Technical Competencies (AI/ML, Data, Modeling, Systems Design, Ethics)	Government Workforce Needs, Skills-Based Hiring, Technical & General Mix
ALA Library	Academic Library Professionals	Knowledge & Understanding, Analysis & Evaluation, Use & Application, Ethical Considerations, Dispositions (e.g., Adaptability)	Domain-Specific Application (Libraries), Information Literacy Context
NIST AI RMF	AI Developers, Deployers	Implied by Trustworthiness Characteristics: Valid, Reliable, Safe, Secure, Fair, Transparent, Accountable, Privacy-Enhanced	Risk Management, Trustworthy AI Development

*Source:* own elaboration.

Synthesizing across these diverse frameworks reveals recurring and essential dimensions of AI skills: technical, application and domain, cognitive and soft, ethical and societal. Technical skills cover foundational understanding of AI concepts (machine learning, natural language processing, deep learning), data literacy (collection, processing, analysis), programming proficiency, algorithm development, AI system design and architecture, and the practical ability to use various AI tools and platforms. Cognitive and soft skills relate to higher-order thinking skills such as critical analysis, complex problem-solving, creativity, and strategic thinking. Also crucial are adaptability, flexibility, learning agility (lifelong learning), collaboration, communication, emotional intelligence, and interpersonal skills. These are often highlighted as increasingly important human skills that complement AI's capabilities. Application and domain skills represent ability to effectively identify opportunities for AI application and integrate AI tools into specific workflows, tasks, and professional domains (e.g., using AI for medical diagnosis, educational personalization, financial modeling, or scientific research). This requires combining AI knowledge with domain-specific expertise. Ethical and societal skills Critical understanding of ethical principles related to AI (fairness, accountability, transparency), awareness of potential biases in data and algorithms, knowledge of data privacy regulations, ability to assess the societal impacts of AI deployment, and commitment to responsible AI development and use (National Institute of Standards and Technology, 2023).

While these frameworks offer valuable perspectives and categorizations, a significant challenge remains: the lack of a universally adopted, standardized taxonomy specifically designed for policy purposes that consistently and clearly distinguishes between AI development and AI adoption skills. The existence of multiple, overlapping, yet distinct frameworks highlight a significant challenge: the lack of a single, universally accepted, detailed taxonomy for AI skills. Terminology varies (literacy, competency, skills), and categorizations differ (levels, themes, roles). Some focus broadly on digital skills, while others are AI-specific. This ambiguity and fragmentation can hinder the design of precisely

targeted government interventions and make comparative evaluation difficult. Establishing a more common policy language remains an important goal for effective national and international strategy development.

### *5.3. The AI Skills Gap and Workforce Development Needs*

A significant body of evidence points towards a growing gap between the demand for AI-related skills and the supply available in the workforce, often referred to as the ‘AI skills gap’. Surveys consistently indicate that employers perceive a significant skills gap within their organizations, hindering their ability to adopt and leverage AI technologies effectively. The World Economic Forum’s Future of Jobs Report 2025, for instance, highlights that skill gaps remain a primary barrier to business transformation, with a large percentage of employers citing this challenge. Executives estimate that a substantial portion of their workforce, potentially up to 40%, will require reskilling in the near future due to AI implementation (Frank Hawkins Kenan Institute of Private Enterprise, 2025a). This perceived gap fuels calls for a ‘reskilling revolution’.

The potential impact of AI on employment is a subject of intense debate and analysis. While some fear widespread job losses due to automation, the dominant view suggests a more nuanced picture involving both task automation and job augmentation. AI is demonstrating capability in automating routine cognitive and non-routine tasks previously thought immune, potentially affecting professions ranging from clerical work to programming and analysis. Estimates suggest a significant percentage of workers will see at least some tasks affected by AI, with a smaller but notable portion facing substantial task automation. However, complete job displacement is considered less likely for many roles than a transformation of tasks within those roles. AI is expected to complement human workers, taking over routine elements and freeing up time for more complex, creative, or interpersonal activities, thereby potentially enhancing productivity (Frank Hawkins Kenan Institute of Private Enterprise, 2025a). This augmentation effect, coupled with economic growth spurred by AI, is also projected to create new jobs, particularly in AI development, data science, cybersecurity, and roles requiring human-AI collaboration. The net effect on employment remains uncertain and likely varies significantly across industries and occupations.

The AI-driven transformation inevitably alters the demand for specific skills. Technical skills related to AI and big data are consistently identified as the fastest-growing and most in-demand competencies. Technological literacy, network and cybersecurity skills are also projected to rise sharply in importance. Conversely, demand for skills associated with routine manual and administrative tasks is expected to decline due to automation. Interestingly, OECD research suggests that for many non-specialist roles highly exposed to AI, the most demanded skills initially were management and business skills (project management, finance, administration), although recent data hints at a potential decline in demand even for these, suggesting a complex and dynamic shift. Crucially, alongside technical skills, there is a growing emphasis on human-centric, cognitive, and socio-emotional skills. Analytical and creative thinking, problem-solving, resilience, flexibility, agility, curiosity, emotional intelligence, communication, and lifelong learning are frequently cited as critical competencies for navigating the future of work. This ‘soft skills paradox’ arises because as AI handles more technical and analytical tasks, the unique value humans bring lies increasingly in areas like complex judgment, ethical reasoning, creativity, and interpersonal interaction.

The existing workforce and general population often exhibit low levels of AI literacy and data literacy (Sidhu et al., 2024). Many individuals lack a basic understanding of AI concepts, how these systems work, or their potential implications. This limits their ability to use AI tools or critically engage with AI-driven information effectively. Nontraditional educational pathways, such as online courses (MOOCs), coding boot camps, industry certifications, and micro-credentials, are playing an increasingly important role in bridging the skills gap. These often offer more flexible, targeted, and rapidly updated training options than traditional degrees. However, questions may remain regarding the quality, recognition, and accessibility of these alternative credentials.

The AI skills gap also has significant global and regional dimensions. Developed economies generally exhibit higher demand for AI skills and possess greater capacity for AI development and training, though they still face shortages. Developing countries often lag significantly behind due to inadequate digital infrastructure, limited investment in education and R&D, and fewer resources for workforce reskilling. This disparity creates a risk of a widening ‘AI divide’, where the benefits of AI

are concentrated in a few leading nations and corporations, while others fall further behind, potentially exacerbating global inequalities. Paradoxically, while a smaller percentage of jobs in developing countries may be currently exposed to automation, these nations may be less equipped to manage the transition or leverage AI for productivity gains due to these underlying gaps.

The identified skills gap and the transformative nature of AI necessitate urgent and large-scale workforce development efforts. This includes significant investment in reskilling and upskilling programs for the existing workforce, fostering a culture of lifelong learning, and adapting formal education systems (primary, secondary, tertiary, and vocational) to equip future generations with relevant competencies. AI itself can play a role in enhancing workforce development through personalized learning platforms and predictive analytics to identify emerging skill needs.

#### *5.4. Distinction Between AI Development and AI Adoption Skills Gaps*

Understanding the nature and scale of the AI skills gap is fundamental to designing effective policy responses. This gap is not uniform; it varies significantly between the specialized skills needed for AI development and the broader competencies required for AI adoption.

Evidence consistently points to a high and rapidly growing demand for individuals possessing AI development skills. Job postings for roles such as AI specialists, machine learning engineers, data scientists, and AI researchers have surged globally across numerous industries. Reports from organizations like the World Economic Forum and LinkedIn, as well as labor market data, indicate significant annual growth rates for these specialized roles, often outpacing overall job growth (World Economic Forum, 2025b). For example, one analysis found that for every AI job posting in 2012, there were seven in 2024, with postings requiring AI skills growing 3.5 times faster than all job postings since 2016 (PricewaterhouseCoopers, 2024).

The mismatch between demand and supply results in critical talent shortages, particularly for high-end AI development roles. Numerous reports document the difficulty organizations face in recruiting and retaining qualified ML engineers, data scientists, and AI researchers. Some estimates suggest only a small fraction of data scientists possess the specialized skills needed for advanced AI work. This acute shortage acts as a bottleneck for innovation and AI deployment.

Initially concentrated in the technology sector, the demand for AI development talent is broadening as AI adoption diffuses across the economy. Sectors such as financial services, healthcare, information technology, professional services, manufacturing, and even agriculture are increasingly seeking professionals who can build and deploy AI solutions. The specific technical skills most sought after by employers align closely with the development competencies outlined previously, particularly proficiency in Python and key ML libraries, cloud platforms (like AWS and Azure), deep learning frameworks, and data engineering capabilities. This intense demand translates into significant wage premiums for workers possessing these specialized AI skills, reported to be up to 25% on average in some markets, and even higher within specific professions like law or finance.

Simultaneously, there exists a potentially larger, though less precisely measured, gap in AI adoption skills across the broader workforce. Surveys of employers and employees reveal a growing expectation that workers in nearly all roles will need some level of AI literacy and the ability to interact effectively with AI tools. A significant majority of students expect their educational institutions to equip them with relevant AI skills, and workers express willingness to retrain for AI-related competencies.

While the shortage of AI specialists receives significant attention, the lack of widespread AI literacy, critical evaluation skills, and ethical awareness may pose a more pervasive barrier to realizing the full economic and societal benefits of AI. If most of the workforce cannot effectively and responsibly use AI tools, productivity gains will be limited, and the risks of misuse or negative societal impacts increase. This highlights a crucial point: the AI skills gap is not monolithic. Policy interventions focusing solely on producing elite AI developers risk neglecting the vast need for foundational and applied AI competencies across the entire population, thereby failing to prepare society adequately for AI integration.

This demand is driven by the way AI is reshaping work. Rather than simply automating jobs wholesale, AI is often augmenting tasks, requiring humans to work alongside AI systems. This human-AI collaboration necessitates new skills. Employees need to understand how to prompt Generative Artificial Intelligence tools to get desired outputs effectively (prompt engineering), critically evaluate

the information AI provides (checking for bias, accuracy, and relevance), understand the ethical implications of using AI in their work, and adapt their workflows to incorporate AI-driven insights.

Furthermore, as AI handles more routine analytical and operational tasks, there is an increasing emphasis on complementary "human skills" (Strietska-Ilina et al., 2021). Skills such as critical thinking, complex problem-solving, creativity, communication, collaboration, leadership, and emotional intelligence are becoming more valuable as they represent areas where humans currently maintain an advantage over AI and are essential for navigating the complexities of an AI-augmented workplace (Sidhu et al., 2024). Table 2 highlights the differences between AI development and AI adoption across key categories.

**Table 2.** Estimated AI skills gap dimensions (development vs. adoption)

Categories	AI Development	AI Adoption
Specific Skill Examples	Machine Learning Engineer, Data Scientist, AI Researcher, Algorithm Developer.	AI Literacy, Data Interpretation, Critical Evaluation, Ethical Use, Prompt Engineering, Human-AI Collaboration.
Evidence of Demand	High job posting growth.	Growing demand across <i>all</i> sectors; High employee/student interest; Need for skills complementary to AI (critical thinking, communication).
Evidence of Supply/Shortage	Widely reported shortages; Difficulties in recruiting; High wage premiums.	Generally low existing literacy in workforce/public; Potential insufficiency of training supply for general literacy; Education lag.
Key Affected Sectors	Technology, Finance, Healthcare, Professional Services, Information & Communication.	All sectors undergoing digital transformation; Knowledge work, Customer service, HR, Marketing, Healthcare, Education.
Regional Variations	Concentrated demand in developed economies; Global competition for limited talent pool.	Significant gaps in developing countries due to infrastructure/education deficits; Risk of AI Divide/Exclusion.

*Source:* own elaboration.

Accurately quantifying these gaps remains challenging. Measuring specialized technical skills through job postings or degree completions is relatively straightforward, but assessing broader competencies like AI literacy or ethical reasoning across diverse populations requires more complex and standardized assessment tools, which are still under development (Strietska-Ilina et al., 2021). The dynamic nature of AI further complicates the picture. The skills required today may differ significantly from those needed in a few years. This suggests a feedback loop: a lack of adoption skills can dampen demand signals for specialized AI development relevant to specific sectors. At the same time, a shortage of developers slows the creation of user-friendly tools that could facilitate broader adoption. Government policy must recognize and address this interplay between the development and adoption skills gaps to foster a virtuous cycle of innovation and effective utilization.

#### 5.4. Conceptualizing AI Skills in the Policy Context

The rationale for government intervention in workforce skills development is well-established in economic and policy theory. Market failures often lead to underinvestment in training, particularly for general skills that are transferable across firms. Employers may be reluctant to invest heavily in training if competitors can easily poach skilled workers, while individuals may face credit constraints or lack information about future skill demands (Glover & King, 2010). Furthermore, a skilled workforce generates positive externalities, benefiting society beyond the direct returns to individuals and firms through increased innovation, productivity, and adaptability (Lopes, Sargento, & Farto, 2023). Human capital theory posits that investments in education and skills are crucial drivers of economic growth. In contrast, endogenous growth theory highlights the synergistic relationship between human capital, technological advancement, and economic progress.

In the context of rapid technological change, such as the current digital and AI transformation, these justifications for government intervention become even more salient. The pace of change often outstrips

the ability of individuals and firms to adapt, creating skills mismatches and potential labor market disruptions (Strietska-Ilina et al., 2021). Governments, therefore, have a legitimate role in steering skill development to align with emerging technological paradigms and national strategic goals, ensuring both economic competitiveness and inclusive growth (Hong, Wang, Fu, & Li, 2024). Policies targeting digital and AI skills are increasingly seen as essential components of national innovation systems, aimed at correcting market inefficiencies, fostering the necessary human capital for technological absorption, and guiding development towards societal priorities (Digital Regulation Platform, 2023).

AI is widely recognized not just as another technology but as a general purpose technology, with the potential to alter most economic processes and activities fundamentally. Its impact is expected to be pervasive, driving significant productivity gains, enabling the creation of new industries and business models, and transforming labor markets and the delivery of public services. This transformative potential creates powerful incentives for governments to shape the development and deployment of AI actively.

A dual imperative drives policy interventions: harnessing the immense opportunities AI presents while simultaneously mitigating its inherent risks. On the one hand, governments seek to leverage AI for economic growth, scientific advancement, improved public sector efficiency, and solutions to societal challenges. On the other hand, they must address significant concerns regarding potential negative consequences, including widespread job displacement due to automation, the exacerbation of income inequality, risks to privacy and data security, and the potential misuse of AI for malicious purposes. Developing appropriate skills across the population is central to achieving this delicate balance. A workforce equipped with relevant AI skills is better positioned to adapt to labor market changes, utilize AI tools productively, and contribute to innovation. Simultaneously, broad AI literacy and ethical awareness are crucial for ensuring responsible deployment, fostering public trust, and enabling informed societal debate about AI governance.

## 6. GOVERNMENT STRATEGIES AND POLICIES FOR CULTIVATING AI SKILLS

Governments have long intervened in markets related to technology, education, and labor, based on various theoretical justifications. Understanding these established paradigms provides context for analyzing government actions aimed explicitly at shaping AI skills. Standard economic theory justifies government intervention primarily to address market failures or achieve equity goals. Market failures relevant to AI skills include externalities, information asymmetries, coordination failures, and public good.

The societal benefits of a skilled workforce (e.g., innovation, productivity spillovers, informed citizenry) may exceed the private benefits accruing to individuals or firms, leading to underinvestment in skills without intervention (Poterba, 1996). AI development itself can generate positive externalities (knowledge spillovers) or negative ones (e.g., societal disruption, security risks), (Taeihagh, 2021). Information asymmetries mean that individuals may lack information about future skill demands or the quality of training providers. Employers may struggle to assess the skills of potential hires accurately (World Economic Forum, 2025a). Aligning the actions of diverse stakeholders towards a common goal like developing a national AI skills base may require government coordination. Beyond market failures, governments intervene to promote equity, reduce inequality, and ensure social protection, for instance, by ensuring access to education, providing safety nets for displaced workers, or enacting anti-discrimination measures. The specific context of AI, characterized by rapid, potentially disruptive change, high uncertainty, network effects, significant ethical considerations, and strategic geopolitical importance, arguably strengthens the rationale for proactive government involvement. Public good in the form of foundational research in AI, like other basic science (non-rivalrous, non-excludable), also potentially requires public support (Howell, 2024). General AI literacy might also be considered a public good necessary for democratic participation in the AI age.

Governments employ various tools to foster technological advancement, including direct funding of R&D (especially basic research in universities and public labs), tax incentives for private R&D, subsidies for technology adoption, government procurement policies that create demand for new technologies, intellectual property protection, and the setting of technical standards. The focus is often on supporting "failure-tolerant, open-ended research" that yields breakthroughs.

The government's role in education is pervasive, encompassing funding (primary, secondary, tertiary), curriculum setting or guidance, teacher training and certification, quality assurance and accreditation, provision of public education, financial aid to students, and policies aimed at ensuring equitable access and outcomes (UNESCO IESALC, 2025). A key function is linking the education system to the needs of the labor market, although this alignment is often challenging, particularly with rapid technological change. AI introduces specific challenges, such as the need to update curricula rapidly, train educators, ensure ethical use of AI tools in classrooms, and address potential impacts on academic integrity and equity (Global Solutions Initiative, 2024).

Governments influence labor markets through a wide range of policies, including setting minimum wages, regulating working hours and conditions, providing unemployment insurance and social assistance, enacting employment protection legislation (hiring/firing rules), supporting collective bargaining and unionization, implementing anti-discrimination laws, funding active labor market policies like job search assistance and training programs, and managing migration policies. These policies interact significantly with technological change; for example, strong employment protection might slow down labor reallocation in response to automation, while robust training programs and social safety nets can ease worker transitions. Some argue that strengthening worker power through labor policy is itself a crucial form of technology policy, enabling workers to shape technology adoption in the workplace (Economic Policy Institute, 2024).

The historical tendency for policymaking to react to technological disruption rather than proactively shape it presents a particular challenge in the context of AI. The unprecedented speed of AI development strains the capacity of traditional policy cycles and educational institutions to adapt, potentially leading to persistent skills gaps and reactive, rather than strategic, policy responses (Frank Hawkins Kenan Institute of Private Enterprise, 2025a).

### *6.1. Policy Rationale and Objectives for AI Skills Development*

Why should governments support AI skill development? This section articulates the motivations and goals behind policy interventions, distinguishing between objectives related to *AI Development Skills* and those related to *AI Adoption Skills*. While overlapping, each has a somewhat different policy rationale.

The major rationale behind supporting AI Development Skills is that these are crucial for national competitiveness and technological sovereignty. Advanced AI skills enable domestic innovation, startup creation, and productivity gains in the economy. Nations with more AI researchers and engineers are better positioned to create cutting-edge AI products and intellectual property. Public policy thus aims to expand the supply of AI specialists to fuel the innovation ecosystem. For example, the EU explicitly notes that to remain globally competitive, Europe needs more professionals with specialized AI skills who can contribute to AI research and the rollout of AI systems (European Commission, 2021). A larger AI talent pool can accelerate technological breakthroughs and economic growth.

Many governments view AI talent as a strategic resource in the global race for technology leadership. Cultivating domestic AI expertise is seen as essential to reducing reliance on foreign technology and talent. This has national security and industrial policy dimensions. By supporting AI education, governments aim to secure a seat at the table in defining the future of AI. Ensuring a self-sufficient talent base in critical areas like AI can be part of maintaining technological sovereignty.

Fostering AI development skills is also about job creation in high-value sectors. Policymakers encourage the growth of AI expertise to attract investments and create high-paying jobs for citizens. Regions with strong pools of AI specialists can become hubs for tech industry growth, as shown by how skilled labor availability has driven clustering in past tech booms. Thus, one policy goal is to create a virtuous cycle: more skilled AI workers lead to more AI companies and projects, fostering more innovation and jobs.

In practice, these rationales translate into concrete targets in policy agendas: for example, aiming to double the number of AI graduates or researchers over a decade, or to have world-class AI research institutions. Achieving these goals typically involves both short-term measures (like attracting existing talent via immigration or industry partnerships) and long-term measures (educational reforms). Ultimately, supporting AI development skills is about building capacity at the frontier of technology, ensuring the country can invent and not just import AI solutions. The theoretical benefit is a higher national absorptive capacity for new innovations and a stronger hand in shaping AI's trajectory globally.

Equally important is the rationale for developing AI Adoption Skills across the general workforce and society. AI's promise of productivity gains will only be realized if businesses and workers can effectively *use* AI tools. A core rationale is to prepare the current workforce to work alongside AI, thereby boosting productivity in all sectors, not just tech. This means upskilling workers so they can integrate AI into manufacturing, healthcare, finance, public services, etc. Governments support broad AI literacy and reskilling programs to ensure that AI-driven innovations diffuse widely through the economy (avoiding a scenario where only a few firms or sectors benefit). In policy terms, this is about technological diffusion, enabling small and medium-sized enterprises (SMEs) and traditional industries, especially, to adopt AI by having employees and managers who understand it.

As AI automates certain tasks, workers need to adapt by moving to tasks that are complementary to AI. Public policy has a protective rationale here: to prevent unemployment or skills mismatch, governments invest in training programs that help workers transition into new roles where AI is a tool rather than a threat. One goal is to future-proof the workforce by fostering adaptability – teaching not only specific tools, but learning-to-learn, digital agility, and foundational data skills so workers can continuously evolve alongside AI advances (Organisation for Economic Co-operation and Development, 2023). By doing so, policymakers aim to reduce the risk of technological unemployment and ensure a smoother adjustment to AI's labor market impacts.

Governments also want to ensure all groups can participate in the AI-driven economy to prevent divides. Raising digital and AI literacy helps workers utilize AI tools and avoid job market polarization. Inclusive policies, like community workshops and targeted programs for underrepresented groups (e.g., women in AI) or rural areas, foster equitable access to AI-related skills.

Beyond the private sector, adoption skills are needed in government and among citizens for AI-enabled public services (e.g. healthcare AI systems used by doctors, AI in education used by teachers, etc.). A policy goal is to improve public sector innovation capacity by training civil servants in digital and data competencies (Mettler, Miscione, Jacobs, & Guenduez, 2024). Likewise, an informed citizenry that understands AI can better navigate issues like data privacy, algorithmic decisions in daily life, and civic debates on AI ethics. In this sense, promoting AI literacy for the public also has a democratic rationale – empowering citizens to engage with the societal implications of AI.

An important goal is fostering ethical AI use by training experts, end-users, and managers on AI bias, fairness, transparency, and safety to build public trust. Educating users on AI ethics helps them make informed decisions and encourages acceptance of AI. Policies highlight the need for understanding AI's limitations, promoting skills like recognizing algorithmic biases through guidelines and training.

In summary, the policy rationale for AI adoption skills revolves around empowering the broader population to work with AI, thus amplifying economic benefits while safeguarding employment and social cohesion. The ultimate goal is an AI-ready workforce and informed society, capable of leveraging AI in a way that enhances productivity and well-being. These rationales complement the innovation-centric goals for development skills: together, they ensure that AI's creation and diffusion are both supported by an enabling skill base.

### *6.2. Conceptual Frameworks for Government Intervention in AI Skill Formation*

Building on the above, different conceptual frameworks can be used to analyze how governments can intervene to shape AI skills. These frameworks offer theoretical lenses for understanding policy action in this domain. We propose here to distinguish between:

1. Human capital investment and market failure framework.
2. Innovation ecosystem and triple helix framework.
3. Social inclusion and public value framework.

From an economic perspective, government intervention in AI skills can be seen as an investment in human capital to correct market failures. In this framework, AI-related skills (both high-end development skills and general digital abilities) are treated as a form of capital that yields social returns – fueling innovation, productivity, and employment. Left alone, markets may underproduce these skills: individual workers may under-invest in expensive training, and firms may poach skilled employees rather than train their own, leading to overall shortages. The role of government, then, is to ensure an adequate supply of AI skills by funding education and training, providing incentives for lifelong learning, and sharing information about skill needs. Policies are justified on efficiency and equity grounds. In short, the government acts as an investor in the nation's AI talent, stepping in where private

actors underinvest, to maximize public value and avoid skill gaps that could hamper AI adoption or exacerbate inequality.

A second framework situates AI skill development within the broader *innovation ecosystem*, emphasizing the interplay between government, industry, and academia (often described by the ‘triple helix’ model). Here, the government’s role transcends funding and includes strategic coordination and vision-setting. Public policy is viewed as a catalyst that brings together universities (which supply education and research), businesses (which demand skills and provide practical training), and government agencies (which regulate and often employ AI talent) to create a robust pipeline of AI competencies. The focus is on systemic capacity-building – for example, establishing research centers of excellence that double as training grounds for AI scientists, or curriculum co-design between industry and educational institutions to keep skills aligned with fast-moving AI advances. This approach also stresses agility and foresight: government continuously scans emerging technology trends and adapts skill programs proactively.

A third framework emphasizes the normative goals of skill policy, viewing government as a steward of inclusive growth and ethical technology use. In this perspective, beyond economic calculus, public policy on AI skills is driven by the mandate to empower citizens to participate in the digital society and to mitigate the social risks of AI (like unemployment or digital divides). Government interventions are framed by concepts of digital inclusion, equity, and public value creation. This means ensuring that AI skills initiatives reach diverse groups, including underrepresented communities in tech, older workers, and those in regions or sectors at risk of being left behind (European Commission, 2021).

Together, these conceptual frameworks provide a multi-dimensional understanding of why and how governments intervene in AI skill formation. They are not mutually exclusive; an effective national strategy may draw on all three – investing in human capital, coordinating the innovation ecosystem, and pursuing inclusion – as we will explore in the policy recommendations.

### 6.3. Proposed National AI Strategy Archetypes

Recognizing the strategic importance of AI skills, governments globally are implementing a wide array of policies and initiatives. The focus and combination of these interventions vary significantly, reflecting different national priorities, economic contexts, and institutional capacities. However, analyzing these strategies reveals distinct approaches to tackling the dual challenges of fostering AI development and enabling widespread AI adoption.

While nearly every national AI strategy acknowledges the importance of skills (Futurium, 2025), the specific emphasis and policy mix often align with broader strategic goals, leading to discernible archetypes (CIFAR, 2018). Comparative analyses, such as the Brookings Institution (2025) cluster analysis and reviews by organizations like CIFAR and OECD (Galindo, Perset, & Sheeka, 2021), help illustrate these patterns.

The first category may be characterized as development-led. These strategies prioritize building national capacity to create and innovate in AI. They focus heavily on funding fundamental and applied R&D, establishing elite research centers, and attracting/retaining top-tier international talent (PhD researchers, experienced engineers). Early strategies in countries like Canada, as well as the stated ambitions of China, often exhibit elements of this approach, aiming for global leadership in AI creation (CIFAR, 2018).

The second group, adoption-led strategies, emphasizes preparing the broader society and economy to utilize AI effectively and responsibly. Policies may focus on nationwide digital literacy programs, extensive workforce reskilling initiatives, promoting AI adoption in the public sector, and establishing robust ethical and governance frameworks. Aspects of the EU's approach, focusing on trustworthy AI and digital single market integration (Futurium, 2025), and Singapore's strategy emphasizing deployment across all sectors (Civil Service College Singapore, 2025), align with this archetype.

The third broad type of strategies may be characterized as balanced, comprehensive approaches. These strategies attempt a more holistic approach, simultaneously investing in high-end talent and R&D while also implementing programs for widespread digital literacy and workforce adaptation. Later iterations of national strategies, and potentially the multi-faceted approach seen in the US (combining R&D funding, STEM education pushes, and workforce initiatives), may fall into this category. Cluster 1 in the Brookings analysis (including India, Mexico, US) planned to use various capability development sources (Brookings Institution, 2025).

These archetypes are not mutually exclusive, and national strategies evolve over time. However, they highlight a potential tension: allocating finite resources and policy attention between cultivating a small pool of elite AI creators versus equipping the entire population with the skills to navigate an AI-driven world. (Brookings Institution, 2025). The optimal balance likely depends on a nation's specific context, including its existing industrial base, educational system, and strategic goals.

#### 6.4. Policy Instruments and Mechanisms for AI Skill Formation

Having identified the *why*, we now explore *how* governments can achieve these goals – the policy tools and mechanisms available to support AI skill development and adoption. In theory, governments have a broad toolkit, ranging from education system reforms to labor market incentives. We categorize these instruments into several key types:

- Educational curriculum reform (pre-university) as one of the foundational levers, to integrate digital and AI-related content into general education. Governments can update school curricula to include computational thinking, coding, and basic AI concepts at earlier stages (primary and secondary education). The aim is to build strong STEM foundations and digital literacy for all students, creating a talent pipeline and a populace comfortable with technology. This policy category ensures the next generation enters the workforce with significantly higher baseline digital competencies than previous ones – a long-term strategy for closing skill gaps.
- Higher education and research initiatives, to expand the capacity of universities and research institutes to produce AI experts. This includes funding new AI degree programs, centers of excellence, and scholarships. Such initiatives increase the output of qualified AI graduates and often incorporate industry partnerships for real-world experience. Another tool is updating university curricula to be interdisciplinary – combining computer science with ethics, business, or domain fields – so that graduates have well-rounded skills for AI development and deployment.
- Vocational training and lifelong learning programs to upskill and reskill adults for AI and digital tasks. This can include government-sponsored training courses, tech bootcamps, online learning subsidies, or expansion of vocational education to cover data analytics and AI. A particular emphasis should be placed on vulnerable groups, low-skilled workers, those in declining occupations, or older workers who get targeted training to adapt to AI changes (Organisation for Economic Co-operation and Development, 2023). Lifelong learning mechanisms also include public employment services providing counseling
- Incentives for employer-led training. Tools here include tax incentives or credits for training expenditures, grants or co-funding for corporate training programs, and recognition awards for companies that excel in workforce development (Organisation for Economic Co-operation and Development, 2025). Some governments set up public-private partnerships where the public sector matches training investments by industry in critical areas (for example, a government might co-finance an AI apprenticeship program run by a consortium of tech companies and universities). Another mechanism is incorporating training requirements or skills development plans into broader innovation grants. Governments may also mandate specific industries to ensure staff are trained in AI ethics or data handling (Organisation for Economic Co-operation and Development, 2023). By lowering the cost or sharing the burden of training, these incentives align private sector behavior with the public goal of a more AI-skilled workforce.
- National skills strategies and coordination bodies that serve as umbrella frameworks aligning various policies. Within these, governments often establish dedicated bodies or task forces (for example, a national AI skills council) to coordinate efforts across ministries (education, labor, industry) and with stakeholders (tech companies, academia, training providers). This ensures coherence, linking education reforms with industry needs and avoiding duplication. For instance, as of 2021, all EU Member States with AI strategies included a skills dimension coordinating actions from school curricula to lifelong learning in a unified plan (European Commission, 2021).
- Digital infrastructure for skills development includes not only physical infrastructure but also platforms and content. Governments can create open educational resources for AI, such as free online tutorials, and promote massive open online courses (MOOCs) on AI topics for widespread reach. For example, Finland's government-backed 'Elements of AI' online course

became a globally popular resource for teaching citizens basic AI concepts. By strengthening the enabling environment for skill development, these investments enhance the effectiveness of educational and training policies.

- Regulatory and ethical guidelines, frameworks, and accreditation standards serve as various ‘soft’ policy tools that indirectly promote the need for skills. For example, if a government issues an AI ethics framework for industry, companies may respond by training their staff in those principles. Similarly, requiring transparency or risk assessments for AI systems in specific sectors might necessitate new expertise, effectively creating demand for training in those areas. This mechanism underscores that policy encompasses not only funding and programs but also shaping the incentive landscape for skill development.
- Public-Private Partnerships (PPPs) as an emerging prominent mechanism for AI skills development. This trend reflects the recognition that neither sector can effectively address the rapidly evolving skills landscape alone (Access Partnership, 2025). PPPs aim to leverage the strengths of each sector: the public sector’s reach, mandate for equity, and educational infrastructure, combined with the private sector’s cutting-edge technological knowledge, understanding of market needs, agility, and resources. Existing case studies illustrate various PPP approaches, such as the California State University system partnering with major tech companies (Microsoft, OpenAI, Google) to provide AI tools (ChatGPT Edu) and training access to students and staff, the National Applied Artificial Intelligence Consortium involving community colleges and companies like Dell and Intel (California State University, 2025). The potential benefits include leveraging private sector expertise and agility, pooling resources, ensuring market relevance of training, and scaling initiatives more rapidly. However, challenges include ensuring alignment of public and private goals, establishing effective governance structures, managing intellectual property, and ensuring equitable access and outcomes, particularly for underserved populations. Examples like Singapore’s multi-stakeholder approach to its national strategy or US initiatives leveraging industry commitments for K-12 education (The White House, 2025) illustrate the diverse ways PPPs are being employed.

In deploying these mechanisms, policymakers must consider the appropriate mix and sequencing. Early in the AI adoption curve, heavy investment in awareness and education might be needed; as the ecosystem matures, incentives for specialized training and continuous learning gain prominence. A theoretical insight is that an optimal policy mix addresses both the supply and demand of skills. By aligning these, governments can more effectively shape the evolution of AI skills in society.

### 6.5. Policy Levers for AI Development and Adoption Skills

Following the proposed distinction between *AI development* and *AI adoption skills*, governments may employ several key policy instruments aimed explicitly at nurturing either of those. In the case of the high-level talent required for *AI Development Skills* these may include:

1. Investment in R&D and higher education, already a cornerstone of most national AI strategies. Governments can provide substantial funding for AI research through grants to universities, dedicated research institutes, and collaborative research programs (Futurium, 2025). Support extends to higher education institutions to establish specialized AI degree programs (Bachelor's, Master's, PhDs), create endowed chairs, and develop advanced curricula. The goal is to build a strong domestic pipeline of highly qualified researchers and engineers.
2. Talent Attraction and Retention (Immigration Policies): Recognizing the global nature of AI talent, many countries use immigration policy as a strategic tool (Center for Security and Emerging Technology, 2025). This includes creating or adapting visa categories for individuals with extraordinary ability. Policies may offer pathways to permanent residency for STEM graduates and AI experts. Some strategies propose dedicated entrepreneur visas to attract AI startup founders (Center for Security and Emerging Technology, 2025).
3. Fostering innovation ecosystems to create environments where AI innovation can flourish. This involves policies that support AI startups and scale-ups through funding (e.g., venture capital initiatives, scale-up funds), incubators, and accelerators. Promoting collaboration between universities, research institutions, and industry is key, often facilitated through dedicated hubs or clusters (Civil Service College Singapore, 2025). Other tools include R&D tax incentives for businesses investing in AI, and strategic government procurement of AI solutions to stimulate

the market. Access to high-performance computing infrastructure and relevant datasets is also crucial (Futurium, 2025).

4. Public-Private Partnerships that involve joint R&D centers (like the MIT-IBM Watson AI Lab), government co-funding of industry-led research, support for AI startups emerging from universities, and collaborative efforts to build shared data or computing infrastructure.

Addressing the need for widespread AI literacy and utilization requires a different set of policy tools, often focused on broader education and workforce development. Policy levers for *AI Adoption Skills* may include:

1. Integrating AI literacy into education. This includes integrating AI concepts, computational thinking, data literacy, and ethical considerations into curricula across various subjects, not just computer science (IBM, 2025). Initiatives often involve developing new teaching resources, online learning modules, and providing professional development for teachers to equip them to teach AI concepts and use AI tools effectively in the classroom (The White House, 2025). Examples include proposed legislation like the US AI Literacy Act, programs like Day of AI, and national digital literacy strategies that incorporate AI elements. Higher education institutions are also encouraged or mandated to offer AI literacy courses for students across all disciplines.
2. Workforce reskilling and upskilling. This includes promoting lifelong learning opportunities, supporting apprenticeships in AI-related fields, funding bootcamps or certification programs targeting specific AI adoption skills, and offering subsidies or tax credits for employer-provided training. Sector-specific training initiatives may target industries undergoing significant AI transformation. For example, in the US, guidance encourages using Workforce Innovation and Opportunity Act (WIOA) funds for AI skills development (The White House, 2025).
3. Promoting Ethical AI awareness and training to build public and workforce understanding of responsible AI use (Bipartisan Policy Center, 2025). This involves developing and disseminating ethical guidelines for AI, funding public awareness campaigns, and incorporating ethics modules into AI training programs at all levels (UNC Executive Development, 2025). The goal is to foster a culture where bias mitigation, fairness, transparency, and privacy are considered integral to AI deployment.
4. Public-Private Partnerships again for collaboration in developing and delivering training programs, creating K-12 educational resources, launching AI literacy campaigns, establishing industry-recognized certifications, and developing ethical guidelines or standards (World Economic Forum, 2024). Governments may partner with tech companies, educational institutions, non-profits, and industry associations (The White House, 2025).

Governments may employ diverse policy instruments to foster AI development and adoption skills. For AI innovation, measures focus on investing in R&D, specialized higher education programs, talent attraction via immigration policies, and creating innovation ecosystems supported by public-private partnerships. To boost AI adoption, policies emphasize AI literacy in education, workforce reskilling, ethical AI training, and collaborations with industry and educational institutions to deliver training and resources.

## 6. CONCLUSION

The lack of appropriate digital skills in society is a key obstacle to the successful implementation of AI, which is why countries are placing a strong emphasis on education, ethics, and regulation in their AI strategies. AI is a tool that can bring great benefits, but it requires understanding and the right approach. It is impossible to stop technological progress, so the application and implementation of AI must be approached responsibly. An analysis of AI implementation strategies in countries reveals a wide range of approaches, reflecting the diversity of economies, legal systems, and priorities of individual countries. Despite these differences, there are many common themes, such as an emphasis on ethics, regulation, talent development, and infrastructure, indicating a global understanding of the key factors for AI success. Differences in sectoral priorities and specific initiatives reflect the specificities of individual countries and their response to the unique challenges and opportunities related to AI.

This research is expected to contribute to the theoretical understanding of how governments shape skill formation in the context of a general-purpose technology like AI. By differentiating between AI development and adoption skills, we sharpen the conceptual focus for policy analysis – highlighting that public interventions must simultaneously cultivate *frontier innovators* and *broad digital competence* in the population. We integrate insights from digital transformation studies, skill formation theory, and innovation policy to propose frameworks (human capital, ecosystem, inclusion) that can be used to analyze not only AI skills policy but also other emerging technology skill agendas. These frameworks contribute to the literature by bridging the often-separate discussions of education policy and innovation policy, showing how they intersect in the case of AI. Additionally, our synthetic review of policy tools provides a structured typology of interventions (education, training, incentives, partnerships, etc.), which can serve as a basis for comparative analysis.

Practically, our findings may help policymakers design more effective AI skill strategies. One key implication is the need for policy balance and coordination: efforts must balance investing in high-end AI expertise with broad-based digital upskilling, and they must coordinate across education systems, labor markets, and industry initiatives for maximum effect. Governments should recognize that addressing the AI skills challenge is a long-term endeavor requiring continuous adaptation – as AI technology evolves, so too must curricula and training programs. The rationale and tools discussed imply that governments should act both as *enablers* (providing resources, infrastructure, incentives) and *stewards* (ensuring inclusion and ethical considerations in skills development).

In conclusion, this research has underscored the critical role of government policy in shaping the skills landscape necessary for navigating the era of Artificial Intelligence. AI's transformative potential necessitates a proactive approach to human capital development, addressing both the specialized expertise required for AI *development* and the broader competencies needed for widespread and responsible AI *adoption*. A significant, dual skills gap currently exists, characterized by acute shortages of high-end AI talent and a pervasive lack of AI literacy and critical usage skills across the general workforce. This gap hinders innovation, limits productivity gains, and exacerbates societal risks associated with AI, including inequality and bias.

Based on the synthesis of findings, the following recommendations are proposed for governments seeking to cultivate a comprehensive AI-ready workforce:

- Develop a clear and aligned national AI skills vision that explicitly defines objectives for both AI development and AI adoption skills. This vision should be integrated with broader economic, industrial, and social policy goals, clarifying the desired balance between fostering innovation leadership and ensuring inclusive societal adaptation.
- Implement a balanced and contextualized policy portfolio targeting both skill types. Avoid an exclusive focus on either elite talent or basic literacy. The specific mix and sequencing of investments should be tailored to the nation's unique starting position, resources, and strategic priorities.
- Mandate the integration of AI literacy – including core concepts, practical application, critical evaluation of outputs, and ethical considerations – across all levels of the education system and diverse disciplines. Invest heavily in teacher training and curriculum development to support this integration. Simultaneously, higher education pathways should be ensured to produce sufficient specialized AI talent aligned with projected industry needs.
- Prioritize foundational and human-centric skills alongside technical expertise. Implement a dual focus in education and training. While nurturing cutting-edge technical AI skills is vital, equally important is strengthening broadly applicable foundational skills – digital literacy, critical thinking, creativity, complex problem-solving, collaboration, communication, ethical reasoning, and adaptability – across all educational levels and workforce development programs (Frank Hawkins Kenan Institute of Private Enterprise, 2025b). These human skills are essential complements to AI capabilities.
- Strengthen lifelong learning ecosystems. Invest significantly in building a robust and accessible lifelong learning infrastructure. Support flexible learning pathways, including high-quality online courses, industry-recognized micro-credentials, and modular training programs. Provide financial support and guidance for individuals undertaking reskilling or career transitions, particularly those displaced by automation. Promote skills-based hiring practices in public and

private sectors to validate diverse learning experiences (Frank Hawkins Kenan Institute of Private Enterprise, 2025b).

- Address the digital divide by ensuring widespread, affordable access to high-speed internet and digital devices, a prerequisite for both AI development and participation in digital skills training.
- Promote policies for secure and ethical data access for AI research and development where appropriate, balancing innovation needs with privacy protection.
- Strengthen governance mechanisms and establish clear inter-agency coordination structures to ensure a coherent "whole-of-government" approach to AI skills policy. Commit to transparency regarding government use of AI and policy outcomes (REI Systems, 2025), and adapt evidence-based strategies.
- Actively develop, promote, and enforce clear ethical guidelines and standards for AI development and deployment. Ensure these principles are integrated into all government-supported skills initiatives, procurement policies, and public sector AI applications.
- Foster agile and well-governed public-private collaboration. Encourage and facilitate PPPs to leverage private sector expertise, resources, and market knowledge, particularly for practical skills training and apprenticeships (UNESCO IESALC, 2025). However, establish clear governance frameworks for these partnerships to ensure transparency, accountability, alignment with public interest goals (including equity), and avoidance of undue corporate influence. Develop national skills gap analyses and industry skilling roadmaps through collaborative processes (Access Partnership, 2025).
- Last but not least, invest in policy implementation capacity, build technical expertise related to AI and data science within government agencies responsible for education, labor, and technology policy. Improve official statistical systems and develop better methodologies for monitoring and evaluating the impact of AI skills policies (Korea Development Institute, 2025). Foster stronger inter-agency coordination mechanisms (National Audit Office, 2025). Address the "AI policy literacy" gap among policymakers and civil servants.

Governments worldwide are responding with diverse national AI strategies and a range of policy instruments targeting education, R&D, workforce training, immigration, and public-private partnerships. However, strategies often vary in their emphasis, implicitly or explicitly prioritizing either development or adoption goals. Effective government intervention appears contingent on policy coherence across domains, strategic alignment with national context, robust stakeholder engagement, and adaptive governance mechanisms. Best practices involve sustained investment in R&D and STEM pathways for development skills, universal AI literacy integration in education, and accessible lifelong learning opportunities to adopt skills. Crucially, fostering "human skills" like critical thinking, ethical reasoning, and collaboration is becoming integral to effective AI adoption.

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