Submodule A:
Artificial Intelligence
The Academy of ICT Essentials for Government Leaders

Frontier ICTs for Sustainable Development for Digital Leaders

Submodule A: Artificial Intelligence
Frontier ICTs for Sustainable Development for Digital Leaders

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Submodule Overview:

The purpose of the whole module is to provide the technological overview and considerations, potential policy recommendations, and international cooperation agenda for the adoption of frontier ICTs for digital leaders in developing countries to unlock the full potential of frontier ICTs.

In this purpose, the entire module consists of an overview of Frontier ICTs and three submodules. In the future, new submodules can be added as needed to cover new emerging technologies.

The overview module covers the definition, scope, and common features of frontier ICTs, as well as barriers and risks of scaling frontier ICTs. It also covers the key areas for policymaking and international cooperation that policymakers should consider from a national perspective for the promotion and development of frontier ICTs.

The submodules address three technologies, i.e. Artificial intelligence, Blockchain, and the Internet of Things, respectively. Each submodule provides an overview of the technology, the impact of the technology on the Sustainable Development Goals, challenges and risks, the status of the technology-related policies. Cases are also reviewed, drawing on policy recommendations and international cooperation agenda for maximizing the development and utilization of the technology.

This submodule covers Artificial intelligence (AI) which is recognized as an important means of achieving the 2030 Agenda for Sustainable Development. However, the use, adoption, and adaptation of the technology are not the same across the globe.

AI is expected to have a greater impact on sustainable development and is also recognized as an important source of concerns for socio-economic development (especially policymaking) in developing countries.

Therefore, this submodule provides fundamental information on the challenges/risks, best practices, policy recommendations, and international cooperation agendas related to AI that policymakers in developing countries should consider when developing and applying AI to enable sustainable development through innovation in their public sector and society.

Objectives

The main objective of the submodule is to provide relevant information, cases, policy recommendations, and international cooperation agenda(s) to enable national policymakers to properly apply AI on their path of achieving the SDGs.

Specifically, this module aims to:

1. Introduce the definition, scope, and features of AI.
2. Examine the role and importance of AI in achieving the SDGs.
3. Present the major challenges, barriers, and risks of developing and introducing AI.
4. Provide the current status of policies related to AI and global cases applied in the public sector.
5. Suggest policy recommendations and international cooperation measures for effective and efficient development and application of AI. This promotes a better understanding of the goals and direction that policymakers within governments can pursue.

Learning outcomes

After working on this submodule, readers should be able to:

1. Enhance their understanding of Artificial Intelligence and frontier ICTs in general.
2. Provide a rationale for the use of AI to achieve the SDGs.
3. Understand challenges and risks in the effective and efficient application of AI for sustainable development and measures to address it.
4. Strengthen their knowledge on AI applications, including its conditions and methods for success.
5. Identify key policy directions and measures to consider in the development, application, and deployment of AI for sustainable development.
6. Provide the ideas for international/regional cooperation to accelerate the application of AI to countries.

Target Audience

This submodule was developed for digital leaders in developing countries interested in AI. This submodule provides digital leaders with the general and comprehensive knowledge they need to understand the use, adoption, and application of AI from a technical and policy perspective. The target audience of this submodule can include people who wish to solve problems faced by their country by utilizing AI, establishing related strategies or plans to maximize the use of AI, or having a holistic view of AI at the government level.

Analytical Framework

In order for policymakers to clearly understand the various issues surrounding the development, application, and deployment of frontier ICTs, this module examines the issues in technological, economic, social, and environmental dimensions, and suggests policy recommendations to address the issues. These four dimensions reflect the technical features of frontier ICTs and the three pillars of SDGs.
Technical features of frontier ICTs: Although there are common characteristics that penetrate frontier ICTs, each technology has distinctive features. Therefore, it is necessary to examine technical issues related to the inherent nature of each frontier ICT such as AI, Blockchain, and IoT.

Three pillars of SDGs: As shown in Figure 1, the 17 Goals of the 2030 Agenda are broadly divided into three main categories or pillars: Society, Economy, and Environment. Although frontier ICTs are expected to have significant positive impacts on the SDGs, they can also lead to negative impacts on some SDGs depending on the technical features and readiness. Issues and considerations for each domain need to be examined to ensure balanced and sustainable development at the social, economic, and environmental levels.

Figure 1 Categorization of the SDGs into the Society, Economy, and Environment groups


Following the description above, this module suggests and uses a TESE (Technological, Economic, Social, Environmental) framework that synthesizes the technical features of frontier ICTs and the three main pillars of SDGs so that digital leaders can identify considerations and potential policy recommendations related to frontier ICTs in a systematic way. Based on the policy recommendations derived in this way, digital leaders can establish policies, plans, and regulations related to frontier ICTs that are suitable for the environment and situation of the country.

Table 1 TESE (Technological, Economic, Social, Environmental) framework

<table>
<thead>
<tr>
<th>Domain</th>
<th>Considerations</th>
<th>Policy Directions</th>
</tr>
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<tbody>
<tr>
<td>Technological</td>
<td></td>
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<td>Economic</td>
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<td>Domain</td>
<td>Considerations</td>
<td>Policy Directions</td>
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<tr>
<td>--------------</td>
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<td>-------------------</td>
</tr>
<tr>
<td>Social</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental</td>
<td></td>
<td></td>
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</table>

**A Suggestion for Learners**

Each technology (AI, Blockchain, IoT) is covered in a structured manner with an intentional order. This order and structure are intended to help and direct the learner not only to absorb the material, but also to practice a sequence of practical steps leading to drafting a policy recommendation agenda which can then be helpful in guiding policy development planning. In each part, a sequence of five preparatory steps (Technology overview, Opportunities for sustainable development, Considerations, Policy, Case studies) lead toward two steps of forming corresponding recommendations (Policy recommendations, International cooperation opportunities). Therefore, it would be most beneficial if readers, after each step, reproduce a similar process and results within their respective countries' national context.

As this submodule is not intended for a specific region, digital leaders should consider their country's social and economic context when formulating policies related to frontier ICTs.
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<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>4S</td>
<td>Safematics Smart Safety System</td>
</tr>
<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>AR</td>
<td>Augmented Reality</td>
</tr>
<tr>
<td>BFSI</td>
<td>Banking, Financial Services, and Insurance</td>
</tr>
<tr>
<td>CIFAR</td>
<td>Canadian Institute for Advanced Research</td>
</tr>
<tr>
<td>dapps</td>
<td>decentralized applications</td>
</tr>
<tr>
<td>DPOS</td>
<td>Delegated Proof of Stake</td>
</tr>
<tr>
<td>ESCAP</td>
<td>Economic and Social Commission for Asia and the Pacific</td>
</tr>
<tr>
<td>ETDA</td>
<td>Electronic Transactions Development Agency</td>
</tr>
<tr>
<td>FTS</td>
<td>Federal Tax Service</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GPT</td>
<td>General-Purpose Technologies</td>
</tr>
<tr>
<td>HIAS</td>
<td>Hebrew Immigrant Aid Society</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communications Technologies</td>
</tr>
<tr>
<td>IoT</td>
<td>Internet of Things</td>
</tr>
<tr>
<td>IP</td>
<td>Intellectual Property</td>
</tr>
<tr>
<td>IPGAIN</td>
<td>IP Global Artificial Intelligence Network</td>
</tr>
<tr>
<td>MIT</td>
<td>Massachusetts Institute of Technology</td>
</tr>
<tr>
<td>ML</td>
<td>Machine Learning</td>
</tr>
<tr>
<td>MOORE</td>
<td>Matching for Outcome Optimization and Refugee Empowerment</td>
</tr>
<tr>
<td>MSIT</td>
<td>Ministry of Science and ICT</td>
</tr>
<tr>
<td>MUAS</td>
<td>Munich University of Applied Sciences</td>
</tr>
<tr>
<td>NITI</td>
<td>National Institution for Transforming India</td>
</tr>
<tr>
<td>NLP</td>
<td>Natural language processing</td>
</tr>
<tr>
<td>OAI</td>
<td>Office for Artificial Intelligence</td>
</tr>
<tr>
<td>OECD</td>
<td>Organization for Economic Co-operation and Development</td>
</tr>
<tr>
<td>OPSI</td>
<td>Observatory of Public Sector Innovation</td>
</tr>
<tr>
<td>P2P</td>
<td>Peer-to-Peer</td>
</tr>
<tr>
<td>PoS</td>
<td>Proof of Space</td>
</tr>
<tr>
<td>PoS</td>
<td>Proof of Stake</td>
</tr>
<tr>
<td>PoW</td>
<td>Proof of Work</td>
</tr>
<tr>
<td>QLUMP</td>
<td>The Queensland Land Use Mapping Program</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
</tr>
<tr>
<td>RFIT</td>
<td>Reducing Friction in Trade</td>
</tr>
<tr>
<td>RL</td>
<td>Reinforcement Learning</td>
</tr>
<tr>
<td>RPA</td>
<td>Robotic Process Automation</td>
</tr>
<tr>
<td>SDGs</td>
<td>Sustainable Development Goals</td>
</tr>
<tr>
<td>SMEs</td>
<td>Small Medium Enterprises</td>
</tr>
<tr>
<td>STEM</td>
<td>Science, Technology, Engineering, and Mathematics</td>
</tr>
<tr>
<td>STI</td>
<td>Science, Technology, and Innovation</td>
</tr>
<tr>
<td>UK</td>
<td>The United Kingdom</td>
</tr>
<tr>
<td>UN</td>
<td>The United Nations</td>
</tr>
<tr>
<td>UNCTAD</td>
<td>The United Nations Conference on Trade and Development</td>
</tr>
<tr>
<td>UNESCO</td>
<td>The United Nations Educational, Scientific and Cultural Organization</td>
</tr>
<tr>
<td>UNICEF</td>
<td>United Nations Children's Fund</td>
</tr>
<tr>
<td>USA</td>
<td>The United States of America</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
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<td>--------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>USD</td>
<td>US Dollar</td>
</tr>
<tr>
<td>VR</td>
<td>Virtual Reality</td>
</tr>
<tr>
<td>WEF</td>
<td>The World Economic Forum</td>
</tr>
<tr>
<td>WFP</td>
<td>World Food Programme</td>
</tr>
<tr>
<td>XAI</td>
<td>Explainable AI</td>
</tr>
<tr>
<td>XR</td>
<td>Mixed Reality</td>
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</tbody>
</table>
1. Overview of Artificial Intelligence

AI technologies are rapidly growing and expanding across most industries and geographies. Thus, it is important to have a common and shared understanding of what is meant by AI, to know how AI can influence the Sustainable Development Goals, and to be aware of various risks and challenges leading to AI adoption. Such knowledge, combined with insights from existing national AI strategies and successful use cases, will be instrumental in establishing the necessary knowledge base for governments and public organizations that wish to incorporate AI or establish AI strategies and policies.

This part is structured as follows:

- An overview of AI technology is presented in Chapter 1.
- Chapter 2 discusses the opportunities for sustainable development.
- Considerations for AI use and application are highlighted in Chapter 3.
- Chapter 4 explores insights from existing AI strategies and policies.
- Case studies and examples are presented in Chapter 5.
- Chapter 6 suggests recommendations for a successful AI policy based on the information outlined in the first five sections,
- Chapter 7 elaborates on international cooperation opportunities enabled by AI.

1.1. Artificial Intelligence defined

Although the term Artificial Intelligence has been around since the 1950s, there is no single and universal definition of AI. It generally refers to computer systems that can perform tasks which normally require human intelligence. According to the OECD\(^1\), AI is defined as the ability of machines and systems to acquire and apply knowledge and to carry out intelligent behavior. This includes a variety of cognitive tasks (e.g. sensing, processing oral language, reasoning, learning, making decisions) and demonstrating the ability to move and manipulate objects accordingly.

Regardless of various definitions, AI is software and generally algorithm-based, although its functions (e.g. talking or playing a game) need to be reflected through a physical substance (e.g. a robot). Such reflection can also be observed through other software such as AI software playing video games with human players or other AI agents. In this sense, AI operates like a human brain, as it takes information from the environment, and evaluates (processes) it to make decisions, or provide information for a decision toward a certain goal. Thus, AI software can be identified and classified based on the general goals it was designed to achieve. To date, AI development has been generally focused on a selection of specific domains presented in Table 2.

Table 2 Major domains of AI

<table>
<thead>
<tr>
<th>Main AI areas</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large-scale machine learning</td>
<td>• Design of learning algorithms, as well as scaling existing algorithms, to work with extremely large datasets.</td>
</tr>
<tr>
<td>Deep learning</td>
<td>• Model composed of inputs such as image or audio and several hidden layers of sub-models that serve as input for the next layer and ultimately have an output or activation function.</td>
</tr>
<tr>
<td>Reinforcement learning</td>
<td>• An area of machine learning that teaches computers to identify optimal behavior in different environments through a cumulative reward function.</td>
</tr>
<tr>
<td>Natural language processing (NLP)</td>
<td>• Algorithms that process human language input and convert it into understandable representations.</td>
</tr>
<tr>
<td>Collaborative systems</td>
<td>• Models and algorithms to help develop autonomous systems that can work collaboratively with other systems and with humans.</td>
</tr>
<tr>
<td>Computer vision (image analytics)</td>
<td>• The process of pulling relevant information from an image or sets of images for advanced classification and analysis.</td>
</tr>
<tr>
<td>Algorithmic game theory and</td>
<td>• Systems that address the economic and social computing dimensions of AI, such as how systems can handle potentially misaligned incentives, including self-interested human participants or firms and the automated AI-based agents representing them.</td>
</tr>
<tr>
<td>computational social choice</td>
<td></td>
</tr>
<tr>
<td>Soft robotics (robotic process</td>
<td>• Automation of repetitive tasks and common processes such as IT, customer servicing, and sales without the need to transform existing IT system maps.</td>
</tr>
<tr>
<td>automation)</td>
<td></td>
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</tbody>
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1.2. Current status

AI development trajectory did not have a smooth ride with new capabilities developed, as well as with the new approaches and disappointments fueled by unrealistic expectations. AI was founded on the assumption that human intelligence “can be so precisely described that a machine can be made to simulate it.”

While the field of AI expands and computers become more capable, businesses can automate increasingly more tasks. By benefiting from algorithms like neural networks, AI technology is growing to provide more accurate insights for businesses. Now, machines can successfully understand human speech, out-compete humans in strategic games like chess and Go, complex computer games like StarCraft II, route deliveries, and handle autonomous vehicles2. In line with the classification presented

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in Table 2, the current status of AI advancement based on AI Multiple (2021)\textsuperscript{3} can be summarized as follows:

**Advances in Computer Vision:** Currently, the main objective of computer vision is to help computers to understand and to implement human visual perceptions. In this field, the most exciting development is autonomous cars. Computer vision is one of the key technologies that allow autonomous cars to operate without human drivers in the vehicle in specific pilot areas like Chandler, Arizona. An essential aspect of autonomous cars is the casualties they will prevent, and the time they will save.

**Advances in Natural Language Processing (NLP):** While NLP is used in many areas, including article summarization, instant translation, spam detection, and information extraction, recent developments help virtual assistants to behave in a more human-like way. Now, AI-powered digital human assistants are starting to be integrated into companies to improve business efficiency thanks to advances in NLP technology.

**Explainable AI (XAI):** One of the most commercially successful AI approaches is deep learning. However, deep learning operates like a black-box model and it is hard to explain why deep learning models make the predictions they do. Businesses naturally hesitate to act without understanding their reasons. To solve this issue, Explainable AI (XAI) tools are starting to emerge. XAI tools provide visualization and what-if analysis for humans to perceive how these tools reach specific conclusions and make AI more understandable for humans.

**Deep Learning:** Deep learning is a broader family of machine learning techniques based on artificial neural networks. While the human brain inspires this algorithm, it is commonly implemented in other technologies like computer vision, natural language processing, social network filtering, and bioinformatics to boost their performance. A real-life example would be the face recognition technology in mobile phones. Face unlock function is available through deep learning algorithms applied to computer vision.

**Reinforcement Learning (RL):** While humans learning from their experience is taken as an example of this development, RL is widely used in robotics today. Robots, chatbots, and game engines like AlphaGo are learning through their experience and are improving their performance during their learning process. The experience here refers to the data produced as a result of interacting with humans or other AI agents while playing games, delivering services, or performing various tasks.

**Transfer Learning:** Transfer learning enables users to benefit from the knowledge gained from a previously used AI model for a different task. As an example, an AI model that is developed for English speech recognition can be used for German speech recognition. Using a pre-trained model will save time rather than start from scratch. This method can be applied when creating a new learning process that might take too long or when there is not enough data for that specific task.

\textsuperscript{3} Ibid.
**Self-Supervised Learning (Self-Supervision):** Also known as self-supervision, self-supervised learning is an autonomous learning technique that helps data scientists further understand human intelligence. The learning model trains itself by taking one part of the data to predict the other part. As a result, it autonomously generates labels and eliminates the necessity of humans to label data. Today, this learning model is used to improve computer vision and natural language processing algorithms in tasks like 3D image rotation, distortion, or speech analysis.

The progress in AI has not been steady all the time. In fact, AI development has witnessed several periods known as “AI winter” where not much interest was put into the research and development of AI (e.g. 1974-80, 1987-93). Based on the current dynamics of R&D in AI, another “AI winter” is not close, and the ongoing “AI summer” is expected to continue for a long time.

AI markets are growing fast (see Figure 2). While any forecasted data should be viewed with caveats given the uncertainties of the economic impact of frontier technologies, it nevertheless shows that the AI market will grow exponentially\(^4\) \(^5\).

**Figure 2 AI software revenue, world markets, 2016-2025**

![Figure 2 AI software revenue, world markets, 2016-2025](source)


### 1.3. Future of AI

The future of AI will be shaped by the major AI use cases that will unlock significant economic value. Some of these use cases are AI assistants, autonomous driving, and

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AI-powered medical diagnosis. Additionally, AI technology will be used in combination with other emerging technologies like Mixed Reality (XR), IoT, and cloud computing. Factors that will drive the future growth of AI can be categorized under three main categories presented below\(^6\).

**Availability of more data.** With the increasing amount of data, AI agents can learn more and understand human capabilities better. Data availability has been growing exponentially and this trend is expected to continue with the increasing ubiquity of IoT devices (Figure 3). Frequently, it is the quantity and quality of data that separates one AI algorithm or product from another. Moreover, it is important to notice the existing snowball-like effect: nowadays, a significant amount of data is generated by AI agents themselves.

![Figure 3 Annual size of the Global DataspHERE](https://www.seagate.com/files/www-content/our-story/trends/files/idc-seagate-dataage-whitepaper.pdf)

**Better algorithms.** New AI algorithms are driving the growth of AI. However, scientists need to rely on more complex AI algorithms to improve the performance of their solutions. The main problem is that the interpretability of these algorithms reduces while the accuracy increases (Figure 4).

**Improved computing power.** Even if new techniques are discovered, it may be a long time until there is enough computational power to use them (e.g. quantum computing) is available. After all, the human brain is estimated to have more computational power than the best supercomputers, and the computational capacity of the human brain is not precisely known yet. AI technology requires greater computing power to run the latest solutions with high performance. With today’s computing technology, it might take too much time for specific AI algorithms to handle high amounts of data. While tech giants like Amazon are producing AI chips to accelerate this process, advances in quantum computing might bring a step-change.

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So far, the biggest impact AI has had on the lives of people materializes in the personalization of services, experiences, and improved digital services. As with any other technology, value is generated by improving the delivery of goods and services to customers. A category of services that are important to everyone around the globe are services for citizens provided by governments. As most governments around the world are moving towards further digitalization, improving digital services plays a pivotal role in the process. Therefore, governments are willing to invest in AI. Some use cases are presented in Chapter 5, but beforehand, it is important to understand the key directions in which AI can help.

1.4. AI in government

What AI offers to governments is similar to what it offers to the private sector. These offerings can be classified into three categories:

**Savings due to operational efficiency**: According to Governing magazine, 53 per cent of surveyed state and local officials had excessive paperwork burdens that impacted their ability to get work done. According to Deloitte (2017), automation of federal government employee tasks in the United States of America could save between 96.7 million and 1.2 billion hours annually. The same study from Deloitte
also reports that automation and AI have the potential to save between USD 3.3 billion and USD 41.1 billion.

**New/improved services:** Citizen-facing applications like self-driving shuttles and personalized education improve the quality of services governments deliver to citizens.

**More data-driven decision-making:** Governments are collecting an abundant amount of data every day. Yet, without an accurate analysis, data is not adequate for actionable insights. Better decision-making has the potential to both improve services and save costs.

Recently, the global community has witnessed faster-than-expected AI adoption due to the COVID-19 pandemic (Figure 5). According to KPMG (2021), the AI adoption rate in the government sector is 61 per cent. This rate is the seventh highest after industrial manufacturing (93 per cent), financial services (84 per cent), tech (83 per cent), retail (81 per cent), life science (77 per cent), and healthcare (67 per cent).

**Figure 5 Accelerated adoption of AI during COVID-19**

More specifically, when looking at the current level and stage of use of AI in operations or function in the government sector, the fully functional at scale reaches 34 per cent and the Moderately functional at 27 per cent. Following that, the Limited/Piloted capacity is 29 per cent, and the Not incorporated is only 10 per cent. However, it was found that the level and stage of AI use in the public sector are lower than that of the top AI-applied industries (Figure 6).

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Figure 6 Current use of AI in operations or functions

2. Opportunities for sustainable development

From the evidence presented above, it is rather obvious that private and public actors across most industries will continue to accelerate their rate of AI adoption. Nevertheless, amidst all the excitement about AI, it is important to address the relationship between AI and sustainable development. AI might impact all aspects of sustainable development, as defined by the 17 Sustainable Development Goals agreed upon in the 2030 Agenda for Sustainable Development.

Based on recent academic literature, AI could help achieve 134 out of the 169 SDG targets (79 per cent). There is also potential for inhibition of 59 targets (35 per cent). Figure 7 summarizes the positive and negative impact of AI in each area of the SDGs. The potential inhibitory effects AI may have on SDGs are covered in Annex 1. The effects AI has on each of the three categories of the SDGs (as explained in the overview section) are summarized below.

Figure 7 Summary of the positive and negative impacts of AI on the SDGs

Note: Documented evidence of the potential of AI acting as (a) an enabler or (b) an inhibitor on each of the SDGs. The numbers inside the colored squares represent each of the SDGs. The percentages on the top indicate the proportion of all targets potentially affected by AI and the ones in the inner circle of the figure correspond to proportions within each SDG. The results obtained when the type of evidence is considered are shown by the inner shaded area and the values in brackets.

2.1. AI and societal outcomes

AI has a significant positive influence on the SDGs within the Society group. 67 targets (82 per cent) within the Society group could potentially benefit from AI-based technologies. For instance, for SDG 1 on no poverty, SDG 4 on quality education, SDG 6 on clean water and sanitation, SDG 7 on affordable and clean energy, and SDG 11 on sustainable cities, AI may act as an enabler for all the targets by supporting the provision of food, health, water, and energy services to populations. It can also underpin low-carbon systems, for example, by supporting the creation of circular
economies and smart cities that efficiently use their resources. Some examples based on SDGs 1, 3, 4, 7, and 11 are provided in Annex 1.

2.2. AI and economic outcomes

According to Vinuesa, Ricardo, et al. (2020)\(^{11}\), a net positive impact of AI-enabled technologies is associated with increased productivity. Although some negative impacts are reported in 20 targets (33 per cent), benefits from AI on 42 targets (70 per cent) have been identified. Case in point, AI can help identify sources of inequality and conflict and potentially reduce inequalities by using simulations to assess how virtual societies may respond to changes. Annex 1 provides examples of how AI can support the SDGs (8, 10, 12, and 16) within the Economy group.

2.3. AI and environmental outcomes

The three SDGs in this group are related to climate action, life below water and life on land (SDGs 13, 14, and 15). For the Environment group, 25 targets (93 per cent) for which AI could act as an enabler were identified. Benefits from AI could be derived by the possibility of analyzing large-scale interconnected databases to develop joint actions aimed at preserving the environment. AI can also be used to help improve the health of ecosystems. The achievement of target 14.1, calling to prevent and significantly reduce marine pollution of all kinds, can benefit from AI through algorithms for the automatic identification of possible oil spills. Another example is target 15.3, which calls for combating desertification and restoring degraded land and soil. Some examples of how AI may be used to advance the SDGs (13, 14, 15) within the Environment group are given in Annex 1.

Even though AI is expected to benefit the achievement of the SDGs, there are potentially detrimental effects. As it can be seen from Figures 25, 26, and 27 (see Annex 1), a number of targets within each group and each SDG can be exposed to negative effects resulting from AI adoption.

Chapter 3 elaborates upon the various challenges and risks linked to AI development and adoption. Altogether, considerations for using AI in conjunction with respective solutions serve as a good indicator towards what should be addressed and resolved by regulations and policies for AI (Chapter 6).

3. Considerations for AI utilization

In harnessing AI technology for public services and purposes, it is important for governments and the public sector to prioritize protecting the interests of their citizens both collectively and individually. AI needs to be developed in an individual-centric manner which considers human rights issues. It is necessary to harness the development of AI technologies in a way that contributes to the achievement of democracy, peace, and the SDGs, while preventing the exacerbation of existing inequalities and the deepening of technical and digital divides\textsuperscript{12}. The following subchapter explores the challenges and risks of AI adoption.

The risks and challenges associated with AI could potentially have unintended negative consequences on the SDGs. Therefore, in order to effectively utilize AI for the SDGs, it is necessary to be aware of its potential detrimental effects. Please refer to Annex 1 for more information.

3.1. Taxonomy of challenges in AI adoption

Campion et. al. (2020)\textsuperscript{13} has classified the challenges of AI in the public sector according to seven categories: 1) social challenges, 2) economic challenges, 3) technological challenges, 4) data challenges, 5) organizational and managerial challenges, 6) ethical challenges (see Figure 8), and 7) political, legal, and policy challenges. Table 3 describes the seven categories of AI challenges in detail.

Some of the challenges are a consequence of the technological aspects of AI and need to be viewed separately. They are presented within Subchapter 3.3. Since AI is a relatively new and fast-paced phenomenon, there are challenges common to all countries and organizations. These are summarized within Subchapter 3.4.

While there are many ways to group and map challenges in AI, it is practically impossible to list them in an exhaustive manner, simply because AI changes too fast and its implications are not studied in detail. Nevertheless, it is important to highlight challenges that are more relevant to developing countries (Subchapter 3.5). Finally, it is crucial to be aware of the relevance of various challenges depending on the stage of AI adoption within organizations. More details are provided in subchapter 3.6.


<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social challenges</td>
<td>Issues related to societal norms and attitudes toward the adoption of AI</td>
<td>• Lack of knowledge of AI technologies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cultural and/or national properties</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Human rights</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Unrealistic expectations toward AI</td>
</tr>
<tr>
<td>Economic challenges</td>
<td>Obstacles concerning profitability and financial sustainability, and the costs for the adoption of AI.</td>
<td>• Computational expenses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Funding for AI projects and R&amp;D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Profits flowing to developed nations</td>
</tr>
<tr>
<td>Data challenges</td>
<td>Problems associated with the data that serves as an input for training the AI models.</td>
<td>• Lack of data integration and continuity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Lack of standards of data collection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Quantity and quality of data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Privacy and security</td>
</tr>
<tr>
<td>Organizational and managerial challenges</td>
<td>Issues related to each organization’s strategy, human resources, and management practices in the adoption of AI.</td>
<td>• Threat of losing jobs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Lack of strategy for AI development</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Lack of talent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Resistance to data sharing</td>
</tr>
<tr>
<td>Technological challenges</td>
<td>Barriers related to the nature and characteristics of AI technologies.</td>
<td>• Lack of interoperability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Lack of transparency and interpretability of AI systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Complexities in interpreting unstructured data</td>
</tr>
<tr>
<td>Political, legal, and policy challenges</td>
<td>Obstacles connected to responsibilities when errors and mistakes occur as a result of using AI, and measures to ensure AI is not used in harmful ways.</td>
<td>• Lack of official industry standards</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Copyright &amp; ownership issues</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Responsibility and accountability issues</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Privacy/safety threats</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Threats from foreign-owned companies collecting sensitive data</td>
</tr>
<tr>
<td>Ethical challenges</td>
<td>Issues based on the impact of AI on moral principles and ways to embed ethics into AI systems.</td>
<td>• Moral dilemmas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Discrimination by AI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Unethical use of shared data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Responsibility and explanation of decisions made by AI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Compatibility of machine versus human value judgment</td>
</tr>
</tbody>
</table>


### 3.2. Risks inherent to AI

As shown in Figure 4, AI models are difficult to interpret. For example, deep learning, the most successful and widely used example of AI, acts as a black box model, making it impossible to explain how it works. In addition, data to AI is like oil to machinery. What and how AI solutions will do highly depend on the quality, quantity, and contents of the data that is used to train its models. Therefore, the inherent nature of AI
technology itself brings various ethical concerns and technical issues, which are further explained below:

Ethical issues:

Bias: AI systems may absorb gender or racial prejudices hidden in human language patterns and amplify human stereotypes. Hopefully, AI will improve itself only to offer the best possible service. Nevertheless, as AI learns, it becomes more useful but also develops its own hidden biases based upon the data it has encountered, which are often flawed based on human prejudices. John Giannandrea, the former Google AI Chief, commented, “the real safety question, if you want to call it that, is that if we give these systems biased data, they will be biased”.

Fraud: AI systems can compose text, audio, and images to a sufficiently high standard that humans have a hard time telling the difference between synthetic and non-synthetic outputs for some constrained applications of the technology. Such functionality can be used for a tremendous range of downstream applications of AI for both socially useful and less useful purposes. Recently, AI systems have learned to generate synthetic images of human faces, then superimpose those faces onto the faces of other people in photographs or movies. People call this application of generative technology a “DeepFake.” Malicious uses of DeepFakes include misinformation and the creation of (predominantly misogynistic) pornography.

Racial Discrimination: AI systems and their profiling may lead to discrimination and thus violate ethical principles such as equality and fairness. The self-learning nature of AI refers to the distorted data the AI discovers in search engines (and subsequently learns from and utilizes), perhaps based upon unconscious and institutional biases, risks inserting racism, and other prejudices into the code that will make decisions for years to come. Researchers from Stanford University found that state-of-the-art automatic speech recognition (ASR) systems exhibited significant racial and gender disparity—they misunderstood Black speakers twice as often as White speakers. It is important to remember that these biases are not intentional, and are a result of biases hidden inside the data, and due to technical properties of the available data. The results suggest that, on average, systems made 19 errors every hundred words for White speakers and 35 errors for Black speakers—nearly twice as many. Moreover, the systems performed particularly

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poorly for Black men, with more than 40 errors for every hundred words (Figure 9). The breakdown by ASR systems shows that gaps are similar across companies.

**Figure 8 Ethical concerns regarding AI technology**

<table>
<thead>
<tr>
<th>Ethical Concerns Regarding AI Technology</th>
<th>Industrial Manufacturing</th>
<th>Tech</th>
<th>Gov</th>
<th>Healthcare</th>
<th>Life Sciences</th>
<th>Retail</th>
<th>Financial Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threats to security and privacy</td>
<td>89%</td>
<td>89%</td>
<td>64%</td>
<td>84%</td>
<td>61%</td>
<td>49%</td>
<td>49%</td>
</tr>
<tr>
<td>Safety issues</td>
<td>30%</td>
<td>47%</td>
<td>33%</td>
<td>43%</td>
<td>39%</td>
<td>41%</td>
<td>27%</td>
</tr>
<tr>
<td>Machine bias issues</td>
<td>&lt;3%</td>
<td>25%</td>
<td>6%</td>
<td>22%</td>
<td>32%</td>
<td>32%</td>
<td>9%</td>
</tr>
<tr>
<td>A lack of personal interaction or humanistic approach</td>
<td>31%</td>
<td>37%</td>
<td>6%</td>
<td>33%</td>
<td>28%</td>
<td>32%</td>
<td>41%</td>
</tr>
<tr>
<td>Potential for AI takeover by malicious entities</td>
<td>39%</td>
<td>37%</td>
<td>6%</td>
<td>31%</td>
<td>39%</td>
<td>37%</td>
<td>28%</td>
</tr>
<tr>
<td>Concentration of benefits around companies using AI technology</td>
<td>29%</td>
<td>33%</td>
<td>11%</td>
<td>25%</td>
<td>27%</td>
<td>33%</td>
<td>33%</td>
</tr>
<tr>
<td>Loss of jobs</td>
<td>22%</td>
<td>26%</td>
<td>14%</td>
<td>27%</td>
<td>14%</td>
<td>32%</td>
<td>28%</td>
</tr>
</tbody>
</table>

Indicates when an industry response is statistically significant compared to total industry respondents.


**Figure 9 The Race Gap in speech recognition technology**


Technical issues:

**Cyber-security and data privacy:** Cybersecurity breaches are the greatest potential risk of AI adoption for all industries, with the healthcare industry viewing privacy violations as the greatest potential risk. Although this is a common challenge for digital technologies, the case of AI is much more sensitive. The majority, if not all, data used for the training of predictive models is the personal and

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private data of individuals. Thus, it is important to view this issue as an inherent barrier to AI. Privacy violations can occur: “as illicit interference in one’s actions, as illicit surveillance, as illicit intrusions in rooms or dwellings”, all of which may arise in connection to AI. AI systems such as robot applications are vulnerable to cyber-attacks, which are particularly dangerous because the attackers gain access to human’s physical living environment and thus their most sensitive area of life in terms of privacy. In addition, privacy concerns may also arise, for instance, in connection to AI-based government surveillance. The vast majority of citizens are worried about the threat that AI poses to their privacy.

**Explainability:** Sophisticated AI algorithms mean, in some situations, that the designers or engineers of the algorithm cannot explain how the AI system makes decisions. This certainly carries risks. For instance, what decisions will a driverless car make when there is an emergency? Research by IBM discovered over 180 human biases that affect the decisions made by AI. As Coeckelbergh identifies, this is an ethical problem since people should have the right to know why a decision that affects them was taken. If a decision cannot be explained, this is unjust. Explainability is thus a moral requirement. The lack of transparency of AI’s thought processes, known as the black box problem, could disguise the creation of a monster. Indeed, Carabantes explains that as AI becomes more intelligent, it becomes more effective in its tasks of prediction and decision-making, but conversely, its processes also become less understandable to humans.

**Fast-paced adoption:** As AI adoption increases, large percentages of business leaders indicate the technology is moving too fast for comfort (Figure 10). Fears about how fast AI is being adopted likely reflect both the newness of the technology and the absence of an established legal and regulatory framework to guide its use. AI systems are becoming more complex and less predictable, and it is unclear to most governments how this affects public governance. This aspect is listed as inherent to AI because it is the first type of technology that is capable of improving on its own, by learning from its own performance combined with a continuous flow of fresh data inputs.

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24 UN ESCAP, FRONTIER TECHNOLOGIES for sustainable development in Asia and the Pacific 2018.
**Data infrastructure**: Data quality and integration are of high importance because the AI system is only as smart as the provided data from which it learns, and data is regarded as the fundamental driver of current AI systems. However, a multitude of companies do not realize the importance of quality data needed to train AI systems. They often underestimate the time to acquire, clean, and prepare data. In addition, data of low quality or untrusted data represents a major challenge for organizations. Accordingly, the collection, aggregation, storage, and usage of unbiased and relevant data is necessary for successfully implementing AI within the public sector, as inaccurate or poor data may lead to failures.

**Figure 10 Level of agreement that it is hard to keep up with the evolving AI landscape**

<table>
<thead>
<tr>
<th>Industry</th>
<th>Strongly disagree</th>
<th>Somewhat disagree</th>
<th>Somewhat agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail</td>
<td>6%</td>
<td>16%</td>
<td>51%</td>
<td>27%</td>
</tr>
<tr>
<td>Financial Services</td>
<td>7%</td>
<td>22%</td>
<td>44%</td>
<td>27%</td>
</tr>
<tr>
<td>Healthcare</td>
<td>7%</td>
<td>29%</td>
<td>39%</td>
<td>25%</td>
</tr>
<tr>
<td>Life Sciences</td>
<td>8%</td>
<td>25%</td>
<td>44%</td>
<td>23%</td>
</tr>
<tr>
<td>Government</td>
<td>14%</td>
<td>16%</td>
<td>47%</td>
<td>21%</td>
</tr>
<tr>
<td>Tech</td>
<td>16%</td>
<td>26%</td>
<td>44%</td>
<td>20%</td>
</tr>
<tr>
<td>Industrial</td>
<td>29%</td>
<td>54%</td>
<td>17%</td>
<td></td>
</tr>
</tbody>
</table>


### 3.3. Common challenges in AI adoption

The majority of challenges that occur in the context of AI systems adoption are common to all companies and organizations. These are issues that need to be known and addressed by anyone wishing to endeavor AI projects.

Social issues:

**Loss of jobs**: Workforce substitution and transformation refer to the impact of AI on the labor market and represents one of the most pervasive challenges to society.

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in the context of AI\textsuperscript{36,37}. There is an increasing concern that further advancement and implementation of AI will lead to unemployment, as work activities and jobs are becoming subject to automation\textsuperscript{38,39}. A study by PwC shows that about one third of jobs are endangered in major industrial nations\textsuperscript{40}, while studies of the Oxford University\textsuperscript{41} and the McKinsey Global Institute\textsuperscript{42} reach quite similar conclusions, stating that about half of the occupations or workforce activities could be automated and are thus at risk.

Democracy, freedom of speech, and access to information: AI tools supplementing humans in almost every sphere of society are triggering a new industrial revolution. This could enable authoritarian governments to control and monitor their citizens to an unknown extent, as of today\textsuperscript{43}. AI has a real potential\textsuperscript{44} to be exploited by unscrupulous politicians and governments to monitor, understand, and control their citizens, thereby turning countries with advanced AI capabilities into digital authoritarian states. It can lead to situations where AI offers authoritarian countries with a plausible alternative to liberal democracy. Through AI, economically advanced countries can enrich their citizens while maintaining control over them. In such cases, governments will be able to selectively censor topics and behaviors to allow information for economically productive activities to flow freely while curbing political discussions that might damage the regime. In addition to retroactively censoring speech, AI and big data will allow predictive control of potential dissenters\textsuperscript{45}.

Ethical issues:

**Responsibility and accountability:** Responsibility and accountability are closely connected to the aspect of governance and refer to defining the legal status of who


is in charge and responsible for decisions made by AI. For instance, the question of who is responsible and liable arises when an autonomous vehicle for public transport harms a pedestrian. Is the hardware or the software designer, the supplier or the operator, the authorities, or even the AI application itself responsible and liable for the consequences of any decisions made by the AI application? Humans do not simply act rationally, there are other traits that influence or determine their decisions and behaviors, such as consciousness or emotion. In addition, there are situations where humaneness should play an important role from a human perspective and there is legal latitude or scope of discretion. It is therefore debatable to grant constitutional personality rights and legal responsibilities to AI systems without these human characteristics.

**Financial inequality:** The combination of unemployment and the increases in profit through AI may reinforce social inequality and widen the gap between the rich and the poor, which in turn leads to social dissatisfaction instead of social acceptance.

**Lack of diversity:** While AI systems have the potential to dramatically affect society, the people building AI systems are not representative of the people those systems are meant to serve. The AI workforce remains predominantly male and lacking in diversity in both academia and the industry, despite many years highlighting the disadvantages and risks this engenders. The lack of diversity in race and ethnicity, gender identity, and sexual orientation not only risks creating an uneven distribution of power in the workforce, but also, equally important, reinforces existing inequalities generated by AI systems, reduces the scope of individuals and organizations for whom these systems work, and leads to unjust outcomes.

**Women in AI:** Data from surveys show that the percentage of female AI and Computer Science (CS) Ph.D. graduates, as well as tenure-track CS faculty, remains low. Female graduates of AI Ph.D. programs and CS Ph.D. programs have accounted for 18.3 per cent of all Ph.D. graduates on average within the past ten years. Across the majority of countries, the AI skills penetration rate for women is lower than for men. Among 12 examined countries, India, the Republic of

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52 Ibid.

53 Ibid.
Korea, Singapore, and Australia are examples of countries where the AI skills penetration rate of females has surpassed that of males (Figure 11).

**Racial and ethnic diversity in AI:** According to the CRA Taulbee Survey, among the new AI PhDs in 2019 who are residents of the United States of America, the largest percentage (45.6 per cent) are White (non-Hispanic), followed by Asian (22.4 per cent). In comparison, 2.4 per cent were African American (non-Hispanic) and 3.2 per cent were Hispanic. Approximately 67 per cent of the tenure-track faculty are White, followed by Asian (14.3 per cent), other races (8.3 per cent), and mixed/other race, ethnicity, or origin (6.3 per cent). The smallest representation among tenure-track faculty are teachers of Black or African and of Hispanic, Latin or Spanish origins, who respectively account for 0.6 per cent and 0.8 per cent.

**AI and crime:** An additional risk prevalent across multiple uses of AI is if the AI decides to use its learnings to commit a financial crime of its own accord. This is a risk that criminal law and technology law academics are currently debating as a hot topic to determine effective solutions and reach conclusions on the liability of AI. This risk increases over time as AI evolves into a more intelligent state, where studies have shown that as AI learns, it can develop its own obscure or prejudicial thought processes.

**Figure 11 Relative AI skills penetration rate by gender, 2015-2020**


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54 Ibid.
Organizational issues:

**Talent acquisition:** The boost in efficiency and productivity promised by AI also presents great challenges\(^{59}\). Companies must scramble to find and retain skilled talent to meet their production needs while being mindful about implementing measures to mitigate the risks of AI use. Many organizations are struggling to find and retain employees with the necessary skillsets to drive their AI strategies. Universities are having a hard time keeping up with demand.

**Resistance to share data:** AI projects are often collaborative in nature\(^{60}\), which means that obtaining the extent of data needed to deploy an AI project may require data sharing among units within the same organization or among different organizations. Organizations must be willing to share data to successfully drive AI projects, but in practice suffers from a lack of a collaborative culture that encourages it\(^{61}\).

### 3.4. Challenges for AI adoption in developing countries

Developments in AI technologies could increase inequalities both between and within countries, in ways that counteract the overall purpose of the SDGs. Researchers and funders should focus more on designing and developing AI solutions, which respond to localized problems in less wealthy regions and nations. Projects undertaking such work should ensure that solutions are not simply transferred from technology-intensive nations. Instead, they should be developed based on a deep understanding of the respective region or culture to increase the likelihood of adoption and success.

Among the challenges listed above, some are particularly important for consideration in developing countries. The risks to which developing countries are vulnerable and more exposed are given below.

Ethical issues:

**Funding and inequalities:** Financial feasibility plays a critical role in implementing AI technology. Thus, insufficient budget is among the biggest barriers faced by organizations when initiating AI programs\(^{62} \) \(^{63}\). AI projects with the highest potential of maximizing profit are more likely to get funded. Most of the research on AI is also expected to be directed towards AI applications where funding and commercial interests are. This may result in increased inequality for developing countries\(^{64}\) because funding is connected to availability of talent, investments in AI research,

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\(^{61}\) Ibid.


and large corporations benefiting from AI solutions, all of which are present mostly within advanced economies. Even when promising AI startups emerge in developing countries, they are quickly acquired by industry representatives from larger economies. Thus, potential future profits and value flow towards richer economies. Consequently, AI-based technologies with the potential to achieve certain SDGs are at risk of not being prioritized, if their expected economic impact is not high. The size of investment in AI is significantly higher in the United States of America and China compared to the average in other countries, as shown in Figure 12. In particular, in 2020, AI investments in the United States of America were 2.3 times higher than those of China and 3.5 times higher than in the rest of the world. This gives such developed countries a constant advantage to continue developing AI technologies that will keep bringing revenues that can, in turn, be used to develop an even better AI.

Figure 12 Private investment in AI by geographic area, 2015-2020


Organizational issues:

**Lack of AI education**: Challenges of AI use can be related to skills, such as employees’ lack of knowledge about AI and machine learning and limited in-house AI talent. The lack of experts and gaps in education for highly technical skills

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are also mentioned. There is a need for and a lack of specialists and experts with relevant skills. The situation is complex to resolve because the majority of specialized AI programs are concentrated within developed countries with advanced economies (Figure 13). Capable talent tends to leave for better opportunities and higher pay in developed countries. This, combined with a lack of specialized AI education, leads to a scarcity of human resources for AI.

**Replacement of human workforce:** Although AI can create new highly skilled jobs, there are potential scenarios where it can displace many rule-based and repetitive tasks. This means that a significant number of jobs that traditionally would be undertaken within emerging market economies will be lost. It is therefore very likely to undermine growth and the livelihoods of workers within Asian and African economies.

The list provided above contains some of the most critical issues but is not exhaustive. Furthermore, some challenges may fall into several categories at once. It is important to remember that these categories of challenges are not mutually exclusive.

**Figure 13 The number of specialized AI programs in EU, 2019-2020**


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3.5. Stages of AI development

As in any innovation project\textsuperscript{72}, there is an adoption stage where the decision to adopt AI is made and there is an implementation stage that can be divided into several phases. Given the multiple risks and challenges, it is important to know which challenges need to be addressed at each stage. Figure 14 can serve as a good reference on which concerns to address depending on the current stage of deployment.

In conclusion, only a minority of companies acknowledge the risks associated with AI, and even fewer report taking steps to mitigate those risks\textsuperscript{73}. Despite growing calls to address ethical concerns associated with AI use, efforts to address these concerns in the industry are limited\textsuperscript{74}, according to a McKinsey survey. For example, issues such as equity and fairness in AI continue to receive comparatively little attention from companies. Moreover, fewer companies in 2020 viewed personal or individual privacy risks as relevant, compared with 2019, and there was no change in the percentage of respondents whose companies are taking steps to mitigate these risks (Figure 15).

Figure 14 Managing AI deployment in the public sector


\textsuperscript{72} Ibid.
\textsuperscript{73} Ibid.
\textsuperscript{74} Ibid.
Additional organizational challenges may include the lack of clear leadership, lack of a strategy regarding the adoption of AI, lack of organizational guidelines on AI deployment, including criteria to standardize the way data are collected and shared, and ease of use of AI applications\textsuperscript{75, 76}. Although business leaders and government decision-makers agree\textsuperscript{77} that companies should implement an AI ethics policy, not all organizations currently have one.

Regarding the risks and challenges\textsuperscript{78} associated with AI, the goal is not to create a moral panic that would hinder the evolution of AI. AI should and can be developed and deployed in a responsible way, to fast forward progress toward the achievement of the SDGs. Nevertheless, any irresponsible development of AI software leaves the utility of the technology exposed to the immense risk of negative consequences.

Business leaders are conscious that controls are needed and overwhelmingly believe the government has a role to play in regulating AI technology\textsuperscript{79}. The next chapter presents some of the most important policy initiatives up to date.

\textsuperscript{78} Truby, J. (2020). Governing artificial intelligence to benefit the UN sustainable development goals. Sustainable Development, 28(4), 946-959.
\textsuperscript{79} KPMG (2021). AI adoption accelerated during the pandemic but many say it’s moving too fast: KPMG survey 2021.
4. Al-related Policy

Governments around the world are interested in AI. As seen in the study results of KPMG (2021)\textsuperscript{80}, the rate of AI adoption is over 60 per cent. This interest has already appeared at the policy level. Self-regulation of AI is getting close to an end all over the globe\textsuperscript{81}. Rather than waiting, organizations are proactively developing AI governance and regulation by creating new policies and initiatives.

However, there are still many gaps in AI development and adoption between or within countries, and the various challenges and risks mentioned above are still not easily resolved. In other words, it shows that the policies may not take these concerns into account, or that there may be difficulties in implementing them properly.

Therefore, to analyze AI-related policies over the world, it is necessary to understand the basic requirements of AI-related policies. To cover this, it is essential to understand the awareness and access to AI-related national strategies and other policy instruments, as well as the framework or methodology to evaluate existing initiatives. The two main resources used to access AI-related policies are:

**The OECD AI Policy Observatory\textsuperscript{82}:** It builds on the momentum of the OECD’s Recommendation on Artificial Intelligence (“OECD AI Principles”\textsuperscript{83}) – the first intergovernmental standard on AI – adopted in May 2019 by OECD countries and adhered to by a range of partner economies. The OECD AI principles provided the basis for the G20 AI Principles endorsed by Leaders in June 2019. The platform combines resources from across the OECD, its partners and all stakeholder groups.

**The 2020 Government AI Readiness Index\textsuperscript{84}:** It ranks governments around the world according to their readiness to implement AI in the delivery of public services to their citizens. Analysis has been conducted by clustering the world into nine regions: North America, Latin America and the Caribbean, Western Europe, Eastern Europe, Sub-Saharan Africa, Middle-East and North Africa, South and Central Asia, East Asia, and the Pacific. Leading countries within each region were evaluated based on three dimensions that correspond to three fundamental pillars of AI readiness:

- **Government** measures the willingness and the ability to adapt and innovate for AI adoption;
- **Technology Sector** assesses the level and quality of tool supply for AI;

\textsuperscript{80} Ibid.
\textsuperscript{82} OECD AI Policy Observatory. Available from https://oecd.ai/en/
\textsuperscript{83} OECD AI Principles. Available from https://oecd.ai/ai-principles
• **Data and Infrastructure** checks the availability of high-quality representative data together with an infrastructure suitable for service delivery and use by citizens.

By using these sources, the national level of AI readiness and AI-related policy status will be analyzed, and at the end, examples of leading countries in the AI field will be introduced.

### 4.1. Global AI policy highlights

Based on the 2020 Government AI Readiness Index\(^\text{85}\), the United States of America comes at the top of the list, followed by several European nations (United Kingdom, Finland, Germany, and Sweden). As expected, results are indicative of the fact that North America and Western Europe are best prepared for AI.

Europe does not have technological hubs that come close to the United States of America. Nevertheless, Western Europe has a high concentration of national AI strategies, supported by the European Union’s region-wide strategy (European approach to excellence and trust)\(^\text{86}\).

On average, Sub-Saharan Africa, Latin America and the Caribbean, together with South and Central Asia have the lowest scores (Figure 16) as regions. This confirms the challenges and concerns about inequality in AI identified in the previous section.

**Figure 16 National AI strategies in the 2020 Government AI Readiness Index**

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\(^{85}\) Ibid.

The ethical use of AI matters even more than its technological or regulatory readiness. In this regard, “Responsible Use of AI” is an important motto and initiative undertaken by nations and corporations. In 2020, 14 governments and the European Union joined hands to create the Global Partnership on Artificial Intelligence (GPAI)\(^\text{87}\) to support the responsible development and use of AI. Coincidentally, it is included as a sub-index within the 2020 Government AI Readiness Index. It measures nine indicators across four dimensions (a detailed description of indicators, and their sources are provided in Annex 3 of the Government AI Readiness Index 2020\(^\text{88}\)):

- **Inclusiveness:**
  - Income Inequality,
  - Automation readiness index;
- **Accountability:**
  - Voice and accountability,
  - Freedom on the net;
- **Transparency:**
  - Corruption Perceptions Index,
  - Corporate Engagement Index;
- **Privacy:**
  - Rule of Law,
  - Surveillance Industry Index,
  - AI Surveillance Index.

Findings from the 2020 report show that Nordic-Baltic countries appear as leaders (Estonia, Norway, Finland, and Sweden are in the top 5). Despite being global leaders in government AI readiness, the United States of America and the United Kingdom both scored significantly lower. Some other large economies (Russian Federation, India, and China) are close to the bottom of the index. Countries on top of this sub-index score favorably in terms of accountability and transparency, while also having low levels of social inequality which allows for the adoption of AI in an inclusive manner. The lower scores of the United States of America and the United Kingdom can be explained by the following factors:

- Both countries scored poorly on the Transparency International Corporate Political Engagement Index. Therefore, government policy is at risk of reflecting the interests of tech companies more than those of citizens.
- Levels of inequality are higher than that of responsible use leaders such as Sweden and Finland.

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4.2. National AI policies and strategies: current status

The first national AI strategy was published in Canada in 2017\(^89\). Since then, many other countries have come up with their own policy instruments. Moreover, there have been several important initiatives at the international level\(^90\): The GPAI and OECD AI Policy Observatory have been promoting intergovernmental efforts to work together to support the development of AI for all. Another sign of the importance of AI has been the fact that the 116th Congress in the United States of America, was the most AI-focused congressional session in history.

AI-related efforts can take many forms and shapes. Countries across the world significantly differ in their capabilities, resources, and priorities. Instruments used to support developments in the field of AI can vary from serious and expensive statewide initiatives such as national AI strategies, to smaller investments like AI hackathons hosted in educational institutions. Based on statistical data from the OECD AI Policy Observatory, policy instruments and initiatives can be classified into four large categories (Table 4): Governance; AI Enablers and Incentives; Financial Support; and Guidance and Regulation\(^91\).

**Governance**: Governance is the largest category within which the largest sub-category is “National Strategies, agendas and plans”, implying that creating a national AI strategy is the highest priority for most countries.

**AI Enablers and Incentives**: The next largest group of initiatives is that of AI Enablers and Incentives, within which networking and collaboration platforms are given the biggest attention. The second-largest sub-category within the enablers is made up of efforts for data access and sharing, which is indeed a necessary and crucially important condition to successful AI projects.

**Financial Support**: Financial Support category is arguably the most important in practice, because it summarizes various approaches that make it possible to fund AI development. The majority of initiatives for financial support are executed as support for public research, as well as R&D and innovation in business.

**Guidance and Regulation**: The smallest number of initiatives is within the Guidance and Regulation category. This is very important as it shows that on a global scale, regulation of AI has just started to emerge and is very far from maturation.

When global AI policy initiatives are grouped and ordered based on the number of initiatives (Table 4), important inferences that are far more than simple statistical data can be made. For example, a conclusion can be drawn about stages of maturity nations and organizations must undergo, from creating national agendas and plans, moving on to establishing instruments to enable AI and provide incentives for those

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\(^90\) Ibid.

who do so. This, in turn lays the foundation for the creation of real projects and business ideas which can be tracked by looking at financial support statistics. Finally, having the highest level of maturity would make it necessary to guide and regulate AI-related initiatives. Thus, it is only natural that the corresponding category has the fewest initiatives. Looking at how policy instruments are lined up within each of the four categories can provide equally important insights.

Table 4 Global AI policy initiatives (as of 28 November 2021)

<table>
<thead>
<tr>
<th>Category</th>
<th>Policy Instruments</th>
<th>Number of Initiatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Governance</td>
<td>National Strategies, agendas, and plans</td>
<td>238</td>
</tr>
<tr>
<td></td>
<td>Public consultations of stakeholders or experts</td>
<td>135</td>
</tr>
<tr>
<td></td>
<td>AI use in the public sector</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>AI co-ordination and/or monitoring bodies</td>
<td>37</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td></td>
<td><strong>479</strong></td>
</tr>
<tr>
<td>AI Enablers and Incentives</td>
<td>Networking and collaborative platforms</td>
<td>116</td>
</tr>
<tr>
<td></td>
<td>Data access and sharing</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Public awareness campaigns and civic participation activities</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>AI computing and research infrastructure</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>AI skills and education</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Knowledge transfers and business advisory services</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Science and innovation challenges, prizes, and awards</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Labor market policies</td>
<td>2</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td></td>
<td><strong>338</strong></td>
</tr>
<tr>
<td>Financial Support</td>
<td>Project grants for public research</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>Grants for business R&amp;D and innovation</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>Procurement programs for AI R&amp;D and innovation</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Fellowships and postgraduate loans and scholarships</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Centers of excellence grants</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Institutional funding for public research</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Indirect financial support</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Equity financing</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Loans and credits for innovation in firms</td>
<td>3</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td></td>
<td><strong>261</strong></td>
</tr>
<tr>
<td>Guidance and Regulation</td>
<td>Emerging AI-related regulation</td>
<td>163</td>
</tr>
<tr>
<td></td>
<td>Regulatory oversight and ethical advice bodies</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>Standards and certification for technology development and adoption</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Labor mobility regulation and incentives</td>
<td>11</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td></td>
<td><strong>249</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>1,327</strong></td>
</tr>
</tbody>
</table>

Source: OECD AI Policy Observatory. Database of national AI policies. [https://oecd.ai/en/dashboards](https://oecd.ai/en/dashboards). It was created as a table using the source.

When countries are assessed based on the extent to which governments and regional organizations have incorporated human rights considerations into their national AI strategies⁹², Global Partners Digital and Stanford’s Global Digital Policy Incubator

found\textsuperscript{93} \textsuperscript{94} that among the 30 states and two regional strategies (the European Union and the Nordic-Baltic states), a number of strategies refer to the impact of AI on human rights, with the right to privacy as the most commonly mentioned, followed by equality and non-discrimination (Table 5). Unfortunately, very few strategy documents provide deep analysis or concrete assessment of the impact of AI applications on human rights. Specifics as to how and the depth to which human rights should be protected in the context of AI is largely missing, in contrast to the level of specificity on other issues such as economic competitiveness and innovation advantage.

Table 5 Human rights references in national AI strategies

<table>
<thead>
<tr>
<th>Human Rights Included</th>
<th>States / Regional Organizations</th>
</tr>
</thead>
<tbody>
<tr>
<td>The right to privacy</td>
<td>Australia, Belgium, China, Czech Republic, Germany, India, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Qatar, Republic of Korea, United States of America</td>
</tr>
<tr>
<td>The right to equality / nondiscrimination</td>
<td>Australia, Belgium, Czech Republic, Denmark, Estonia, European Union, France, Germany, Italy, Malta, Netherlands, Norway</td>
</tr>
<tr>
<td>The right to an effective remedy</td>
<td>Australia (responsibility and ability to hold humans responsible), Denmark, Malta, Netherlands</td>
</tr>
<tr>
<td>The rights to freedom of thought, expression, and access to information</td>
<td>France, Netherlands, Russian Federation</td>
</tr>
<tr>
<td>The right to work</td>
<td>France, Russian Federation</td>
</tr>
</tbody>
</table>


4.3. National AI policies & strategies: examples

Being familiar with the global status and general types of AI policy initiatives may not be enough for a comprehensive understanding. Therefore, it is important to take a look at regional leaders in the field of AI. To this end, based on the analysis on AI policies conducted by KPMG (2021)\textsuperscript{95}, considering the geographical scope, four examples are selected: Canada (North America), the United Kingdom (Western Europe), India (South and Central Asia), and the Republic of Korea (East Asia).

According to a study by KPMG (2021)\textsuperscript{96}, despite all the mentioned developments, the majority of countries still haven’t developed a definitive set of guidelines or legislation specific to AI. Only a select few have AI-specific laws for society and for conducting

\textsuperscript{93} Ibid.
\textsuperscript{96} Ibid.
business\textsuperscript{97}. Figure 17 presents some well-known cases of AI regulations around the globe. Only half of the mentioned cases were funded, while the rest were in the form of non-funded guiding documents. The majority of funded AI strategies are from developed countries that have large and strong economies, as opposed to most non-funded cases. Furthermore, very few of them touch upon ethics in a specific framework, council, or regulation.

Figure 17 AI regulations around the globe

<table>
<thead>
<tr>
<th>Country</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>AI Ethics Framework (2018)</td>
</tr>
<tr>
<td>Austria</td>
<td>AI for Humanity (2018)</td>
</tr>
<tr>
<td>Canada</td>
<td>Canada AI Strategy (2017), Draft on Artificial Intelligence (2019)</td>
</tr>
<tr>
<td>China</td>
<td>Principles of Non-discrimination AI Governance: &quot;Responsible AI&quot; (2018)</td>
</tr>
<tr>
<td>Estonia</td>
<td>Kõrvemaa Concerning Artificial Intelligence (2018), AI task force (2018)</td>
</tr>
<tr>
<td>Japan</td>
<td>Japan AI Technology Strategy (2017), report by Japan Society for Artificial Intelligence, AI made a part of integrated innovation strategy (2018)</td>
</tr>
<tr>
<td>Korea</td>
<td>AI Strategy for the Fourth Industrial Revolution, AI Basic Act (2019)</td>
</tr>
<tr>
<td>Korea</td>
<td>AI Strategy, AI Basic Act (2019)</td>
</tr>
<tr>
<td>South Africa</td>
<td>Sector-specific ethics guidelines by Government for AI (2019)</td>
</tr>
<tr>
<td>UAE</td>
<td>AI Principles and Guidelines for the Emirate of Dubai (2018)</td>
</tr>
</tbody>
</table>


Note: When interpreting regulatory background, it is important to remember that AI regulation undergoes continuous improvements and changes. For example, in Figure 17, the Republic of Korea is not marked as a country that includes ethics in its AI regulation. Since then, the Republic of Korea drew up its first-ever ethical standards for artificial intelligence, with a focus on humanity-centered technology towards the end of 2020\textsuperscript{98}. In a similar manner, other countries may have had some progress too. Accordingly, throughout this module, it is important to focus on the general trends, extracted meaning and patterns, rather than specific data that may have been updated.

\textsuperscript{97} Ibid
North America: Canada

North America is a regional leader in AI. Canada was among the first countries to ever release a national AI strategy in 2017. The strategy has been noticed for its focus on attracting and cultivating highly skilled talent. Other key initiatives include the Advisory Council on Artificial Intelligence\(^9\), and the Digital Charter\(^{100}\) that defines ten principles to guide the use of data and digital technologies. It is important to note that Canada has established a policy directive that includes requirements for the government's procurement, use, and the monitoring of AI-enabled tools\(^{101}\)\(^{102}\)\(^{103}\).

Figure 18 Canada in 2020 Government AI Readiness Index

Table 6 AI strategy summary of Canada

<table>
<thead>
<tr>
<th>Document Name</th>
<th>Pan-Canadian Artificial Intelligence Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Background</strong></td>
<td>To retain and attract top academic talent, and to increase the number of postgraduate trainees and researchers studying artificial intelligence and deep learning, Budget 2017 announced USD 125 million to launch a Pan-Canadian Artificial Intelligence Strategy for research and talent. The Strategy will promote collaboration between Canada's main centers of expertise in Montréal, Toronto-Waterloo, and Edmonton and position Canada as a world-leading destination for companies seeking to innovate through artificial intelligence technologies. Expanding the pipeline of Canadian talent for artificial intelligence will benefit businesses in a large breadth of sectors. To foster positive societal reception of AI, the Strategy makes an investment in CIFAR's AI and Society Program, to examine the multifaceted questions AI poses for society, engage diverse perspectives, responsibly communicate new knowledge and insights, and inform policy development around AI. Through the program, CIFAR funds policy-relevant working groups to examine the implications of AI as it relates to diverse topics (e.g. economy, ethics, policymaking, philosophy, and the law), publish their findings and inform the public and policy-makers.</td>
</tr>
</tbody>
</table>

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Responsible Governmental Body

- Canadian Institute for Advanced Research (CIFAR)

Objectives

- To increase the number of outstanding artificial intelligence researchers and skilled graduates in Canada.
- To establish interconnected nodes of scientific excellence in Canada’s three major centers for artificial intelligence in Edmonton, Montreal and Toronto-Waterloo.
- To develop global thought leadership on the economic, ethical, policy, and legal implications of advances in artificial intelligence.
- To support a national research community on artificial intelligence.
- To foster cooperation between AI research centers and industry.

OECD AI Principles Addressed

- Inclusive growth, sustainable development, and well-being
- Human-centered values and fairness
- Investing in AI R&D
- Building human capacity and preparing for labor market transition

Relevant Policy Areas Covered

- Digital economy
- Education
- Employment
- Industry and entrepreneurship
- Innovation
- Science and technology
- Social and welfare issues

Note: It is summarized in tabular form using two sources.

Western Europe: United Kingdom

Western Europe dominates the top 20 places within the 2020 Government AI Readiness Index. Among the top are the United Kingdom (2nd globally), Finland, Germany, and Sweden.

The British government is creating 16 new centers for doctoral training at universities across the country, estimated to deliver 1,000 new AI Ph.Ds. over five years. The industry also provides funding for new AI master’s degrees. The Office for AI and the Government Digital Service have written guidelines for the use of AI in the public sector and government procurement of AI.

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Figure 19 The United Kingdom in the 2020 Government AI Readiness Index


Table 7 AI strategy summary of the United Kingdom

<table>
<thead>
<tr>
<th>Document Name</th>
<th>Artificial Intelligence Sector Deal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Background</strong></td>
<td>The government and the Artificial Intelligence (AI) sector have agreed on a £1 billion package of support from government and industry to boost the United Kingdom’s global position as a leader in developing AI technologies.</td>
</tr>
<tr>
<td></td>
<td>It will act to advance the Industrial Strategy’s AI and Data Grand Challenge and ensure the United Kingdom is the leading destination for AI innovation and investment.</td>
</tr>
<tr>
<td></td>
<td>This deal will anchor the United Kingdom as the go-to destination for AI innovation and investment.</td>
</tr>
<tr>
<td></td>
<td>The Industrial Strategy is built on five foundations: becoming the world’s most innovative economy, creating jobs and better earnings potential, infrastructure upgrades, favorable business conditions, and building prosperous communities throughout the country.</td>
</tr>
<tr>
<td><strong>Responsible Governmental Body</strong></td>
<td>Office for Artificial Intelligence (OAI)</td>
</tr>
<tr>
<td><strong>Objectives</strong></td>
<td>Ideas - the world’s most innovative economy</td>
</tr>
<tr>
<td></td>
<td>People - good jobs and greater earning power for all</td>
</tr>
<tr>
<td></td>
<td>Infrastructure - a major upgrade to the United Kingdom’s infrastructure</td>
</tr>
<tr>
<td></td>
<td>Business environment - the best place to start and grow a business</td>
</tr>
<tr>
<td></td>
<td>Places - prosperous communities across the United Kingdom</td>
</tr>
<tr>
<td><strong>OECD AI Principles Addressed</strong></td>
<td>Inclusive growth, sustainable development and well-being</td>
</tr>
<tr>
<td></td>
<td>Human-centered values and fairness</td>
</tr>
<tr>
<td></td>
<td>Robustness, security and safety</td>
</tr>
<tr>
<td></td>
<td>Accountability</td>
</tr>
<tr>
<td></td>
<td>Investing in AI R&amp;D</td>
</tr>
<tr>
<td></td>
<td>Providing an enabling policy environment for AI</td>
</tr>
<tr>
<td></td>
<td>Building human capacity and preparing for labor market transition</td>
</tr>
<tr>
<td></td>
<td>International co-operation for trustworthy AI</td>
</tr>
</tbody>
</table>
Relevant Policy Areas Covered

- Competition
- Corporate governance
- Development
- Digital economy
- Education
- Employment
- Environment
- Finance and insurance
- Health
- Industry and entrepreneurship
- Innovation
- Investment
- Public governance
- Science and technology
- Social and welfare issues
- Tax


Note: It is summarized in tabular form using two sources.

South and Central Asia: India

The top five countries in this region are India, Kazakhstan, Azerbaijan, Turkey, and Georgia. Except for India and Turkey, three out of the five countries are former Soviet Union members and are located along the Belt and Road Initiative by China (Silk Road Economic Belt\textsuperscript{107}).

India published a National Strategy on AI in 2018. Written by the Government think tank NITI Aayog, the strategy sets out some focus areas for AI in India, including Healthcare, Agriculture, and Smart Mobility. NITI Aayog has also helped run some pilot AI projects in these areas - they worked with IBM to pilot AI in agriculture\textsuperscript{108}. India launched an advisory AI Task Force\textsuperscript{109} in 2017.

\textsuperscript{107} MEI@75 (2019). China’s Belt and Road Initiative and Turkey’s Middle Corridor: A Question of Compatibility, January 29. https://www.mei.edu/publications/chinas-belt-and-road-initiative-and-turkeys-middle-corridor-question-compatibility


\textsuperscript{109} India’s Artificial Intelligence Task Force. https://www.aitf.org.in/
Figure 20 India in 2020 Government AI Readiness Index


Table 8 AI strategy summary of India

<table>
<thead>
<tr>
<th>Document Name</th>
<th>• National Strategy on Artificial Intelligence: #AIforAll</th>
</tr>
</thead>
</table>

**Background**

• The role of the Government has been clearly delineated to develop the research ecosystem, promote adoption and address AI skills in the population.
• The strategy also flags issues such as ethics, bias, and privacy issues relating to AI, and envisions the government promoting research in technology to address these concerns.
• The strategy focuses on the sectoral areas of agriculture, health, and education, where public investment would be necessary.

**Responsible Governmental Body**

• National Institution for Transforming India (NITI Aayog)

**Objectives**

• In pursuance of the AI policy, NITI Aayog has adopted a three-pronged approach – undertaking exploratory proof-of-concept AI projects in various areas, crafting a national strategy for building a vibrant AI ecosystem in India and collaborating with various experts and stakeholders.
• Since the start of the year 2018, NITI Aayog has partnered with several leading AI technology players to implement AI projects in critical areas such as agriculture and health.

**OECD AI Principles Addressed**

• Human-centered values and fairness
• Investing in AI R&D
• Building human capacity and preparing for labor market transition

**Relevant Policy Areas Covered**

• Agriculture
• Education
• Health Investment

Note: It is summarized in tabular form using the source.

East Asia: Republic of Korea

The East Asian region is expected to gain the most from AI adoption due to the huge potential of scales in terms of population (over 20 per cent of the world). Each
government in the region has formulated detailed long-term national strategies\textsuperscript{110} for AI integration into the economy. Specialized government bodies were established for this purpose: China’s AI Plan Promotion Office under the Ministry of Science and Technology; Japan’s Strategic Council for AI Technology; the Republic of Korea’s Presidential Committee on the Fourth Industrial Revolution; and Singapore’s National AI Office\textsuperscript{111}. Ranked as the second and third in East Asia respectively, the Republic of Korea and Japan have the strongest advantages in Data Availability and Data Representativeness. Both countries have a very high number of Internet users (percentage of the adult population), which is used as a rough proxy for the availability of data that could be used to train AI models.

**Figure 21 The Republic of Korea in the 2020 Government AI Readiness Index**

![Government AI Readiness Index](https://www.oxfordinsights.com/government-ai-readiness-index-2020)

**Table 9 AI strategy summary of the Republic of Korea**

<table>
<thead>
<tr>
<th>Document Name</th>
<th>National Strategy for Artificial Intelligence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Background</strong></td>
<td>While machines replaced the manual labor during industrialization in the past, artificial intelligence is now developing beyond automation to a level that can perform intelligent tasks that could only be done by humans.</td>
</tr>
<tr>
<td></td>
<td>As AI is causing a paradigm shift not only in technology but one that encompasses all sectors including humanities, the Republic of Korea is preparing for the shift on national and social levels.</td>
</tr>
<tr>
<td></td>
<td>The Korean strategy calls for plans to facilitate the use of AI by businesses and to streamline regulations to create a more favorable environment for the development and use of AI and other new industries.</td>
</tr>
<tr>
<td></td>
<td>The Korean government also plans to leverage its dominance in the global supply of memory chips to build the next generation of smart chips by 2030.</td>
</tr>
<tr>
<td><strong>Responsible Governmental Body</strong></td>
<td>Ministry of Science and ICT (MSIT)</td>
</tr>
<tr>
<td><strong>Objectives</strong></td>
<td>To rank third in terms of global digital competitiveness by 2030.</td>
</tr>
<tr>
<td></td>
<td>To create 455 trillion Korean won of economic surplus through AI.</td>
</tr>
<tr>
<td></td>
<td>To enter the top ten countries in terms of quality of life.</td>
</tr>
</tbody>
</table>


| **OECD AI Principles Addressed** | • Human-centered values and fairness  
• Investing in AI R&D  
• Fostering a digital ecosystem for AI  
• Providing an enabling policy environment for AI  
• Building human capacity and preparing for labor market transition |
| **Relevant Policy Areas Covered** | • Manufacturing and industry-wide  
• Bio and medical  
• Smart city and construction  
• Transportation and logistics  
• Energy  
• Network  
• Agriculture & fisheries  
• Culture and art  
• Environment  
• Legal affairs  
• Defense |

Note: It is summarized in tabular form using two sources.
5. Case studies in the public sector

AI has a tremendous potential to benefit citizens, the economy and society, and it has already demonstrated its prospect to generate value in various applications and domains in the public sector.\footnote{Craglia, M. (Ed.). (2018). Artificial intelligence: a European perspective. Publications Office of the European Union.}

5.1. AI usage and typical AI application in the public sector

According to a case study of AI application in the public sector in Europe by Misuraca. et.al. (2020), the use of AI was highest in "General Public Services", followed by the use of AI in the domain of “Economic Affairs”, “Public Order and Safety”. In addition, several AI application cases were found in “Health”, “Social Protection”, and “Environmental Protection”, although less than in the previous three domains. Looking at the type of AI technology used, the use was highest in the order of “Natural Language Processing”, “Pattern Recognition”, “Image Recognition”, “Robotics”, and “Robotic Process Automation”.

**Figure 22** AI type of technology per public sector in Europe

![Image](image1.png)


**Figure 23** Types of AI technologies in use in the public sector in Europe

![Image](image2.png)


Bernd et al. (2019) suggested ten AI application areas in a public sector context by synthesizing AI use cases identified in the literature. The suggested AI applications in the public sector include AI-Based Knowledge Management Software, AI Process Automation Systems, Virtual Agents, Predictive Analytics and Data Visualization, Identity Analytics, Cognitive Robotics and Autonomous Systems, Recommendation Systems, Intelligent Digital Assistants, Speech Analytics, Cognitive Security Analytics and Threat Intelligence. The detailed descriptions and examples for potential AI use in the public sector are presented in Table 10.

Table 10 Potential AI applications for the public sector

<table>
<thead>
<tr>
<th>AI Application</th>
<th>AI Value Creation and Functional Proposition</th>
<th>Public Sector Use Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI-Based Knowledge Management (KM) Software</td>
<td>• Generation and systematization of knowledge – gather, sort, transform, record and share knowledge</td>
<td>• Clinical documentation powered by AI (Lin et al. 2018)</td>
</tr>
<tr>
<td></td>
<td>• Expert systems can support the codification of the knowledge of KM</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Use of neural networks enables to analyze, distribute and share knowledge with others</td>
<td></td>
</tr>
<tr>
<td>AI Process Automation Systems</td>
<td>• Automation of standard tasks; perform formal logical tasks with unpredictable conditions in consistent with quality</td>
<td>• Faster and higher quality request processing for immigration application forms (Chun 2007)</td>
</tr>
<tr>
<td></td>
<td>• Complex human action processes (formal logical or dangerous tasks) can be transferred to automation systems, which can support humans in performing tasks</td>
<td>• Automated image diagnoses (Collier et al. 2017)</td>
</tr>
<tr>
<td></td>
<td>• May include rule-based assessment, workflow processing, schema-based suggestions, data mining, case-based reasoning, intelligent sensor technology</td>
<td>• Human-computer interaction for repetitive tasks like data entry etc. (Jefferies 2016)</td>
</tr>
<tr>
<td></td>
<td>• Robotic process automation has emerged as a sub-area through further technology innovations. This leverages the ability of software robots or AI-driven workers to mimic human interaction with user interfaces of software systems</td>
<td></td>
</tr>
<tr>
<td>Virtual Agents</td>
<td>• Computer-based system that interacts with the user by means of speech analytics, computer vision, written data input but may also include real-time universal translation and natural language processing systems and affective computing</td>
<td>• Task allocation according to the respective area of responsibility of a specific agency (smart HR services) (Zheng et al. 2018)</td>
</tr>
<tr>
<td></td>
<td>• Software that can perform tasks for humans</td>
<td>• Virtual nursing assistant (Collier et al. 2017)</td>
</tr>
<tr>
<td></td>
<td>• Sub-areas are chatbots and avatars</td>
<td>• A chatbot for helping refugees that seek asylum to fill out and search documents (Mehr 2017)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AI Application</th>
<th>AI Value Creation and Functional Proposition</th>
<th>Public Sector Use Case</th>
</tr>
</thead>
</table>
| **Predictive Analytics & Data Visualization** | • These analytics are based on a quantitative and statistical analysis of data.  
• Processing of big data for reporting, prescriptive analysis and predictive analysis  
• Machine learning as a technical sub-area based on algorithms that can learn from data  | • Control and performance monitoring in public areas for police departments to determine terror threats and crime hotspots for preventive action (Power 2016)  
• Determine high crime risk situations to secure public transport (Kouziokas 2017)  
• Forecast model to predict water levels (Kouziokas et al. 2017)  |
| **Identity Analytics**                  | • Software combined with big data, advanced analytics and identity access management to control the access to IT systems and automate risk-based identity checks  
• May include deep learning and machine learning, affective computing and artificial immune systems | • Facial recognition software to verify or identify criminals in public areas (Power 2016)  
• AI fraud detection to secure governmental data (Hemken and Gray 2016) |
| **Cognitive Robotics and Autonomous Systems** | • Systems with higher-level cognitive functions that involve knowledge representation and are able to learn and respond  
• Sometimes in connection with affective computing to determine and adapt human behavior as well as respond to respective emotions | • Electric-powered autonomous vehicles for public transport (Christchurch International Airport Limited 2016, Jefferies 2016)  
• Robot-assisted surgery (Collier et al. 2017) |
| **Recommendation Systems**              | • An information filtering system  
• Software-based systems that screen personalized information to predict preferences of individuals | • E-service for government offices to provide personalized information for employees (Cortés-Cediel et al. 2017) |
| **Intelligent Digital Assistants (IDA)** | • Software based on speech analytics  
• Providing an intuitive interface between a user and a system/ device to search for information or complete simple tasks | • Connecting federal programs to IDA’s to make public service information available for customers (Herman 2017)  
• IDA-Amelia to help residents locate information and complete applications forms using speech analytics and affective computing (Jefferies 2016) |
| **Speech Analytics**                    | • Software for intelligent recognition and processing of language  
• Understand or respond to natural language  
• Translate from spoken to written language or from one to another natural language  
• May include real-time universal translation and natural language processing systems (Pannu 2015) | • Real-time universal translation (Microsoft 2018) to translate speech and text in face-to-face communications in public service settings  
• Administrative workflow assistance with voice to text transcription (Collier et al. 2017) |
5.2. Case studies in the public sector from OECD OPSI

A total of 19 cases of AI application in the public sector were identified from 2016 to December 2021 in the OECD OPSI. 11 cases were selected as the final analysis target, excluding the overlapping case application fields in consideration of the innovation maturity. There is a summary of the identified cases in Table 11, and detailed information on each case can be found in Annex 2.

Table 11 AI adoption cases in the public sector from OECD OPSI

<table>
<thead>
<tr>
<th>No</th>
<th>Sector</th>
<th>Country</th>
<th>Year</th>
<th>The name of project</th>
<th>Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Counterfeit</td>
<td>Germany</td>
<td>2019</td>
<td>Rapid, optical and global detection tool against counterfeits in every pocket</td>
<td>Developing Proposals, Implementation</td>
</tr>
<tr>
<td>3</td>
<td>Education/Safety</td>
<td>United States of America</td>
<td>2021</td>
<td>Simplifying the Identification of School Infrastructure Vulnerability at Scale</td>
<td>Implementation</td>
</tr>
<tr>
<td>4</td>
<td>Industry</td>
<td>Australia</td>
<td>2019</td>
<td>IP Global Artificial Intelligence Network (IPGAIN)</td>
<td>Implementation</td>
</tr>
<tr>
<td>5</td>
<td>Land use</td>
<td>Australia</td>
<td>2018</td>
<td>Potential for mapping the world’s land resources using satellites and artificial intelligence</td>
<td>Diffusing Lessons</td>
</tr>
<tr>
<td>6</td>
<td>Participation</td>
<td>France</td>
<td>2018</td>
<td>Plateforme d’Engagement du Citoyen</td>
<td>Implementation</td>
</tr>
<tr>
<td>7</td>
<td>Refugee</td>
<td>United States of America</td>
<td>2018</td>
<td>Annie™ MOORE (Matching for Outcome Optimization and Refugee Empowerment)</td>
<td>Implementation, Evaluation, Diffusing Lessons</td>
</tr>
<tr>
<td>8</td>
<td>Social Issues</td>
<td>United Kingdom</td>
<td>2017</td>
<td>Slavery from Space</td>
<td>Implementation, Evaluation, Diffusing Lessons</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No</th>
<th>Sector</th>
<th>Country</th>
<th>Year</th>
<th>The name of project</th>
<th>Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Tax</td>
<td>Colombia</td>
<td>2018</td>
<td>Tracking potential tax evaders on Instagram</td>
<td>Implementation, Evaluation, Diffusing Lessons</td>
</tr>
<tr>
<td>10</td>
<td>Welfare</td>
<td>Republic of Korea</td>
<td>2017</td>
<td>Prevention of solitary deaths through smart care ICT</td>
<td>Generating Ideas or Designing Solutions</td>
</tr>
</tbody>
</table>
6. Policy recommendations

A rapid increase in remote working and other measures necessitated by the COVID-19 pandemic have accelerated the adoption of AI all around the world\textsuperscript{115}. AI has proven itself useful within cases and applications in a wide variety of domains such as healthcare, education, law enforcement, financial services, and others. New policy instruments and regulations directed towards governing AI technology development and adoption are signalling the end of self-regulatory trends and the emergence of new perspectives\textsuperscript{116}y\textsuperscript{117}. For example, the frequency of AI mentions in the Government of the United States of America has dramatically increased in recent years (Figure 24).

Figure 24 Mentions of AI in the United States of America's congressional record by legislative session, 2001-2020

![Image of bar graph showing mentions of AI in US congressional record]


A sudden expansion of AI-driven solutions has highlighted the benefits and exposed potential risks of AI. As observed in Subchapter 3.1, AI adoption also has the potential for the inhibition (see Annex 1 for details) of 59 out of the total 169 targets (35 per cent) across the SDGs. Because AI is a multi-purpose technology, there is no single-use case of AI. Moreover, the circumstances and conditions significantly differ among countries. Therefore, with the many forms and various purposes AI may be used to fulfill, there can be no potential “one size fits all” solutions to AI regulation\textsuperscript{118}.

Nevertheless, even if it is impossible to suggest policy recommendations that are specific and appropriate at the same time, it is worthwhile to build a generic set of

\textsuperscript{115} Hodan, O. (2021). Principles to Promote Responsible Use of AI for Workforce Decisions, Center for Data Innovation.


\textsuperscript{118} Google. Recommendations for Regulating AI. Available from https://ai.google/static/documents/recommendations-for-regulating-ai.pdf
policy recommendations that are built upon the well-known critical challenges and issues. For this purpose, the remainder of this subchapter is organized as follows:

- First, main AI considerations identified in Chapter 3 are summarized using the TESE framework (see the overview section);
- Second, important policy implications that can be used to draw valuable recommendations are extracted from Chapter 4;
- Third, insights relevant for policy recommendations are identified within case studies presented in Chapter 5;
- Finally, the main directions for policy building are listed together with the appropriate recommendations.

### 6.1. Mapping of AI considerations to policy directions

Chapter 3 provided a deep dive into the challenges associated with AI technology. For better understanding and clarity, factors to consider were categorized based on a taxonomy from the research literature and classified based on their scope into risks inherent to AI, risks that are common across the globe, and risks relevant for developing countries. Table 12 presents AI considerations summarized using the TESE framework for easy mapping, with policy directions required to address them.

#### Table 12 Summary of AI considerations and policy directions using TESE framework

<table>
<thead>
<tr>
<th>Domain</th>
<th>Considerations</th>
<th>Policy Directions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technological</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1. Data collection standards are not well established.</td>
<td>TP1. Encourage cross-border uniform standardization.</td>
<td></td>
</tr>
<tr>
<td>T2. Privacy and security risks are high in AI.</td>
<td>TP2. Develop regulation that proactively protects personal data</td>
<td></td>
</tr>
<tr>
<td>T3. Lack of interoperability.</td>
<td>TP3. Support international initiatives for standardization of AI.</td>
<td></td>
</tr>
<tr>
<td>T4. Lack of transparency and interpretability.</td>
<td>TP4. Support Explainable AI.</td>
<td></td>
</tr>
<tr>
<td>T5. Lack of official industry standards.</td>
<td>TP5. Develop AI regulation and standards in cooperation with industry players.</td>
<td></td>
</tr>
<tr>
<td>T6. AI systems absorb the bias hidden in data.</td>
<td>TP6. Ensure data screening and evaluation procedures together with bias elimination policies.</td>
<td></td>
</tr>
<tr>
<td><strong>Economic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EC1. AI can be used for political and social targeting to influence and control people.</td>
<td>ECP1. Provide mechanisms for regulating the use of personal data.</td>
<td></td>
</tr>
<tr>
<td>EC2. AI may significantly increase the economic gap between nations due to differences in the availability of data and analytic resources.</td>
<td>ECP2. Encourage cross-border data sharing and cooperation.</td>
<td></td>
</tr>
<tr>
<td>EC3. AI may deepen inequality by disproportionately rewarding the educated.</td>
<td>ECP3. Promote AI research and education, especially in developing countries.</td>
<td></td>
</tr>
<tr>
<td>EC4. AI projects and R&amp;D require funding.</td>
<td>ECP4. Provide incentives for investing in AI.</td>
<td></td>
</tr>
<tr>
<td>Domain</td>
<td>Considerations</td>
<td>Policy Directions</td>
</tr>
<tr>
<td>----------</td>
<td>-------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Social</td>
<td>S1. AI technology is unevenly distributed: access to technology is hard for people in rural areas and developing economies.</td>
<td>SP1. Reduce gaps in access to infrastructure and funds.</td>
</tr>
<tr>
<td></td>
<td>S2. AI used in regions where ethical scrutiny, transparency, and democratic control is lacking may trigger inequalities.</td>
<td>SP2. Promote policies with strong values of equality, transparency, and democracy.</td>
</tr>
<tr>
<td></td>
<td>S3. AI systems may increase discrimination against women and minorities.</td>
<td>SP3. Promote AI technology that is inclusive of women and minorities.</td>
</tr>
<tr>
<td></td>
<td>S4. There is a lack of gender, racial, and ethnic diversity in the AI workforce.</td>
<td>SP4. Diversify the AI talent pool in terms of gender, race, ethnicity.</td>
</tr>
<tr>
<td></td>
<td>S5. AI can be used for committing crimes (e.g. money laundering).</td>
<td>SP5. Prevent the access of malicious actors to powerful AI tools.</td>
</tr>
<tr>
<td></td>
<td>S6. Lack of talent and knowledge in AI.</td>
<td>SP6, SP7. Promote investment in AI education, research, and retraining.</td>
</tr>
<tr>
<td></td>
<td>S7. AI threatens traditional jobs.</td>
<td>SP7. Explore the creation of new jobs through AI.</td>
</tr>
<tr>
<td></td>
<td>S8. Responsibility and accountability issues.</td>
<td>SP8. Support research in AI ethics and human oversight in AI.</td>
</tr>
<tr>
<td></td>
<td>S9. AI may be used to generate fraud.</td>
<td>SP9. Invest in fraud detection.</td>
</tr>
<tr>
<td>Environmental</td>
<td>EN1. AI applications have high energy needs.</td>
<td>ENP1. Adopt renewable energy sources and research energy-efficient AI solutions.</td>
</tr>
<tr>
<td></td>
<td>EN2. AI may drive overexploitation of natural resources.</td>
<td>ENP2. Promote ethical and responsible AI.</td>
</tr>
</tbody>
</table>

Note: Considerations in chapter 3 were categorized by using TESE framework and policy directions were drawn by authors to match with every consideration.

### 6.2. Policy implications from national AI strategy analysis

Chapter 4 provided a detailed description of the global status of AI policy and presented an overview of national AI strategies around the globe. Several conclusions that are meaningful for addressing AI policy recommendations are given below.

- Although nations are developing AI governance and regulation, there are still many gaps in AI development and adoption between or within countries. Therefore, it is important to promote collaboration inside and outside national borders.
- North America and Western Europe are best prepared for AI, while the Chinese government has achieved significant progress in implementation. In contrast, the developing world (i.e. Sub-Saharan Africa, Latin America and the Caribbean, South and Central Asia) has the lowest progress. This confirms the challenges and concerns about inequality in AI, identified in previous subchapters.
“Responsible Use of AI” is an important motto and initiatives undertaken by nations encourage cooperation with organizations such as the Global Partnership on Artificial Intelligence (GPAI) and support the responsible development and use of AI.

Nations should benefit from the GPAI and OECD AI Policy Observatory and join intergovernmental efforts to work together and support the development of AI for all.

Because countries significantly differ in their capabilities, resources, and priorities, cross-border collaborations for data sharing, funding, and policy development must be encouraged to promote equality between nations.

Government funding alone is not sufficient; governments must establish instruments to enable AI and provide incentives for investments from the private sector.

Some practical implications can be derived by analyzing the specific national AI strategies from Subchapter 4.3 (Table 13).

### Table 13 Lessons from the experiences of advanced countries in AI policy

<table>
<thead>
<tr>
<th>Country</th>
<th>Lessons learnt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>• Governments need to make significant investments to attract talent and conduct AI research.</td>
</tr>
<tr>
<td></td>
<td>• Local disparities must be eliminated. Cooperation among local centers of expertise is necessary.</td>
</tr>
<tr>
<td></td>
<td>• Efforts and investment must be put into communicating new knowledge and insights about AI.</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>• National leadership in AI is a common purpose for both the government and industry. Therefore, joint funding instruments must be established.</td>
</tr>
<tr>
<td></td>
<td>• Creating an environment that is friendly and welcoming for AI projects and solutions can be a great way to attract foreign investment.</td>
</tr>
<tr>
<td>India</td>
<td>• Before large-scale commitments and investments, it is always better to execute pilot projects to test the feasibility and financial viability.</td>
</tr>
<tr>
<td></td>
<td>• Identify key sectors of the economy where AI deployment would have the highest impact.</td>
</tr>
<tr>
<td></td>
<td>• AI will not be sustainable if it only benefits a fraction of the population. Thus, policies that target all layers of society must be adopted.</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>• To achieve the best results, AI policy should formulate long-term national plans.</td>
</tr>
<tr>
<td></td>
<td>• Governmental bodies specialized in AI regulation and promotion can be very beneficial (e.g. The Republic of Korea’s Presidential Committee on the Fourth Industrial Revolution; China’s AI Plan Promotion Office under the Ministry of Science and Technology; Japan’s Strategic Council for AI Technology; and Singapore’s National AI Office).</td>
</tr>
<tr>
<td></td>
<td>• Provide incentives that encourage the participation of businesses in the creation of an environment favorable for AI development and use by industrial players.</td>
</tr>
<tr>
<td></td>
<td>• Set measurable short-term and long-term goals.</td>
</tr>
</tbody>
</table>

Note: Lessons were drawn by the authors based on the content of Subchapter 4.3.
6.3. Policy implications from AI use-case analysis

After analyzing eleven use cases presented in Subchapter 5.2 and Annex 2, several crucial points for best practices can be identified:

- In order to assure accuracy regardless of context, environmental conditions, and other variable factors, tests should be conducted on several pilot projects.
- Cross-border collaboration is one of the few strategies where everyone wins. All participants get better access to data and have more opportunities to exchange information and know-how.
- Demands of industry players can be met using AI projects that help match societal needs (e.g. job search) to the needs of companies (e.g. search for talent).
- For successful projects, the needs of all stakeholders must be considered.
- Data collection does not have to be expensive or privacy invasive. Designing ways to utilize crowdsourcing from populations appropriate for the project context by providing the right incentives is an effective solution.
- Being a member State of large organizations, blocks of countries, or alliances (e.g. Commonwealth of Nations, the European Union, etc.) provides opportunities for better data access and collaboration.
- AI methods can be reused in different domains. The same data can be utilized in various projects. Thus, resources can be catalogued, for potential use in AI projects.
- Having state-of-the-art methods applied within a project can make the difference between success and failure. Therefore, it is critical to have access to top talent in the area of AI.
- AI projects have several different types of stakeholders, which makes it necessary to have access to talent and stakeholders from all kinds of profiles (e.g. public affairs, corporate management, marketing, psychology, etc.).
- Having useful data available publicly can help realize a variety of AI projects. It is important to support and promote open-data initiatives.
- AI doesn’t have to be a threat to existing jobs. AI projects can be utilized in scenarios where there is a lack of human resources.
- It is extremely important to promote public-private partnerships.
- Overall, having an efficient digital infrastructure is essential, especially access to Cloud infrastructure.

6.4. Recommended policy directions

When it comes to technology development, the role of government has been a driving force to provide conditions and infrastructure to support a safe and beneficial approach towards the adoption of new technological advancements. For instance, when the automobile became a mass-produced technology, governments made sure to create highways and regulations in the form of traffic laws. In a similar manner, for the greater good of citizens and the development of industry, governments must get involved and invested to support the necessary infrastructure and rules to achieve an AI-driven economy\(^\text{119}\).

Based on policy directions identified from AI considerations in Subchapter 6.1, extended by the implications and policy insights derived from AI policy analysis (6.2) and AI use cases (6.3), policy recommendations are presented in nine categories below.

1. Establish technological standardization based on cross-border cooperation

In the digital world, everything operates through the medium of interconnected networks of various scales which are eventually connected to the Internet. Therefore, national borders as we know them, do not exist in the context of the digital economy. Accordingly, it is extremely important for AI regulatory frameworks and technical standards to operate across nations and regions. With AI being deployed in most fields of industry and trade, it is crucial for AI technologies to evolve with interoperability across borders as a default. That is only possible when a common set of technical standards is in place. Several initiatives are under development on an international level involving organizations like ISO and IEEE. Although having a single set of global standards is unlikely for practical reasons, several families of commonly recognized standards can be expected.


The European Union’s “Policy and investment recommendations for trustworthy Artificial Intelligence” calls for the creation of recognized standards and fostering the development of standards for the interoperability of public applications and data sources.

In 2019, NIST developed the United States of America’s AI standards strategy in response to the 2019 Executive Order for a National AI strategy. The NIST plan includes background specific to AI standardization. The plan notes that there are a number of cross-sectoral (horizontal) and sector-specific (vertical) AI technical standards already available, and many are under development. There are fewer

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standards available in non-technical areas such as trustworthiness. AI standardization should make maximum use of existing standards. Systems using AI technologies are generally systems of systems (e.g., smart sustainable cities) and AI standards should take this into account.

2. Establish a balanced privacy protection

An essential minimal requirement for privacy protection is obtaining consent for data collection. It is important to understand that the timing of consent expression is a sensitive matter. Some policymakers argue that affirmative consent should be obtained before citizens use AI solutions. In contrast to this view, there stands the approach that suggests individuals to place explicit requests for their data not to be collected or used, with data being collected by default if no requests are filed. Another name for these two approaches is “opt-in” and “opt-out” respectively. The “opt-in” regime may not be favorable for technology providers because it may lead to unsatisfactory data sharing as most users usually go for the default option (i.e. not sharing). Another issue is that asking for and obtaining affirmative consent is associated with noticeable transaction costs. Finally, if “opt-in” is used, process automation with AI becomes practically impossible for large companies due to limitations of scale. Limitations arise because the people choosing not to share their data automatically must be served using manual procedures.

Based on the reasoning above, it may seem that an “opt-out” regime is preferable. This is not true. Although corporations and government entities may prefer to use the “opt-out” approach for practical reasons, “opt-in” provides the best privacy protection for users. Therefore, it is important to consider both approaches depending on the area of application. For example, when an AI solution is adopted with minimal exposure to personally identifiable data, “opt-out” would be a better choice. “Opt-in” could be a better alternative in systems where AI is used for personalized service that uses highly sensitive data (e.g. health data). It is imperative that policymakers and regulators exert enough effort to carefully analyze various types and domains of AI systems and suggest the appropriate regime of data collection. Choosing to go with the more conservative “opt-in” approach for all cases could be very harmful and detrimental for the growth and development of the AI industry.

To ensure the growth of AI industries, nations must have a data protection approach that supports innovation. Even if a country embraces a light-touch approach to AI, strict data protection laws will impact data processing, which lies at the heart of all AI systems. For instance, the GDPR gives individuals the right not to be subject to a decision based solely on automated processing, which limits how efficiently and effectively organizations can use AI for decision-making.

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Japan has taken a light-touch approach to AI regulation, stating a preference for goal-based rather than rule-based regulation. The Ministry of Economy, Trade, and Industry (METI) rightly explained in a 2020 report that the government’s role is to work with businesses to develop non-binding guidelines and standards that help them achieve their innovation goals—and cemented this view in a 2021 report in which it stated that “legally-binding horizontal requirements for AI systems are deemed unnecessary at the moment.”

Governments should ensure that data protection legislation does not limit AI innovation. It is important to reduce unnecessary regulatory costs and promote safe reuse of data to increase the supply of innovative technologies and services.

3. Acquire talent and mitigate unemployment

Issues around the search for talent and job loss are tightly related and interdependent with AI R&D and education. While it is true that AI may lead to a loss of jobs, the adoption of AI also creates new opportunities for those who are able to acquire skills necessary within an AI-enabled economy. Therefore, governments must come up with policies that would help workers engaged in low-skill occupations to make successful transitions into new roles. The best way to do so is through education reforms that will make it possible for workers to learn new technical skills that will allow them to engage in AI-enabled jobs.

As a next step, strategies for the promotion of AI-based innovation must be developed. Such initiatives could be in the form of targeted R&D funding and accelerated adoption of AI in the public sector and sectors with public oversight (e.g. education, finance, health care, transportation).

An important method to avoid job loss is to maximize the value derived from augmentation using AI, rather than full automation or replacement of labor. Full automation may lead to errors due to lack of human judgment, which could have serious legal and financial consequences. It is important to design AI solutions with an effort to preserve human control, especially when trust and legal responsibility is involved. For a concrete case, please refer to the TradeMarker, an AI tool developed by the students at Ben Gurion University in Israel. The tool decreased the workload and labor time required of the Trademarks Office of the Justice Department to handle all incoming requests for new trademarks.

AI solutions cannot be simply adapted from one geographical location to another because of different local contexts as well as variations in cultural and linguistic features of target user populations. Therefore, off-the-shelf AI services are not

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129 Ibid.
131 Ibid.
recommended in cases when decisions and processes may affect human beings. Human workforce can be attracted for localizing and reclassifying terms based on cultural context. By providing built-in functionality to make necessary context-specific adjustments and meet the needs of target populations, AI tool developers can help prevent job loss resulting from automation\textsuperscript{133}.

4. Establish ethical standards

Due to challenges of transparency, explainability, and accountability that are inherent to AI, incorporating human ethics into the algorithmic designs is a responsibility that has fallen upon software developers\textsuperscript{134}. Some ethics-focused standards and AI-specific principles were recommended by the IEEE\textsuperscript{135}. The Japanese Society for Artificial Intelligence Ethical Guidelines states that AI should be designed to contribute to humanity through Social Responsibility\textsuperscript{136}.

Some of the key principles for an ethical AI are:

- Inclusive growth, sustainable development, and well-being;
- Human-centered values and fairness;
- Transparency and explainability;
- Robustness, security, and safety;
- Accountability.

Governments must develop legislation that supports transparency and accountability in AI as part of the effort to decide upon the ethical standards for AI-based technology solutions\textsuperscript{137}. International organizations such as IEEE are driving the debate on AI ethics. Requirements for AI processes transparency by the United Kingdom’s House of Commons Science and Technology Committee argue that transparency should be a default property for algorithms that affect the public\textsuperscript{138}.

Ethical standards account for an essential part of national strategies and frameworks in several countries within the Asia-Pacific region\textsuperscript{139}. For instance, the Department of Industry, Innovation and Science of Australia has developed Australia’s Ethics Framework\textsuperscript{140} in 2019. The principles included within the framework are human, social and environmental wellbeing, human-centered, fairness, privacy protection and

\textsuperscript{133} ESCAP, U. (2019). Artificial Intelligence in the delivery of public services.
\textsuperscript{134} Truby, J. (2020). Governing artificial intelligence to benefit the UN sustainable development goals. Sustainable Development, 28(4), 946-959.
\textsuperscript{138} Truby, J. (2020). Governing artificial intelligence to benefit the UN sustainable development goals. Sustainable Development, 28(4), 946-959.
\textsuperscript{139} ESCAP, U. (2019). Artificial Intelligence in the delivery of public services.
security, reliability and safety, transparency and explainability, contestability and accountability. In 2019, the National AI Governance Commission of China developed the Governance Principles for a New Generation of AI with ethical principles. The principles include harmony and friendliness, fairness and justice, inclusivity and sharing, respect for privacy, secure/safe and controllable, shared responsibility, open collaboration, and agile governance.

5. **Design transparency requirements**

Transparency is a way to enable accountability, empower users, and build trust and confidence in AI. When designing transparency requirements, governments should consider what they are trying to achieve and how best to meet those goals in a given context. Transparency may come at a cost in the form of a trade-off against service speed, safety, and privacy. For example, if the source code or actual user data are disclosed, malicious actors could gain new opportunities to attack AI systems. Therefore, while it is important for policymakers to ensure the transparency of AI systems, they should also carefully consider possible trade-offs.

As mentioned in the previous recommendation on ethical standards, transparency requirements are included within the AI frameworks of major countries within the Asia-Pacific region (e.g. Australia, China, Singapore, Japan, etc.).

Unfortunately, the presence of key ethical principles, such as transparency, in national AI strategies does not guarantee their successful implementation. Therefore, it is important to check and verify whether the principles are being adhered to. For this purpose, an AI auditing framework must be adopted. Due to the specifics of each country and region, it is hard to suggest universal rules. Nevertheless, government officers and employees may benefit from the AI Auditing Framework published by the Information Commissioner’s Office (ICO), United Kingdom.

6. **Ensure explainability**

A key property of technology is reliability and consistency in terms of reproducibility of results and the possibility to explain how different results are obtained. Guaranteeing these attributes helps to identify potential harmful effects, empower users, and hold technology providers accountable. Therefore, governments should put in place appropriate policy instruments to ensure the explainability of AI and demand it from AI solution providers.

One of the early attempts can be found within the General Data Protection Regulation (GDPR) of the European Union, which can be interpreted to demand some degree of

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human judgment or oversight. Although not specific to AI, the GDPR is applied when algorithms are used with personal data as input for tasks like profiling or automatic decision-making. In such cases, the persons who are subject to such decisions have the right to know the logic behind decisions, which allows them to appeal against the outcome.

The GDPR's requirement that automated algorithmic decisions affecting humans must be explainable, limits the black box risk of unexplainable decision-making by AI systems. A sustainable development principle and continuous auditing requirements would limit the extent to which AI could stray from its purpose.

7. Proactively prevent gender, race, ethnic biases

Biases leading to discrimination on the basis of gender, race, and ethnicity are usually introduced through biased data which is used to train AI models. Therefore, policy instruments should be implemented to establish procedures for data validation. Training data for AI models should be checked in advance for any imbalances and content that may be flagged as discriminatory.

An even more effective solution may come from involving more women and representatives of minorities in decision-making positions related to AI policy and technology development in general. One of these initiatives is an organization that runs events and programs to support women in the field of machine learning (ML), Women in Machine Learning (WiML), founded in 2006 by Hanna Wallach, Jenn Wortman, and Lisa Wainer. The number of participants attending WiML workshops at NeurIPS has been steadily increasing since the workshops were first offered in 2006.

Suggestions by the World Wide Web Foundation from the Policy Brief W20 Argentina provide a great starting point in the form of general guidelines to improve the situation around gender inclusion in AI. Three proposals were included:

- Proposal 1: Countries need to take proactive steps towards the inclusion of women in the coding and the design of machine learning and AI technologies.
- Proposal 2: States need to implement industry guidelines to protect women from discriminatory algorithms and embrace openness and transparency for AI.
- Proposal 3: Countries must assess the economic, political and social effects of AI and machine learning technologies on the lives of women.

146 Ibid
8. Implement effective ways for human oversight

From problem and goal articulation to data collection and curation, and model and product design, human input is an essential driving force behind AI innovation. The choice of which priorities to pursue in AI development must be guided by humans, especially because of the existing legal and financial constraints. Moreover, human users provide essential feedback to improve AI systems over time. Human judgment is necessary to guarantee the fairness of automated decision-making by AI. Case in point, Finland’s National Non-Discrimination and Equality Tribunal has decided that automated statistical-based decision-making to determine if an applicant is eligible for credit, is a form of discrimination and consequently illegal.

It is not surprising that requiring human oversight comes with tradeoffs. For instance, requiring an AI system’s output to be reviewed by a person before being acted upon may make sense for some applications (e.g. AI systems used for critical, non-time-sensitive medical diagnostics). However, for other applications, it could lead to sluggish output, reduced privacy (if it means more people are exposed to sensitive data) or undermine accuracy (if human reviewers lacked the necessary expertise or were more biased). At an extreme, it could even put people at risk by delaying automated safety overrides.

Nevertheless, implementing effective ways for human oversight and feedback on AI systems can build trust that facilitates increased adoption. Thus, policymakers must consider mechanisms to incorporate human oversight in a manner that is appropriate within their jurisdiction.

9. Establish innovation principles for accountability and auditability

All of the policy recommendations provided so far cannot be effective unless there is an established mechanism to make sure the recommended principles are adhered to. In other words, AI solutions must be auditable.Auditability enables regulators to ensure that AI-enabled software tools deployed within their jurisdiction comply with policy principles. This could include measures to restrict the sale or use of non-compliant software. When auditability measures are enacted through large and influential organizations like the OECD or the European Union, AI software developers around the world are given incentives in the form of opportunities for commercialization within the jurisdictions requiring compliance (e.g. the European Union has a market of over 500 million consumers).

Just as with other policy recommendations, governments should follow the “innovation principle” rather than the “precautionary principle” when handling auditability and accountability issues. Rather than requiring companies to disclose their source code (“algorithmic transparency”) or being able to interpret any automated decision (“algorithmic “explainability”)—proposals that would limit AI innovation—policymakers should focus on holding companies accountable for outcomes (“algorithmic accountability”)\(^{154}\).

Regulatory initiatives should implement widely recognized international principles in a proactive manner that benefits sustainable development. Countries should not have to use AI-enabled software that does not respect the critical principles explained in this subchapter. Algorithmic auditing will help to guarantee the tapping into the benefits related to the United Nations SDGs while avoiding unnecessary risks. It is important that such regulation is not burdensome on a level that discourages software providers from innovating and investing in AI\(^{155}\).


7. International cooperation opportunities

Some of the policy recommendations suggested in this module, such as the development of standards, interoperability, and ethical requirements can fully be addressed only through international cooperation. Since every country is different in terms of the technical and economic environment, rather than giving specific recommendations, this subchapter elaborates upon possible ways governments can engage in international cooperation.

The most relevant and up-to-date information on cross-border cooperation opportunities in AI is presented in the AI Index Report 2021. The best way to collaborate with and benefit from international efforts in AI is through joint initiatives led by large global organizations, or regional alliances. Overall, international efforts and initiatives can take the form of working groups, summits, meetings, and bilateral agreements. Countries with advanced stages in AI development, such as Japan, the Republic of Korea, the United Kingdom, the United States of America, and members of the European Union are active participants of intergovernmental efforts on AI.

Intergovernmental initiatives depend on groups of experts and policymakers from member states. Such groups play an essential role in developing strategies for AI in a way where key regional players and many nations can contribute and participate. The largest and most effective working groups are listed below.

Global Partnership on AI (GPAI):

- **Participants:** Australia, Brazil, Canada, France, Germany, India, Italy, Japan, Mexico, the Netherlands, New Zealand, Republic of Korea, Poland, Singapore, Slovenia, Spain, United Kingdom, United States of America, and the European Union (as of December 2020)
- **Host of Secretariat:** OECD
- **Focus Areas:** Responsible AI; data governance; the future of work; innovation and commercialization
- **Notable Activities:** Two International Centers of Expertise—the International Center of Expertise in Montreal for the Advancement of Artificial Intelligence and the French National Institute for Research in Digital Science and Technology (INRIA) in Paris—are supporting the work in the four focus areas and held the Montreal Summit 2020 in December 2020. Moreover, the data governance working group published the Data Governance Framework in November. Since then, several other reports have been published in 2021 and 2022.

OECD Network of Experts on AI (ONE AI):

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158 Ibid.
• **Participants:** OECD countries
• **Host:** OECD
• **Focus Areas:** Classification of AI; implementing trustworthy AI; policies for AI; AI compute
• **Notable Activities:** ONE AI convened its first meeting in February 2020, when it also launched the OECD AI Policy Observatory. In November 2020, the working group on the classification of AI presented the first look at an AI classification framework based on OECD’s definition of AI divided into four dimensions (context, data and input, AI model, task and output) that aims to guide policymakers in designing adequate policies for each type of AI system.

High-Level Expert Group on Artificial Intelligence (HLEG):

• **Participants:** European Union countries
• **Host:** European Commission
• **Focus Areas:** Ethics guidelines for trustworthy AI
• **Notable Activities:** Since its launch at the recommendation of the European Union AI strategy in 2018, HLEG presented the European Union Ethics Guidelines for Trustworthy Artificial Intelligence and a series of policy and investment recommendations, as well as an assessment checklist related to the guidelines.

Ad Hoc Expert Group (AHEG) for the Recommendation on the Ethics of Artificial Intelligence:

• **Participants:** member States of the United Nations Educational, Scientific and Cultural Organization (UNESCO)
• **Host:** UNESCO
• **Focus Areas:** Ethical issues raised by the development and use of AI
• **Notable Activities:** The AHEG produced a revised first draft Recommendation on the Ethics of Artificial Intelligence, which was transmitted in September 2020 to the member States of UNESCO for their comments by December 31, 2020. On 24 November 2021, the Recommendation on the Ethics of Artificial Intelligence was adopted by UNESCO’s General Conference at its 41st session.\(^{159}\)

It is very important for governments to join these global initiatives and benefit from the opportunity to catch up with more advanced states and make sure their voices are heard, and concerns are raised.

Another valuable opportunity for international cooperation can be obtained through participating in global summits and meetings on AI. Some of the most influential ones are listed below.

AI for Good Global Summit:

• **Participants:** Global (United Nations and its agencies)
• **Hosts:** International Telecommunication Union, XPRIZE Foundation

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Focus Areas: Trusted, safe, and inclusive development of AI technologies and equitable access to their benefits

AI Partnership for Defense:
- Participants: Australia, Canada, Denmark, Estonia, Finland, France, Israel, Japan, Norway, Republic of Korea, Sweden, United Kingdom, and United States of America.
- Hosts: Joint Artificial Intelligence Center, United States of America Department of Defense
- Focus Areas: AI ethical principles for defense

China-Association of Southeast Asian Nations (ASEAN) AI Summit:
- Participants: Brunei Darussalam, Cambodia, China, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam
- Hosts: China Association for Science and Technology, Guangxi Zhuang Autonomous Region, China
- Focus Areas: Infrastructure construction, digital economy, and innovation-driven development

Some issues like data sharing, AI in agriculture, and radio spectrum management can be handled in a more effective way when cooperation is done between close neighbors or two specific countries with a shared interest. For this reason, bilateral agreements focusing on AI have been gaining popularity. Some of the well-known recent examples are listed below.

India and the United Arab Emirates: Invest India and the United Arab Emirates Ministry of Artificial Intelligence signed a memorandum of understanding in July 2018 to collaborate on fostering innovative AI ecosystems and other policy concerns related to AI. Two countries will convene a working committee aimed at increasing investment in AI startups and research activities in partnership with the private sector.

India and Germany: India and Germany have committed to increase cooperation on Artificial Intelligence
- Both nations have issued a joint statement which showcases the strengthening of cooperation in the field of AI and digital transformation. The initiative is part of Germany’s AI strategy, commissioned by the German Ministry for Economic Cooperation and Development (BMZ), and implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

In September 2020, the United States of America and the United Kingdom made a declaration through the Special Relationship Economic Working Group, stating that the two countries will enter into a bilateral dialogue on advancing AI, in line with shared democratic values and further cooperation in AI R&D efforts.

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161 Ministry of External Affairs of India (2019). Joint Statement during the visit of the Chancellor of Germany to India. Available from https://mea.gov.in/bilateral-documents.htm?dtl/31991/Joint-Statement+during+the+visit+of+Chancellor+of+Germany+to+India
India and Japan: India and Japan were said to have finalized an agreement in October 2020, which focuses on collaborating on digital technologies, including 5G and AI.

France and Germany: France and Germany signed a roadmap for a Franco-German Research and Innovation Network on artificial intelligence as part of the Declaration of Toulouse in October 2019, in an effort to advance European efforts in the development and application of AI, considering ethical guidelines.

For international collaboration to be successful and effective, development of common standards must be ensured. For developing countries, it is important to join and follow international efforts and developments in AI standardization. One of the best ways to do that is to engage in efforts of organizations involved in the development of international standards. Some of the most important ones are the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), and the International Telecommunication Union (ITU). IEC works on electrical and electrotechnical standardization and ISO in virtually all other areas except telecommunications, which is covered by ITU. A joint technical committee (JTC) of ISO and IEC (JTC1) deals with information technology standardization. ISO, IEC, and ITU are all working on standardization related to AI and IoT\textsuperscript{162}.

Annex 1: AI and sustainable development - examples

1. Opportunities for sustainable development

AI and positive societal outcomes

SDG 1 (No poverty): In many developed nations, household surveys and census data can be used to identify poor neighborhoods. But this information is not always readily available in developing countries. Gathering this kind of data on the ground can be slow, difficult, and prohibitively costly. In this respect, researchers and scientists are applying AI to identify poverty.\(^\text{163}\)

SDG 3 (Healthcare): Developing countries are endemicly short of medical workers. AI applications have the potential to fill this gap. In the case of the Ebola virus, machine learning enabled the identification of species that harbored the virus. More recently, AI applications have been developed that substitute and complement highly educated and expensive expertise by analyzing medical images.\(^\text{165}\) For example, in an experiment that tested an AI algorithm for detecting cancer against 21 trained oncologists, it performed just as well as the doctors’ performance.\(^\text{166}\)

SDG 4 (Education): Quality of education is a key development challenge for many developing countries. A study of the United Nations Educational, Scientific and Cultural Organization (UNESCO) shows that 27.3 million primary school teachers will need to be recruited worldwide and remarked that trained teachers are in short supply in many countries. AI could provide customized teaching and automated assessment of essays.\(^\text{167}\)

SDG 7 (Affordable and clean energy): AI can help to integrate various renewables by enabling smart grids that partially match electrical demand to times when the sun is shining, and the wind is blowing.\(^\text{168}\)

SDG 11 (Sustainable cities): AI can enable smart and low-carbon cities encompassing a range of interconnected technologies such as electrical autonomous vehicles and smart appliances that can enable demand response in


the electricity sector\textsuperscript{169} \textsuperscript{170} (with benefits across SDGs 7, 11, and 13 on climate action).

**Figure 25 Detailed assessment of the impact of AI on the SDGs within the Society group**


Note: Each block in the diagram represents a target. Targets highlighted in green or orange indicate that AI could potentially enable or inhibit such targets, respectively. The absence of highlighting indicates the absence of identified evidence. It is noteworthy that this does not necessarily imply the absence of a relationship.

\textsuperscript{169}\textsuperscript{170}Ibid.

\textsuperscript{170}Fuso Nerini, F. et al. (2019). A research and innovation agenda for zero-emission European cities. Sustainability 11, 1692.
AI and positive economic outcomes

SDG 8 (Decent work and economic growth): Within the SDG 8, target 10 seeks to increase access to banking, insurance, and financial services for all, seen as key to financial inclusion\textsuperscript{171, 172}. Without this, people are unable to gain the credit history needed to access credit to grow businesses, save, invest, and make digital payments. SDG 8.3 specifically envisions access to financial services as a means of facilitating the growth of small and medium-sized enterprises and supporting productive activities, decent job creation, entrepreneurship, creativity, and innovation. Enhancements in financial technology facilitate opportunities for digitized financial inclusion\textsuperscript{173}, and this is enhanced further by AI. Financial institutions have been employed to make access to banking simpler, more efficient, and more accessible, creating opportunities for the 1.7 billion unbanked adults (mostly) in the developing world, to gain access to banking and finance\textsuperscript{174}. It has also the potential to make trading and banking safer through improved compliance and monitoring, such as AI-enhanced scrutiny to prevent rogue traders\textsuperscript{175}.

Figure 26 Detailed assessment of the impact of AI on the SDGs within the Economy group

![Figure showing detailed assessment of the impact of AI on the SDGs within the Economy group]


Note: The interpretation of the blocks and colors is as in Figure 25.


SDGs 8, 10, 12 (Agriculture). A critical area where AI has potential for developing countries is in increasing agricultural efficiency. For example, recent advances in image recognition allowed researchers to scan more than 50,000 photos of plants to help identify crop diseases at sites using smartphones with a success rate of over 99 percent.\(^{176}\)

SDG 16 (Sustainable development): The focus of SDG 16 (as supported by UNODC) is upon “strengthening the effectiveness, fairness, and accountability of criminal justice institutions to tackle crime, corruption, and terrorism”. SDG 16.4 includes a goal to minimize illicit financial flows to tackle organized crime, SDG 16.5 sets a goal to eliminate corruption, while SDG 16.A seeks to build capacity and cooperate internationally to combat crime and terrorism. AI software can significantly improve rates of monitoring and enforcement in developed and developing countries. This can vastly reduce the ability of those benefiting from crime or corruption\(^{177}\) to launder the proceeds of their illicit deeds.

AI and positive environmental outcomes

SDG 13 (Climate action): There is evidence that AI advances will support the understanding of climate change and the modeling of its possible impacts. Furthermore, AI will support low-carbon energy systems with high integration of renewable energy and energy efficiency, which are all needed to address climate change.\(^{178}\)\(^{179}\) AI and deep learning can help climate researchers and innovators test out their theories and solutions as to how to reduce air pollution. One example of this is the Green Horizon Project from IBM that analyses environmental data and predicts pollution as well as testing “what-if” scenarios that involve pollution-reducing tactics. By using the information provided by machine learning algorithms, Google was able to cut the amount of energy it used at its data centers by 15 percent. Similar insights can help other companies reduce their carbon footprint.\(^{180}\) AI helps not only in mitigating climate change but also in adapting to climate change. A recent UN ESCAP publication provides some examples of how AI can be used to adapt to climate change.\(^{181}\)

SDG 14 (Life below water). To prevent and significantly reduce marine pollution of


all kinds, algorithms for automatic identification of possible oil spills may help\textsuperscript{182}.

**SDG 15 (Life on land):** Neural networks and objective-oriented techniques can be used to improve the classification of vegetation cover types based on satellite images\textsuperscript{183}, with the possibility of processing large amounts of images in a relatively short time. AI techniques can help to identify desertification trends over large areas, information that is relevant for environmental planning, decision-making, and management to avoid further desertification, or help reverse trends by identifying the major drivers.

**Figure 27 Detailed assessment of the impact of AI on the SDGs within the Environment group**

![Image](image-url)

Note: The interpretation of the blocks and colors is as in Figure 25.

2. Potential for a negative impact on sustainable development

**AI and negative societal outcomes**

**SDG 2 (Zero hunger):** AI technology is unevenly distributed\textsuperscript{184}: for instance, complex AI-enhanced agricultural equipment may not be accessible to small farmers and thus produce an increased gap with respect to larger producers in more developed economies\textsuperscript{185}, consequently, inhibiting the achievement of some targets.

**SDGs 1, 4, 5 (Equality):** AI-enabled technology can trigger inequalities that may act as inhibitors of equality. An important drawback of AI-based developments is that they are traditionally based on the needs and values of nations in which AI is being developed\textsuperscript{186}. If AI technology and big data are used in regions where ethical scrutiny, transparency, and democratic control are lacking, AI might enable


\textsuperscript{184}Ibid.


nationalism, hate towards minorities, and biased election outcomes\(^\text{187}\).

**SDG 5 (Gender equality):** Even though there is insufficient research assessing the potential impact of technologies such as smart algorithms, image recognition, or reinforced learning on discrimination against women and minorities\(^\text{188}\), there are many concerns about this. For example, machine-learning algorithms uncritically trained on regular news articles will inadvertently learn and reproduce the societal biases against women and girls, which are embedded in current languages. Word embeddings, a popular technique in natural language processing, have been found to exacerbate existing gender stereotypes\(^\text{189}\). In addition to the lack of diversity in datasets, another main issue is the lack of gender, racial, and ethnic diversity in the AI workforce\(^\text{190}\).

**SDG 16 (Peace, justice, institutions):** The AI software is a code that learns from the data it encounters, making itself more effective and being able to predict possible future attempts more accurately\(^\text{191}\). An unfortunate consequence of an AI program that has mastered the art of detecting and preventing anti-money laundering (AML) attempts, is that it is equally an expert in identifying vulnerabilities that would enable it to successfully launder money\(^\text{192}\). This makes it invaluable if acquired by organized crime or terror finance groups, who could utilize the software to disguise their money laundering with precision and sophistication. Similarly, there is the potential for AI to be manipulated to perpetuate corruption in developing countries where vulnerabilities in the AML system exist\(^\text{193}\).

**AI and negative economic outcomes**

**SDGs 8, 9, 10 (Reducing inequalities for work):** Future markets may rely heavily on data analysis and when these resources are not equally available in low- and middle-income countries\(^\text{194}\), the economical gap may be significantly increased due to the newly introduced inequalities significantly impacting SDGs 8 (decent work and economic growth), 9 (industry, innovation and infrastructure), and 10 (reduced

\(^{190}\) Truby, J. (2020). Governing artificial intelligence to benefit the UN sustainable development goals. Sustainable Development, 28(4), 946-959.
\(^{191}\) National Science Foundation (2018). Women and Minorities in the S&E Workforce.
inequalities). Brynjolfsson and McAfee (2014) argued that AI can also exacerbate inequality within nations. By replacing old jobs with ones requiring more skills, technology disproportionately rewards the educated.

**AI and negative environmental outcomes**

**SDG 13 (Climate action):** Advanced AI technology, research, and product design may require massive computational resources only available through large computing centers. These facilities have a very high energy requirement and carbon footprint (compromising outcomes in the SDG 7 sphere, but also on SDG 13 on Climate Action).

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197 Ibid.
Annex 2: Case Studies of AI based on OECD OPSI

1) Rapid, optical and global detection tool against counterfeits in every pocket (Germany, 2019)

Case summary

In 2019, Germany developed TrueMed®, the world’s first counterfeit detection service for the pharmaceutical industry. This innovation allows customs and consumers to rapidly detect counterfeits at any point of distribution. Through image processing, a combination of AI and Computer Vision Techniques, users of TrueMed can just scan the package in a mobile app and identify the counterfeits. TrueMed does not have to add tags to products and within the supply chain. Moreover, it works instantly for both new and established products and offers unique comparison, forensics, analytics, and reporting tools available on smartphone.

Data is collected worldwide for further analysis in the public safety and pharmaceutical industries. The detected counterfeits are grouped and provide advanced comparison tools, analysis, reports, and alerts with a self-learning AI platform. TrueMed has been tested on several pilots, and its detection accuracy rate is 99.97 per cent. It can provide services to up to 10 million users per month.

Challenges

- Different lighting conditions: A variety of support technical features allowing mobile devices to still be used on the spot has been implemented and to secure the detection speed and detection accuracy under various external conditions.
- Capacity issue: Capacity issues have virtually disappeared with the development of extensions to add capacity in the cloud.

Conditions for success

- Ultimately, success can be expected if governments and brand owners digitize the processes which are currently carried out manually.
- Successful cross-border collaboration between governments is needed.
- It needs all parties to become involved in stopping counterfeits, which requires collaboration with cross-border and brand owners.

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200 OECD OPSI (Observatory of Public Sector Innovation), Rapid, optical and global detection tool against counterfeits in every pocket, https://oecd-opsi.org/innovations/rapid-optical-and-global-detection-tool-against-counterfeits-in-every-pocket/
2) A Free Education Portal: An Education Strategy for the 21st Century (Brazil, 2017)²⁰¹

Case summary

In 2017, the Brazilian government promoted an open free education platform based on practical interactive content that induces individual growth for low-income youth (age 16 to 24), which covers about 40 per cent of Brazilian teenagers who have not graduated from high school.

The project was led by Industrial Social Service and proceeds with projects in cooperation with educational institutions, companies, and non-profit organizations. This free education platform provides customized educational content tailored to individual needs, internship opportunities provided by various companies, and serves a collaborative community function for volunteers interested in mentoring youth. Through this, it is possible to contribute innovatively to solving problems in industries that had difficulty identifying and selecting the right talent for interns. As of January 2021, 47,063 people were provided with educational opportunities, 300 students succeeded in finding jobs, and 3,000 are in the process of the curriculum.

Challenges

- Design issues: It was difficult to identify contents that would really engage target groups and software that was easy to use and collaborative (previous versions of the platform were unsuccessful). To solve this issue, preliminary research was conducted in an informal and free approach to assess the specific needs of adolescents, businesses, governments, and social organizations.

Conditions for success

- A mechanism for active participation of stakeholders, along with multilateral partnerships, is required to identify and reflect the needs of users and stakeholders before building the platform.
- In order to maximize user convenience, online tools should actively utilize channels that are connected to users' daily lives.
- The requirements of the platform and the vision and mission of the institution must be fully integrated.

2. Brazil's Free Education Platform LIVRE website, https://www.edulivre.org.br/ mainly based on this source
3) Simplifying the Identification of School Infrastructure Vulnerability at Scale (United States of America, 2021)\(^{02}\)

Case summary

California Polytechnic State University, San Luis Obispo (Cal Poly DxHub) and Munich University of Applied Sciences (MUAS DTLab) have participated in the design of safe schools in cooperation with the World Bank's Global Program (GPSS). Two universities collaborated to demonstrate the use of Artificial Intelligence and Machine Learning methods for a more effective way to evaluate school buildings in areas that are difficult to access for World Bank evaluators.

Using AI algorithms and photo images from school buildings in Nepal and Kyrgyzstan, they have developed technical solutions to the problem of identifying the most vulnerable school building infrastructure in developing countries. With this solution, an estimated 875 million children and teachers at risk of injury can be better protected from natural disasters.

To build a standardized set of photos compatible with AI algorithm input, public sector organizations jointly designed and demonstrated mobile applications that allows school administrators and other community members to collect and register photo data. Afterwards, AI processes data to identify structural types and evaluate vulnerabilities.

Challenges

- Consistency issue: As the AI model designed in the AI classes of the two universities is improved and expanded, it is becoming increasingly difficult to continue these efforts due to frequent changes in student teams’ composition. To address this problem, they are looking for additional funding opportunities and are forging partnerships with cloud service providers.

Conditions for success

- The strategy of using mobile apps to secure crowd-sourced data for AI learning proved to be effective.
- The technical team’s support and the development of classification algorithms to efficiently classify the obtained data enabled effective scaling-up.

\(^{02}\) OECD OPSI (Observatory of Public Sector Innovation), Simplifying the Identification of School Infrastructure Vulnerability at Scale, https://oecd-opsi.org/innovations/simplifying-the-identification-of-school-infrastructure-vulnerability-at-scale/
4) **IP Global Artificial Intelligence Network (IPGAIN), (Australia, 2019)**

**Case summary**

In September 2019, IP Australia launched IP GAIN (Intellectual Property Global Artificial Intelligence Network), an innovative market that provides global access to technology solutions for the IP ecosystem. IP GAIN is a simple and secure service that can expose IP Australia’s other IP Offices’ and third-parties’ AI and Machine Learning (ML) tools. It enables partners to co-design and contribute to the development of future AI and ML tools, as well as increasing IP Offices’ capabilities in AI governance and ethics.

The goals for the IP GAIN prototype have been broken down into two phases. The goal for the first phase was to create an application store or marketplace for AI and ML tools that support the IP ecosystem. The second phase consists in collaborative problem solving and solution delivery through continuous improvement and new co-development opportunities. IP Australia has completed a prototype of IP GAIN with the Intellectual Property Office of the United Kingdom. The initial service testing will then be expanded to include the Canadian IP Office.

**Challenges**

- International collaboration issue: Implementing any international collaboration initiative requires time to break down long-established operating silos. The IP ecosystem is small and niche, but the institutions and practices can often be outdated or obsolete.

**Conditions for success**

- Leadership is critical in bringing IP offices with different motivations and business problems together to collaborate.
- Cloud-based infrastructure enabled the team to develop the IP GAIN platform and associated AI and ML tools in an agile manner.

5) **Potential for mapping the world’s land resources using satellites and artificial intelligence (Australia, 2018)**

**Case summary**

The Queensland Land Use Mapping Program (QLUMP) has been mapping and assessing land use patterns and changes throughout Queensland, Australia for twenty years. Although many advances have been made in process automation, using

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203 OECD OPSI (Observatory of Public Sector Innovation), IP Global Artificial Intelligence Network (IPGAIN), https://oecd-opsi.org/innovations/ipgain/

204 OECD OPSI (Observatory of Public Sector Innovation), Potential for mapping the world’s land resources using satellites and artificial intelligence: an Australian case study in land use., https://oecd-opsi.org/innovations/potential-for-mapping-the-worlds-land-resources-using-satellites-and-artificial-intelligence-an-australian-case-study-in-land-use/
conventional methods, it is time- and resource-intensive, taking about 30 years for one person to map a whole state's land use. To solve this problem, the Queensland government developed a solution that uses machine learning and computer vision to automatically map and classify land use features in satellite imagery.

QLUMP used existing land use mapping of banana plantations to test the capability of computer vision to map land-use features as a proof of concept. The results were very encouraging with an overall mapping accuracy rate of 97 per cent, well above the required 80 per cent.

Using this technology, the Queensland Government can accurately map and classify the land use in a timely manner, aiding the response to biosecurity and natural disaster events. They have a plan to expand this method into other land use classes, in an attempt to fully or semi-automate land use mapping in Queensland.

Challenges

- Similar color issue: The problem is that different features can have similar colors such as banana plantations and rain forests or even grasslands as they are all green. The development team was able to increase its accuracy by having the AI learn all the components related to banana plantations.
- Managing expectations: Training AI and training data are very important. Although they already had quality land use mapping data, some errors were identified and fixed to produce quality outputs.

Conditions for success

- Collaboration with Envista, an AI specialist, conducted during the initial proof-of-concept stage, made it possible to apply a cutting-edge algorithm suitable for the problem.
- Quality land use mapping data was already available.
- The research team had access to high-performance computing resources and substantial archives of satellite imagery.

6) Plateforme d’Engagement Citoyen (France, 2018)

Case summary

In 2018, the Make.org Foundation developed a large-scale participation platform that allows numerous people to join hands in order to change society based on the "Participating Agreement Positively". The platform is created as a 100 per cent open source to ensure transparency to citizens. Through the platform, citizens can raise

2. Make.org Website, https://make.org/, mainly based on this source
questions of common interest or vote on other participants’ opinions. To prevent trolling phenomena and overexpression of interest groups, an algorithm was developed by Make.org, allowing the measurement of citizens’ support to any given proposal.

Algorithm-based digital tools enable citizens and partners to participate in various issues and translate proposed results into meaningful action plans on a large-scale. It is possible to overcome digital limitations and derive optimized results by supplementing them with offline-based face-to-face workshops. With the platform, it is possible to achieve a true grassroots democracy.

Challenges

- Limitations of digital: Digital platforms allow large-scale citizens to raise problems and suggest solutions, but in order for the final solution to be practicably applied, a more in-depth offline discussion is required. For this purpose, Make.org covers everything from problem raising to solution derivation through the online platform, and the derived solution is supplemented with face-to-face workshops.
- Team building: The design and building of an AI-enabled platform requires the creation of a team with diverse profiles (and skillsets) ranging from data scientists to public affairs managers.

Conditions for success

- The project succeeded in building a team of experts with various profiles to design and build the platform.
- For proof of concept, small and fast iterations were performed.
- By reconnecting on-the-ground stakeholders, they bring field knowledge to the subject.

7) Annie™ MOORE (Matching for Outcome Optimization and Refugee Empowerment), (United States of America, 2018)

Case summary

While tens of thousands of refugees are permanently resettled to host countries every year, governments lack the capacity to know in which communities to place refugee groups. For this purpose, the Hebrew Immigrant Aid Society (HIAS), one of a refugee settlement institution, recommends optimal placement for refugees from hosting communities across the United States of America using Annie™ MORE (Matching and Outcome Optimization for Refugee Empowerment), which has been utilizing advanced machine learning and state-of-the-art integer optimization methods since May 2018. Annie™ is the first-ever software that uses predictive and prescriptive analytics to optimize employment outcomes of resettled refugees and runs on light, flexible, open-

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OECD OPSI (Observatory of Public Sector Innovation), Annie™ MOORE (Matching for Outcome Optimization and Refugee Empowerment), [https://oecd-opsi.org/innovations/annie/](https://oecd-opsi.org/innovations/annie/)
source software. Annie’s goal is to propose refugee placement and maximize employment opportunities while not exceeding refugee needs (e.g. child support or language support) and service capabilities in hosting communities (e.g. residences or places in training programs).

Two steps were considered when Annie™ was activated. First, the machine learning methods find patterns in large datasets covering all refugee sites in HIAS over the past decade and select characteristics that allow refugees to get a job in a specific community. For the second step, the organizing committee determines the community in order to allocate all refugee families in a way that maximizes employment. The result indicates that Annie™ is increasing employment performance by more than 30 per cent.

Challenges

- Acute lack of resettlement agency budget, staff, time, and data;
- Complex decision environment comprising host communities, refugees and the public-private, federal, non-profit, academic partnership;
- Volatile political climates and attitudes, domestic and abroad, generating crippling uncertainty in resettlement agency operations and planning,
- Lack of other relevant integration outcome measures such as education, physical and mental health, and English proficiency.

Conditions for success

- The collaboration between the United States of America Department of State and HIAS provided the necessary infrastructure for successful data sharing agreements and understanding of the day-to-day operations which enhanced the prototyping of Annie™, leading to its eventual adoption.
- From the very start, the co-design and feedback of software involving all users and stakeholders led to the development of software suited to this problem.

8) Slavery from Space (United Kingdom, 2017)

Case summary

According to the Global Slavery Index, there are an estimated 40 million slaves worldwide. To achieve the United Nations SDGs, it is necessary to secure data on the current status of slavery, in the most accurate way possible, to capture the exact number of slaves worldwide, locations, and reasons for the continuation of slavery.

207 1. OECD OPSI (Observatory of Public Sector Innovation), Slavery from Space, https://oecd-opsi.org/innovations/slavery-from-space/

In 2017, Dr. Doreen Boyd's team at the University of Nottingham's "Rights Lab," developed a machine-learning algorithm to calculate the scale of modern slavery present to secure valuable knowledge about slavery. The "Rights Lab" compiled, synthesized, and integrated satellite data for the brick kilns fields to apply machine learning to calculate the number of the slaves based on the assumption that one third of the estimated 40 million slaves would be detectable from space.

To increase the result accuracy of the machine learning algorithm, it is promoted based on crowdsourcing so that citizens can visually check and correct satellite images. Through this civic participation platform, civic scientists upload qualitative observations (e.g. memos, photos) to correct spatial patterns and slavery patterns and trends with more detailed information. The accuracy can be improved by retraining with more kiln cases by adjusting the methodology to reflect the push results, reducing the limitations of data mapping errors, and utilizing deep learning across a wider geographical area.

Challenges

- Secure accurate data: Unpaid citizens were involved as scientists through their role in visually verifying satellite images via the citizen science platform, Tomnod and Zooniverse.
- Costs of up-to-date high-resolution satellite: To overcome this, partnerships with key providers were established.

Conditions for success

- Early-stage research was funded through sponsorship from the Rights Lab (www.nottingham.ac.uk/.rights-lab).
- The input and advice from some of the world's leading anti-slavery scholars have contributed to the right solution.

9) Tracking potential tax evaders on Instagram (Colombia, 2018)

Case summary

Digital tax evasion was increasing along with the rapidly growing digital economy in Medellin. To identify potential tax evaders, the local Treasury Department manually detected unregistered online stores, but this was not a sustainable method. As a result, the treasury department started looking for a new solution with the Government Innovation Lab of Ruta N, the city's business and innovation center.

Through this collaboration, the department decided to work with the local startup Grupo Boötes, which had proposed the development of KBoot, an algorithm that scrapes Instagram profiles and matches data with those of local telephone operators.

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208 OECD OPSI (Observatory of Public Sector Innovation), Tracking potential tax evaders on Instagram, https://oecd-opsi.org/innovations/tracking-potential-tax-evaders-on-instagram/, mainly based on this source
to identify unregistered businesses and invested money to test the idea during a three-month pilot period.

Through KBoot software, 2,683 Instagram sellers were identified, and 2,230 of them were not registered as business operators (83 per cent of all sellers).

**Challenges**

- Integration into the regular economy: A lot of thought was given on how to address the situation of the 2,337 identified potential new taxpayers. Since migrating to a different municipality is simple online, the treasury department started campaigns to encourage identified companies to register their businesses. However, only 17 of these companies have registered their business using the “Crecer es Posible” program.
- Nature of public sectors: The subsequent implementation after pilot tests based on the agile environment provided by Ruta N has been relatively slow due to bureaucratic processes.

**Conditions for success**

- Law on the digital economy (Acuerdo 066 de 2017) created the necessary legal framework to tax online commercial activity.
- Spaces such as the Government Innovation Lab allowed the public and private sector to work together and build alliances to jointly deliver public goods.
- Regular communication and coordination between the Fiscal Intelligence unit and Grupo Boötes made it possible to run several iterations of the bot, provide feedback, and adapt it.

**10) Prevention of solitary deaths through smart care ICT (Republic of Korea, 2017)**

**Case summary**

With the rise of single-person households and an aging population, society is demanding a guarantee for healthy life and welfare services. In particular, the demand for customized care services for the socially vulnerable is increasing. However, it is difficult to meet the exponentially increasing welfare demand through face-to-face interactions alone. Therefore, AI speakers were distributed to senior citizens living alone in socially disadvantaged single households, so that they can have someone to talk to, listen to music with, and receive information from. In particular, the project developed an ICT caregiving service where the AI speakers can recognize emergency signals and respond to them promptly.

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209 1. OECD OPSI (Observatory of Public Sector Innovation), Prevention of solitary deaths through smart care ICT (KakaoTalk, mobile phones, and AI), https://oecd-opsi.org/innovations/ict-care/
As a result, the groups who are at risk of solitary death were quickly identified; and customized caregiving services were provided to vulnerable single households based on this information to prevent solitary deaths.

According to the announcement of Gyeongsangnam-do (2021), from the end of 2019 until recently, 45 people were transported to hospitals by emergency services through this service and their lives were saved.

Challenges

- Test to prove the idea: During the test operation period, many issues were resolved, and details of the project were improved through collaboration between the department of welfare policy, individual community service centers, and private organizations (SKT, Lucis).

Conditions for success

- As various interested parties cooperated to improve the sustainability of the project, in the end, an innovative solitary death prevention system was successfully created. Community service centers selected the potential service recipients and the district office established partnerships and funded the project, while the telecommunication company offered its services along with system development and management capacity. A social enterprise also offered system operation and data analysis and reporting services.

11) “The Work”, AI Job Recommendation Service Using the National Job Information Platform (Republic of Korea, 2019)\(^\text{210}\)

Case summary

In this flood of information, it is not easy for job seekers to find information on suitable jobs. To address this problem, the Korea Employment Information Service (KEIS) established “The Work,” a service that recommends jobs suitable for each job seeker without the need to conduct individual searches. The job opening recommendations are made using AI, which analyzes the job seeker’s CV registered on Work-Net, his/her past training experience, any funding or grants already received, and the job seeker’s own areas of interest.

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3. The Ministry of Employment and Labor press release, the Ministry of Employment and Labor, and the start of AI-based job-talent recommendation service., 2020.7.9. mainly based on this source
In January 2019, KEIS began piloting services that improved the identification and shortlisting of qualified talents for jobs at a faster pace. Reflecting on the results of the pilot operation, "The Work AI" began in July 2020.

Focusing on the difficulties of job seekers, it was possible to derive practical results by combining AI with the information search of job seekers and the improvement of job seekers' recruitment announcement process. The scope of AI application will be expanded by reflecting the service operation results and feedback.

**Challenges**

- Secure data volume and quality: Cooperation with other government ministries and public agencies, as well as related third parties, was established.
- Cost, time, and manpower for data cleaning: The cost, time, and manpower it takes to identify and correct the results of improper data analysis are far greater than those needed to correctly cleanse data prior to analysis.

**Conditions for success**

- The KEIS and the Ministry of Employment and Labor proposed an amendment to the 'Framework Act on Employment Policy' to enable the furnishing of data by outside bodies in this project.
- “The Work” is based on vast amounts of public data accumulated by the National Job Information Platform. The National Job Information Platform is a consolidated database for public administration data, which includes information on job openings, training, and certificates, etc. The quality of this information far surpasses that of the information available to private businesses, whose data is limited to their own clients.
APCICT

The Asian and Pacific Training Centre for Information and Communication Technology for Development (APCICT) was inaugurated on 16 June 2006 as a regional institute of Economic and Social Commission for Asia and the Pacific (ESCAP), and is located in Incheon, Republic of Korea. Guided by the 2030 Agenda for Sustainable Development and other internationally agreed development goals, the Centre’s objective is to build and strengthen the capacity of members and associate members of ESCAP to leverage information and communication (ICT) for the purpose of socio-economic development. APCICT’s work is focused on training, knowledge sharing, and multi-stakeholder dialogue and partnership.

APCICT is located in Incheon, Republic of Korea.

http://www.unapcict.org

ESCAP

The Economic and Social Commission for Asia and the Pacific (ESCAP) is the most inclusive intergovernmental platform in the Asia-Pacific region. The Commission promotes cooperation among its 53-member States and 9 associate members in pursuit of solutions to sustainable development challenges. ESCAP is one of the five regional commissions of the United Nations.

The ESCAP secretariat supports inclusive, resilient and sustainable development in the region by generating action-oriented knowledge, and by providing technical assistance and capacity-building services in support of national development objectives, regional agreements and the implementation of the 2030 Agenda for Sustainable Development.

https://www.unescap.org