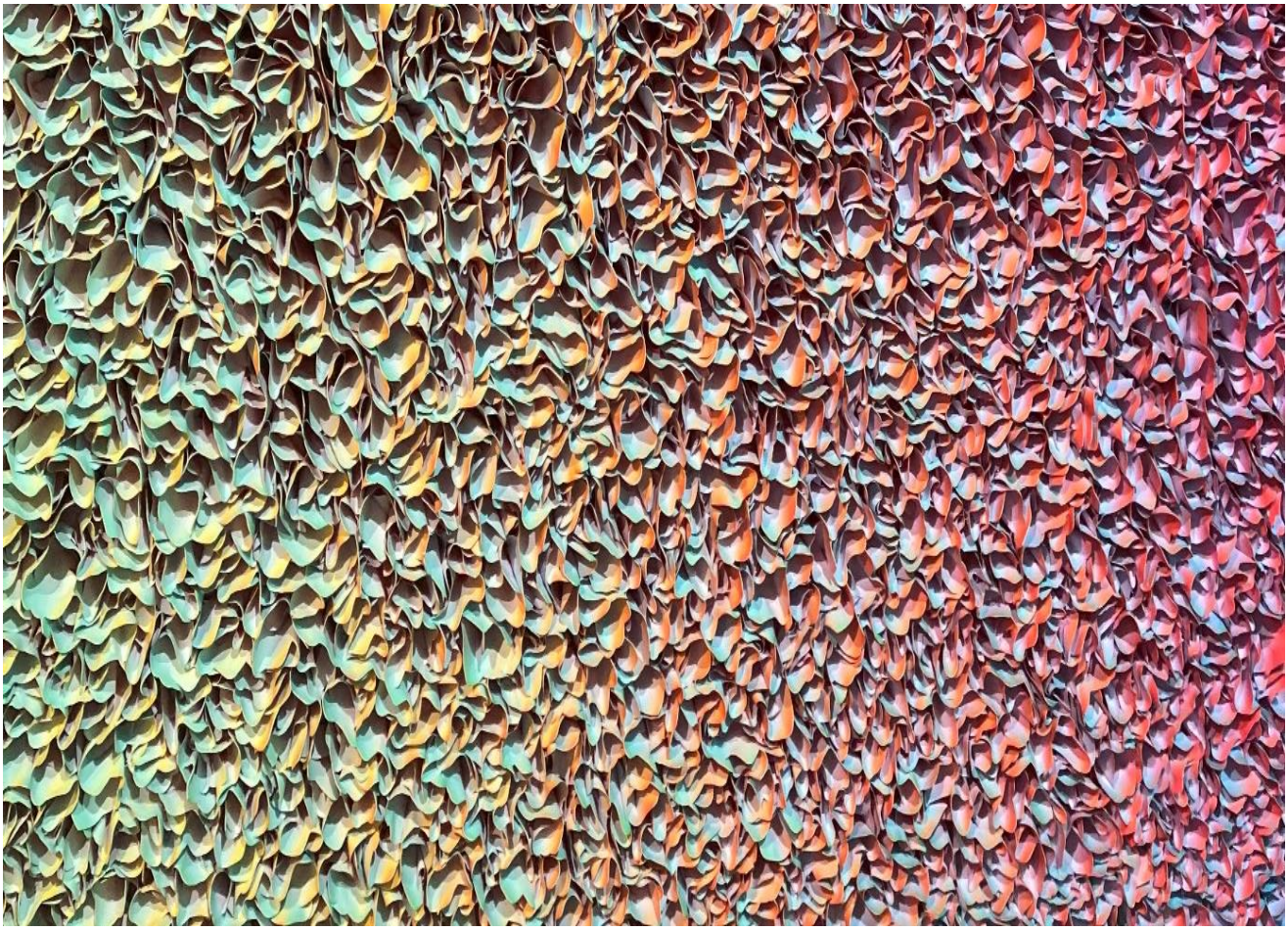
Developing a national AI strategy

Comparative national approaches



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Report by George James Consulting (GJC) – May 2023. info@Georgejamesconsulting.com Developed by GJC under a Creative Commons Attribution 4.0 International License.

Introduction

The application of Artificial Intelligence (AI) is now a high priority for governments – both developed and developing. It is well recognised that AI has the potential to support government objectives in all domains and improve the lives of citizens.

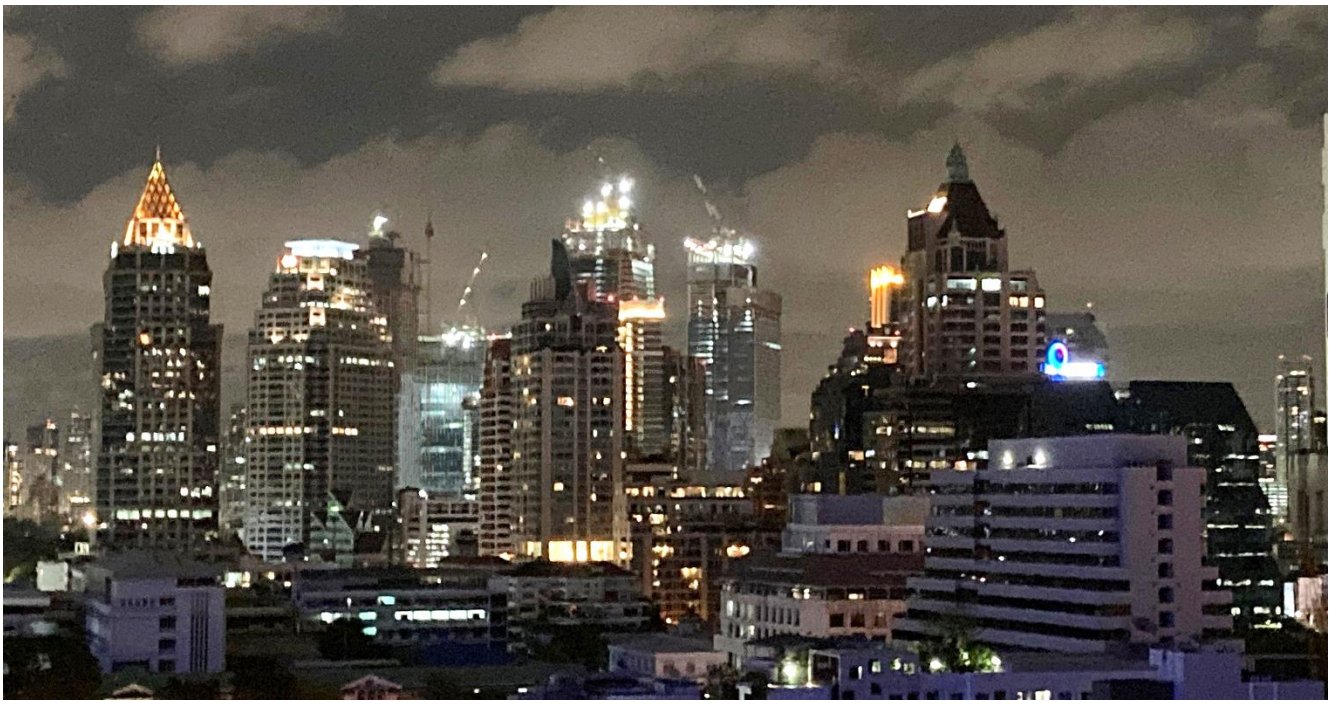
From larger economies such as the US and China who seek to focus on the full gambit of AI applications, to developing countries who may be more interested in specific areas. All need a clear strategy to assist them pursue their AI aspirations.

Nations are also backing up the rhetoric around AI with significant investment and this needs to be carefully guided to deliver value. As with other emergent technology, investment can not be based upon hype and needs realistic priority setting.

The following report is an **analysis of different approaches to support the development of national level AI strategies.** It includes a review of resources developed by the World Economic Forum (WEF), the OECD, and the European Union (EU).

The report then highlights the national AI strategies of the UK, US, and China before providing a high-level view of the **themes** from the AI strategies of a number of countries including: France, the Netherlands, Germany, Sweden, Denmark, Singapore, Australia, Spain, Canada, Italy, and Norway. Particular (but not exhaustive) examples of **AI research and application** by each nation are also noted.

It is stressed that AI is an inherently dynamic field and new strategies, initiatives and the individuals and entities involved with them change rapidly. This report is a summary at a point in time and may not cover new developments within different national and international contexts.



The World Economic Forum (WEF) AI framework

The WEF have been undertaking extensive research and collaboration with a number of international stakeholders for a number of years around emergent technological trends including AI. This has included the production of whitepapers and sponsoring research and other activities.

In 2019 and in response to the growing focus on AI, the WEF published 'A Framework for Developing a National Artificial Intelligence Strategy'. The WEF suggest that:

> *'**The (AI) framework** will help teams responsible for developing the national strategy to ask the right questions, follow the best practices, identify and involve the right stakeholders in the process and create the right set of outcome indicators. Essentially, the framework provides a way to create a "minimum viable" AI strategy for a nation'.*

WEF notes the rapidly changing nature of the fourth industrial revolution requires governments to take a proactive approach to technological change. The pervasive nature of AI requires a sound multistakeholder approach to manage preventable harms, have technologically informed policies, alleviate public and ethical concerns and ensure the best outcomes.

It is noted that a country's AI strategy needs to reflect its real world strengths and weaknesses. A developed country may seek to increase the automation of health care in reflection of its demographics, whereas a developing country may want to highlight STEM and growing the knowledge economy.

Designing the AI strategy

WEF suggest starting with a basic Strengthens, Weaknesses, Opportunities, Threats (SWOT) analysis. This will allow the identification of priority focus areas for the AI strategy and where investment may be required and the supporting human resources, processes, and technology.

Each of the items within each domain (Strengths, Weaknesses, Opportunities, Threats) can then be ranked for prioritisation. An overall list of possible actions can be pulled together with the overlay of whether they are short, medium, or long term and any dependencies.

Establish objectives for the AI strategy

WEF note that a national AI strategy should be designed to serve a set of clearly defined objectives. In line with the SWOT analysis, the objectives of the national AI strategy should focus on specific targets in the following areas:

- Capacity – human resources and digital infrastructure
- Investments – research and development, grants
- Adoption – socioeconomic sectors, industrial sector
- Regulation – enabling regulation such as privacy and ethical standards for data use.

Key dimensions of a national AI strategy

The WEF suggest that while each country will have its own national policy priorities within its AI strategy, certain elements should be in a “minimum viable” strategy. These include:

Dimension 1: Standardized data-protection laws and ethics

The criticality of good data for AI requires a robust regulatory environment that embeds trust between data subjects and the organizations using this data. This regulation needs to govern how data is collected, stored, processed, and shared and requires attention to ethical issues.

Dimension 2: Establishing research environment and integration

Access to open data between the research, academic and business communities is crucial as is the creation of a research environment for industry-academia collaboration. AI talent development is a national issue that needs cross-sectoral integration and good governance.

Dimension 3: Preparing the workforce for the AI economy

The impact of AI upon the workforce needs to be actively anticipated and consequently require planning for the skills required in the future workforce. WEF notes the need to build the capacity and underlying infrastructure for this shift such as upskilling and re-skilling.

Dimension 4: Investing primarily in strategic sectors

The WEF emphasise the need for nations to primarily focus on their respective comparative advantage and design their AI ecosystems accordingly. Most nations have finite resource and investment to allocate to the AI strategy and it should seek to address national challenges.

Dimension 5: Engaging in international collaboration

The rapid pace of AI evolution makes it a field nations need to develop in conjunction with others and in alignment to international initiatives. This is because AI knowledge is globally distributed and no one nation is likely to have all the required expertise and capabilities required. WEF asserts that it is crucial that nations actively seek international collaboration and contribute to international regulation and governance.

Create an implementation plan

National strategies need an implementation plan that allocates responsibilities across the stakeholders involved. The broad impact of AI means that this needs to be across government, legislature, businesses, academia and other societal players. The WEF suggest nations develop a responsibility matrix for stakeholders and includes the following:

- Phases, milestone; and timelines;
- Role of all stakeholders (government agencies, legislature, industry, standard-setting, private-sector, academia, research institutions, civil society);
- Budget/investment allocation – both by public and private sector; and
- Administrative structures for oversight of the strategy.

OECD AI strategy development guidance

The OECD is well established in its focus on AI and research on strategy and policy matters. The OECD 'going digital toolkit', which is an overview of national AI strategies and policies was published in April 2021. The Toolkit seeks to provide policy makers with the guidance they need in a digital and data-driven world.

The OECD report stresses that AI advances require policy makers to shift from 'principles to practice' to achieve the benefits and mitigate the risks. The Going Digital Toolkit also provides an overview of various AI policy initiatives underway by governments with a focus upon (1) policy design (2) policy implementation (3) policy intelligence and (4) international and multi-stakeholder policy co-operation.

According to the OECD, key priorities governments in the formulation of national AI strategies and polices are the promotion of trustworthy AI systems, investment in responsible AI research and development and digital environment enabling access to data, alongside privacy protection.

The rapid development of AI policy has led the OECD to create the OECD AI Policy Observatory (OECD.AI) which includes more than 600 national AI policies from 60 countries. This resource is designed to assist countries' compare AI policy initiatives according to the recommended OECD AI Principles (see Figure 1.0).

Figure 1.0 – OECD principles and recommendations for AI

The OECD five principles for stewardship of AI:

1. AI should benefit people, planet and drive inclusive growth, development and well-being.
2. AI systems should respect the rule of law, human rights, democratic values, diversity, and include appropriate safeguards;
3. There should be transparency and responsible disclosure to ensure understanding of AI-based outcomes and can challenge them;
4. AI systems must function in a robust, secure and safe way throughout their life cycles and potential risks should be continually assessed and managed.
5. Organisations and individuals developing, deploying or operating AI systems should be held accountable for their functioning in line with the above principles

The OECD also recommends that governments:

- Facilitate public and private investment in R & D innovation in trustworthy AI;
- Foster accessible AI ecosystems with digital infrastructure, technologies and mechanisms to share data and knowledge;
- Ensure a policy environment that supports deployment of trustworthy AI systems.

European Union (EU) AI strategy

The primary entities responsible for developing the European Union (EU) AI strategy are the European Commission (policies and regulations at the EU level); European AI Alliance (engaging stakeholders around strategy); and the European Parliament (legislates policies and regulations). Other EU entities and stakeholders are also involved.

There are multiple EU AI strategies and plans published by the European Commission noting the intention to make the EU a 'global hub for AI'. They reiterate the need for the underlying rules being applied reinforce European values and support AI develop in a trustworthy and safe way that respects fundamental rights while still promoting innovation.

The AI Act provides a legal framework that will help regulate specific uses of AI and should to be considered with the accompanying 'Coordinated Plan on AI'. In April 2021, the Commission presented its AI package that highlighted the need for a common EU approach. This work is being implemented through a shared Strategic Action Plan for AI (SAPAI) together with newly applied regulation and impact assessments.

The European approach to building trust in AI

The EU Commission emphasize the need to develop trustworthy AI. This effort is supported by various tools including:

1. The European legal framework for AI to address fundamental rights and safety risks;
2. A civil liability framework - adapting liability rules to the digital age and AI;
3. The revision of sectoral safety legislation (e.g. Machinery Regulation, General Product Safety Directive).

The 2021 plan is also designed to support the uptake of AI in the EU so that research can be commercialised and build strategic leadership in high-impact sectors. The 2021 Coordinated Plan on Artificial Intelligence aims to increase collaboration between the Commission and Member States by: (1) **accelerating investments in AI technologies** to drive resilient economic and social recovery aided by the uptake of new digital solutions (2) **acting on AI strategies and programmes** by fully and timely implementing them to ensure that the EU benefits from first-mover advantages; and (3) **aligning AI policy** to remove fragmentation and address global challenges.

Overall, a key priority for the EU relates to **AI governance and regulations**. The focus being the establishment of regulatory frameworks and guidelines for ethical and responsible AI deployment within the EU. Research includes investigating the legal, ethical, and socio-economic implications of AI technologies across various sectors. Countries developing an AI strategy may find EU work relating to governance and regulation provides a good base to build their own approach from.

The United Kingdom – AI strategy

The key UK entities involved in setting the national AI strategy include the Office for AI, within the Department for Science, Innovation and Technology (responsible for coordinating AI strategy and policy across government); The Department for Digital, Culture, Media and Sport (DCMS); the Alan Turing Institute (the national institute for data science and AI research); and the Government Digital Service (GDS).

In 2018, the UK government signalled around £1 Billion would be invested in the UK AI ecosystem. This investment was directed to enable a 'step-change' regarding AI in the UK and build the resilience, innovation, and productivity of the public and private sectors.

The UK strategy has a ten-year vision to make the UK:

> *"the best place to live and work with AI, with clear rules, applied ethical principles, and a pro-innovation regulatory environment..."*

The strategy identifies the core elements for successful AI as essentially: people, data, digital infrastructure ('compute') and finance. The pervasiveness of AI's impact upon mainstream society is noted as requiring agile governance and regulatory regimes that uphold the safety, security and rights of citizens.

With this context the UK's National AI Strategy focuses on:

1. **Investing in the long-term needs of the AI ecosystem.** Investment and planning for the long-term needs of the AI ecosystem to continue leadership as a science and AI superpower;
2. **Ensuring AI benefits all sectors and regions.** Supporting the transition of the UK to an AI-enabled economy, ensuring the benefits of innovation are evenly distributed across the UK;
3. **Governing AI effectively.** Ensuring the UK is positioned at the national and international level to foster innovation, investment, and the protection of fundamental values.

The strategy then uses these three areas of 'pillars' to break down the short (next 3 months), medium (next 6-12 months), and long term (next 12 months and beyond) actions that the UK will be undertaking (see figure 2.0 below)

The UK National AI Strategy has an accompanying **implementation plan** that will support delivery of the strategy as well monitoring and assessing its overall progress.

Figure 2.0 – Summary of detailed actions under the UK AI strategy (for example of actions)

	Investing in the long-term needs of the AI ecosystem	Ensuring AI benefits all sectors and regions	Governing AI effectively
Short term	• Framework for better data • Cyber-Physical; Infrastructure Framework; • Build skills through bootcamps.	• Begin AI strategy for health and social care; • Publish Defence AI strategy; • Consult on AI copyrights.	• Publish assurance roadmap; • Consider data protection in governance; • Develop All of Government international strategy.
Medium term	• Publish research on AI skills requirements; • Assess investment need for AI startups; • Ensure AI education is accessible; • Support diverse AI workforce; • Implement AI R&D Declaration (UK/US); • Publish review of UK compute capability; • Start visa regimes to attract AI talent to the UK.	• Publish research on diffusion of AI across the economy; • Consider specific use cases for AI such as energy; • Extend UK aid for AI innovation in developing countries; • Create repository of AI for real-world applications.	• Publish national position on governing and regulating AI; • Complete analysis on algorithmic transparency for government standard; • Pilot AI Hub for standards; • Establish horizon scanning functions for awareness of AI safety.
Long term	• Review international and domestic semiconductor supply chains; • Consider what government datasets can be published for AI models; • Launch a new National AI Research and Innovation Programme; • Support diversity in top talent in AI; • Use National Security and Investment Act in balanced way; • Include AI in trade deal provisions.	• Launch joint Office for AI to support development of AI in low maturity sectors; • Continue development of capabilities around trustworthiness, adoptability, and transparency of AI; • Coordinate identification of where AI can contribute to strategic challenges.	• Develop AI technical standards toolkit to support ecosystem engage globally; • Work with global partners on R&D challenges; • Work with the Alan Turing Institute to update guidance on AI ethics and safety in the public sector; • Work with national security/Defence on AI use to mitigate catastrophic risks.

The United States - AI strategies

The primary United States government entities involved in national strategy setting include the White House Office of Science and Technology Policy (OSTP) - Coordinating policy and strategy at federal level; the National Institute of Standards and Technology (NIST) - standards and guidelines; the Department of Defense (DoD); and the National Science Foundation (NSF). It is important to note the wide breadth of other federal, state, private sector, not for profit, and other organisations that also contribute to the US AI strategy in different capacities.

The Executive Order 13859 'Maintaining American leadership in AI' highlights the breadth of U.S. government intent to sustain an advantageous scientific, technological, and economic position of the US through a co-ordinated Federal government strategy via the American AI Initiative.

The National Artificial Intelligence Initiative (NAII) was consequently established by the National Artificial Intelligence Initiative Act of 2020 (NAIIA) in 2021. The main purpose of the initiative is to coordinate efforts across the US ecosystem. Areas for focus across the Federal agencies include:

- **AI innovation** - Leadership in AI Research and development. There is a specific Research and Development strategic plan;
- **Advancing trustworthy AI.** The development and use of trustworthy AI systems in public and private sectors. This included the use of metrics, assessment tools and standards;
- **AI education and training.** The efforts preparing the current and future US workforce for the integration of AI systems across all sectors;
- **AI infrastructure –** This includes the availability of quality data, models, and computational infrastructure;
- **AI applications –** Across a wide range of sectors including agriculture, financial Services, healthcare and social services, pandemic response, national security and defense, science and technology, justice, transportation, weather forecasting and education;
- **International cooperation** around AI – Diplomatic and aid related.

An area of ongoing focus in the US is **'AI ethics and responsible AI'**. This work involves the development of ethical guidelines and frameworks for AI development and deployment. This is seen as crucial with research and the ethical implications of AI technologies, including challenges such as bias and algorithmic fairness.

Given the size of the US government and the wide variety of applications, there are a large number of sectoral and/or institutional level AI strategy documents. Each have their own purpose, priorities, opportunities and risks (see references for links).

Considering US government AI strategies can be overwhelming due to the complexity of the US federal system. What may be helpful for other countries are the thematic priorities developed by the US and sector specific strategies. This may assist a country in determining its own priorities as well as identify possible opportunities for collaboration with the US.

United States – key AI institutions within US Universities

The National Science Foundation (NSF) AI Institute for Artificial Intelligence and Fundamental Interactions (IAIFI) is a collaboration of both physics and AI researchers at MIT, Harvard, Northeastern, and Tufts. A core focus is the use of innovative methods to improve theory calculations, experiments, and to advance the field of AI.

The Ohio University based **AI Institute for Future Edge Networks and Distributed Intelligence (AI-EDGE)**. Research includes the synergies between networking and AI to design the next generation of edge networks (6G and beyond)**.** The Institute will develop the key underlying technologies for distributed and networked intelligence to enable a host of future transformative applications such as intelligent transportation, remote healthcare, distributed robotics, and smart aerospace.

The **AI Institute for Collaborative Assistance and Responsive Interaction for Networked Groups (AI-CARING)**. This is collaboration between Georgia Tech, Carnegie Mellon University, Oregon State University, the University of Massachusetts Lowell, and Oregon Health & Science University. The AI-CARING mission is to develop the next generation of personalized collaborative AI systems that improve the quality of life and independence of aging adults living at home.

The National Science Foundation AI Institute for Student-AI Teaming (iSAT) at Colorado University. This is an interdisciplinary research community dedicated to transforming classrooms into more effective, engaging and equitable learning environments.

MIT Computer Science and Artificial Intelligence Laboratory (CSAIL) – Research is wide ranging and includes AI and Machine Learning, Algorithms, computational biology, computer architecture, graphics and vision, Human-computer interaction, robotics, and others with a focus on how they impact the likes of big data, cyber security, energy, education, Internet of Things (IoT), wireless, transport, healthcare, and manufacturing.

China AI Strategy

The primary Chinese entities involved in the national AI strategy include the State Council of the People's Republic of China (strategy and policy); Ministry of Industry and Information Technology (MIIT) (regulation); the Ministry of Science and Technology (MOST); and the National Development and Reform Commission (NDRC). It is noted that a number of other State, military, private sector and research organisations not identified here are also involved in the Chinese AI strategy.

In 2017, China unveiled its overarching national AI strategy entitled **'A New Generation Artificial Intelligence Development Plan'.** The plan has four basic principles:

1. **Technology-led.** Taking a long-term support, China will strive to lead transformational and disruptive breakthroughs in methods, tools, and systems for AI;
2. **System approach.** Systematic development of strategy to take advantage of the [socialist] system to concentrate resources required major AI projects;
3. **Market-dominant.** Accelerate the commercialization of Chinese AI technologies. Utilizing government support for planning, policy, security, market, ethical regulation;
4. **Open-Source.** Promotion of open-source sharing between industry and academia and as well as military and civilian entities to achieve technological innovation.

Key milestones for the Chinese AI strategy

The plan notes that China should have made significant progress in advancing **AI models and methods** by 2020. It also stresses China should be competitive at the global level and be heavily involved in establishing AI ethical norms, policies, and regulations.

By 2025, the Plan sets the expectation that China should have made major **'theoretical and technological' breakthroughs in AI** to support it becoming a world leader in AI. China should also have laws, regulations, ethical norms, and methodologies to undertake AI security assessments. The Plan projects that by 2030, China should emerge as the **'world leader in AI'** with AI technology innovations and centres that support personnel training.

To support China's strategy, the **Chinese AI Open Source Software Development League** has also put out a strategy. This has three parts including the (1) adoption and participation in AI open source (2) leading on AI open source development including natural language processing and (3) leading the trend towards AI open source and emphasizing systems to evaluate AI open source.

One specific area of interest to the Chinese government has been the use of **AI-powered surveillance and facial recognition technology**. This has included the extensive development and deployment of advanced surveillance systems using AI and facial recognition technologies. Research is ongoing using facial recognition algorithms, biometric data analysis, and AI-enabled surveillance technologies.

Themes from other national AI strategies

France

The main French entities involved in setting the national AI strategy include the French Ministry of Economy, Finance, and Recovery (strategy and policy); the French Ministry of Higher Education; and the French National AI Strategy Committee (NSAI). There are other organisations involved in the development of the French AI strategy not noted here.

The French National Strategy for AI (SNIA) was allocated a budget of €1.5 billion for five years (2018-2022) and includes the following three themes:

1. **AI research and development:** Developing the highest scientific levels of AI by training and attracting the best global talent in the field. Promoting AI research and development to enhance innovation and economic competitiveness;
2. **Data-driven economy:** Encourage the widespread adoption of AI in the economy and society, particularly through startups, public private partnerships and data sharing;
3. **Ethical AI:** Ensuring an ethical framework that supports responsible use of AI technologies and appropriate transparency and fairness.

The French government have also emphasised the need for **AI in public services** to improve efficiency, citizen-oriented services, and the importance of active international collaboration. This includes strong ties with EU partners such as the German Research Center for Artificial Intelligence (DFKI) and with Japan.

France – National priority for AI strategy – building the supporting infrastructure.

The Jean Zay supercomputer that provides high performance computing for AI applications. Jean Zay has a computing power of more than 36,85 petaflops per second and has supported key projects such as BLOOM, the largest multilingual "open science" model, with over 46 languages including 20 African languages and 176 billion parameters. Jean Zay is also leading development of energy efficiency with its water-cooling technology.

The application of AI in France is also present within **the arts and culture sector**. Research has included investigating the use of AI algorithms for artistic creation, music composition, and digitization of cultural heritage. A specific example is the French based "AIVA: Artificial Intelligence Virtual Artist" which is an AI-based virtual artist capable of composing original music..

Netherlands

Key entities involved in the national AI strategy include the Dutch Ministry of Economic Affairs and Climate Policy (policy and innovation); Dutch Ministry of Education, Culture, and Science; the Dutch AI Coalition (Public-private partnership driving AI strategy and collaboration), and the Parliamentary Standing Committee on Digital Affairs. It is noted that are other organisations involved in the development of the Dutch AI strategy not noted here.

The Dutch Digitalisation Strategy 2021 has a significant focus on AI and is based on the EU Strategic Action Plan for AI (SAPAI). The Dutch strategy includes the following themes:

1. **Public-private partnerships:** Encouraging collaboration between the government, industry, and academia to promote AI research and innovation. This has included the work of the Dutch AI Coalition (NLAIC);

2. **Responsible AI:** Emphasizing the development and deployment of AI technologies that safeguards public values and human rights – so AI use is ethical, transparent, and fair. Recent focus has been around the legal aspects of decision-making algorithms, the unforeseen effects of self-learning algorithms, and modernisation of Dutch law to consider big data;

3. **International engagement** – The Dutch Government is active within EU bodies, international entities such as the Global Partnership on Artificial Intelligence (GPAI), and through a number of bi-lateral agreements.

The Dutch strategy also emphasises the importance of **AI skills and education** to build a skilled AI workforce, the use of **data**, digital **inclusion, connectivity**, and the application of **AI in key sectors** such as healthcare, government, agriculture, energy, and mobility.

Netherlands – AI application to address national priority – Water management.

One area that the Netherlands has taken a specific interest in is how AI can assist with **water management.** The focus has been on flood prediction, and climate adaption and resilience. Research has included studying the use of AI for real-time monitoring, modeling, and decision support in water management.

A specific example of this work has been underway at the Deltares research institute in the Netherlands since 2015. Deltares specializes in water and subsurface issues and have been collaborating with the Dutch government on the development of models integrating data from various sources using AI techniques to develop real-time flood forecasting and other water management models.

Germany

Key entities involved in the national AI strategy include the Germany Federal Ministry for Economic Affairs and Energy - AI strategy; Federal Ministry of Education and Research (BMBF) - research and development; and the German Research Center for Artificial Intelligence (DFKI): research and technology transfer. Not all German organisations involved in the development of the AI strategy are noted here.

The AI Strategy of the German Federal Government includes the following themes:

1. **'Minds'**: training, attracting and retaining more AI specialists in Germany. This includes initiatives such as the German Academic Exchange Service (DAAD);
2. **Research -** establishing leading and internationally recognised research structures with a focus on the provision of cutting-edge AI and computing infrastructure;
3. **Transfer and application -** establishing AI ecosystems of international standing that are based on excellent research and with effective transfer structures to support the application of AI to business purposes. This includes support for start ups and SME's.
4. **Regulatory framework** – Fostering the conditions for innovation whilst also ensuring human-centric AI applications and infrastructure that is regulated to be safe, secure and trustworthy;
5. **Society -** supporting civil society in its engagement in the development and application of AI so that it serves the common good.

The German government and research institutions have also been active in International cooperation arrangements. This has included collaborating with EU, US, Japan and other international partners to exchange knowledge and promote AI advancements.

Germany – AI application to address a national priority – manufacturing

Germany has taken a particular interest in **AI in manufacturing and industry 4.0**. This is not surprising given Germanys significant industrial base with the focus has been upon utilizing AI to drive innovation and efficiency in manufacturing processes and industrial automation. Particular research is focused on exploring the application of AI in predictive maintenance, supply chain optimization, and human-robot collaboration.

An example of how AI can assist with 'predictive maintenance' is underway at the Fraunhofer Institute for Manufacturing Engineering and Automation (IPA) Researchers have developed AI-based predictive maintenance solutions that use machine learning algorithms and data analytics to predict possible equipment failures, likely downtime, and optimized maintenance schedules.

Sweden

The key entities involved in setting the national strategy include the Swedish Innovation Agency (Vinnova) - research, development, and innovation; Ministry of Enterprise and Innovation - strategy and policy; Swedish Research Council (VR) - funds research and academic projects. It is noted that are other organisations involved in the development of the AI strategy not highlighted here.

The Swedish national AI strategy includes the following themes:

1. **Education and training -** Efforts to increase the level of AI talent in Sweden, encourage skills development both through formal education and training as well as 'lifelong learning'. This also includes the introduction of AI components in non-technical and professional development programmes;

2. **Research (lab to market) –** A focus upon basic and applied research environment in AI, strong connections with leading international AI research, use of pilot projects and 'safe' environments, along with efforts to adequately manage AI risks;

3. **Innovation and use –** Building from the underlying research base, this includes the provision of support for projects and startups for economic and societal benefit**;**

4. **Framework and infrastructure** – The use of data and digital infrastructure to support AI projects within a framework of enabling legislation, rules, standards, norms and ethical principles.

Sweden has also sought to be an active participant in the development of EU and international standards and regulations that promote the ethical use of AI. This has also accelerated the establishment of governance mechanisms such as the Swedish government Committee for Technological Innovation and Ethics (KOMET).

Sweden - AI application to address a national priority – green technology

A particular area of interest within AI for the **Swedish** government has been with **AI in sustainability and green technologies**. Here the focus has been upon the application of AI to address sustainability challenges and accelerate the development of green technologies. Research has been primarily around the use of AI in renewable energy optimization, smart grids, and environmental monitoring.

Some of this research has been undertaken in collaborative efforts between the Swedish Energy Agency and Swedish academia. Researchers have conducted research on AI-based optimization of renewable energy systems with a focus on AI algorithms and models that improve the efficiency, reliability, and integration of renewable energy sources into the power grid.

Denmark

The primary agencies involved in setting the national AI strategy include the Danish Agency for Digitalisation – responsible for government digital transformation; the Danish Ministry of Higher Education and Science - research and education; and the Danish Board of Technology (engaging with stakeholders on policy). It is noted that there are other Danish organisations involved in the development of the AI strategy not noted here.

The National Strategy for AI outlines the vision for Denmark is to be a 'front-runner in responsible development and use of artificial intelligence'. It also notes the following themes:

1. **A responsible foundation for AI** – this includes the use of principles for responsible development and use of AI that will be supplemented by efforts to: strengthen cyber security and legislation and ensure responsible and transparent use of AI. Governance mechanisms will also be strengthened through the Data Ethics Council.
2. **Access to more and better data** – More public-sector data being made available for AI in collaboration with businesses and research communities. This will initially focus on environmental and climate data from the transportation sector. There will also be a specific focus on the Danish language and accompanying resources to accelerate Danish language-technology solutions to benefit citizens, authorities and businesses;
3. **Strong competences and new knowledge** – To build the level of skills and experience of AI in in the public sectors a number of projects that will be undertaken within health, social sector and employment areas;
4. **Increased investments** – New sources of investment in AI will be developed including the Danish Growth Fund and by attracting new international investment.

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Denmark – AI application to address a national priority – citizen engagement

A specific area the Danish government has been exploring is where the AI could augment **public services and citizen engagement**. The focus of this work has been around utilizing AI technologies to improve public service delivery and citizen participation with research investigating AI for personalized public services, chatbots, and data-driven policymaking.

An example is research underway at the Denmark based Alexandra Institute, Aarhus University, and Danish Agency for Digitisation around **how AI can personalise public service delivery**. Researchers have been developing AI algorithms and systems designed to tailor public services to individual citizens' needs, preferences, and circumstances. The research has centred around data analysis, machine learning, and user-centric design approaches to enhance the user experience and effectiveness of public services.

Singapore

The primary entities involved in the Singaporean national AI strategy include the Info-communications Media Development Authority (IMDA); the Smart Nation and Digital Government Office (SNDGO); and National Research Foundation (NRF). It is noted that are other organisations involved in the Singapore AI strategy not highlighted here.

Key themes from the Singapore National Artificial Intelligence Strategy include:

1. **Emphasise deployment** - Work across public, private and research institutions to enable AI solutions. Includes R&D, regulatory, and capability development;
2. **Focus on key sectors** - AI deployment in key sectors with high social or economic value that builds on existing strengths such as transport and logistics, manufacturing, finance, safety, security, cybersecurity, smart cities, healthcare, education and government services;
3. **Strengthen the AI Deployment Loop –** Within the "AI deployment loop" identify and initiate collaborative AI projects ("National AI Projects"). Utilise these projects to learn lessons;
4. **Adopt a human-centric approach** - Focus on benefits to citizens and businesses in alignment with our Smart Nation approach. This means focusing on deployment in high value sectors of and addressing the risks and governance issues.

Singapore - AI national priority – developing the Singapore AI ecosystem

The strategy also identifies unique Singaporean **'ecosystem enablers'** that include: (1) **The Triple Helix Partnership** between the research community, industry and government enabling the commercialisation and deployment of AI solutions (2) **AI talent and education** – efforts to the shortfall of AI talent across the ecosystem through training and the attraction of top-tier global talent; (3) **Data architecture** – initiatives to increase the rapid and secure access to high-quality cross-sectoral datasets. This work will focus on the use of frameworks for public-private data collaboration, trusted data intermediaries for data exchange; (4) **Progressive and trusted environment** – strengthen citizens trust in the development and deployment of AI solutions; (5) **International collaboration** – ongoing work with international partners to collaborate and guide international AI discourse and develop global standards, policies and guidelines.

The Strategy also notes the ongoing focus on **high impact AI Projects** within wide range of sectors including: Intelligent freight planning; municipal Services; medical – including chronic disease prediction and management; education – including personalised education through adaptive learning and assessment; and border clearance operations.

Australia

Key organisations involved in the Australian national AI strategy include the Department of Industry, Science, Energy, and Resources - policies and innovation; the Australian Centre for Artificial Intelligence and Digital Ethics (CAIDE): ethics and policy guidance; the Commonwealth Scientific and Industrial Research Organisation (CSIRO) - research and industry collaboration. It is noted that are other organisations involved in the development of the Australian AI strategy not highlighted here.

Themes from the Australia's Artificial Intelligence Action Plan include:

1. **Focus one: Developing and adopting AI to transform Australian businesses** – support to help Australian businesses develop and adopt AI technologies to create jobs and increase their productivity and competitiveness;
2. **Focus two: Creating an environment to grow and attract the world's best AI talent** – support to ensure Australian businesses have access to world-class talent and expertise;
3. **Focus three: Using cutting edge AI technologies to solve Australia's national challenges** – support to harness Australia's world-leading AI research capabilities to solve national challenges, and ensure all Australians benefit from AI;
4. **Focus four: Making Australia a global leader in responsible and inclusive AI** – support to ensure AI is inclusive and technologies are built to reflect Australian values.

Australia's focus on the **ethical and responsible use of AI** is guided by the Australia's Artificial Intelligence Ethics Framework that focuses on human, societal and environmental wellbeing and promotes respect for human rights, diversity, and the autonomy of individuals. It also seeks to promote fairness, privacy, security, safety, underpinned by transparency, contestability, and accountability.

Australia - AI application to address a national priority – agriculture

One specific area of interest within **Australia** has been the use of **AI in agriculture and rural innovation**. This work is focused on understanding how Australia can leverage AI technologies to optimize agricultural practices to improve productivity and support sustainable rural development. This includes livestock management, precision agriculture, and crop yield prediction. Research into the use of AI for livestock management is being sponsored by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and other institutions. Of note has been the use of AI algorithms, machine vision, and other sensor technologies to monitor animal behaviour and health. This work has led to the development of AI-powered systems for early disease detection, automated feeding systems, and animal behaviour analysis.

Spain

Organisations involved in the Spanish national AI strategy include the Secretary of State for Digitalization and Artificial Intelligence (strategy and policies); National Institute of Cybersecurity (INCIBE); and the Ministry of Science and Innovation - research and development initiatives. It is noted that are other organisations involved in the development of the AI strategy not noted here.

Key themes for the Spanish National Artificial Intelligence Strategy include:

1. **Axis 1 - Promote scientific research, technological development and innovation in AI.** This includes the Spanish Network of Excellence in AI, academic research, national centers for multidisciplinary research and funding for the private sector;
2. **Axis 2 - Promote the development of digital capabilities, national talent, and the attraction of global talent in AI.** This includes the National Digital Skills Plan, vocational training, university education, and the "SpAIn Talent Hub" program, including a focus on female talent;
3. **Axis 3 - Develop data platforms and technological infrastructures to support AI.** The establishment of a Chief Data Officer, industrial data spaces with accessible repositories and the strategic supercomputing capabilities (cloud, edge, quantum);
4. **Axis 4 - Integrating AI into value chains to transform the economic fabric.** This includes programs supporting companies incorporate AI through Digital Innovation Centers, public-private venture capital fund, and national green algorithms program;
5. **Axis 5 - Enhance the use of AI in public administration and in strategic national priorities.** This includes establishing the innovation laboratory (GobTechLab), promoting skills and "AI for data-driven public sector" program with a focus on health, justice, employment.
6. **Axis 6 - Establish an ethical and regulatory framework that reinforces the protection of rights.** Establish observatories to evaluate the impact of algorithms, the Charter of Digital Rights, and an AI Advisory Council.

Spain - AI application to address a national priority – Tourism.

An area of specific interest in the application of AI for **Spain** has been **tourism and hospitality**. The focus has been upon using AI technologies to enhance personalized experiences and destination management. Research has been underway between academia in Spain and the tourist industry. Researchers have used AI algorithms and machine learning techniques to analyze large quantities of tourism data, including social media data, booking data, and other tourist behaviour. The research is designed to gain insights, trends, and patterns to support decision-making in destination management, marketing strategies, and subsequent resource allocation.

Canada

Key entities involved in the national AI strategy for Canada include the Canadian Institute for Advanced Research (CIFAR) - research and initiatives; Innovation, Science, and Economic Development Canada (ISED) policies and innovation; and the Canadian Digital Service (CDS): digital transformation across public services. It is noted that are other Canadian organisations involved in the development of the AI strategy not noted here.

The **Pan-Canadian Artificial Intelligence Strategy** notes the vision of the Government of Canada to have '*one of the most robust national AI ecosystems in the world, founded upon scientific excellence, high-quality training and deep talent pools, public-private collaboration and our strong values of advancing AI technologies to bring positive social, economic and environmental benefits for people and the planet'*. Key themes include:

1. **Pillar one: commercialization.** This is focused on the use of National Artificial Intelligence Institutes (Amii, Mila and Vector Institute) to translate research in artificial intelligence and commercial applications and support for business to adopt these;

2. **Pillar two: standards.** Support the Standards Council of Canada and the Canadian Government more generally its efforts to advance the development and use of standards and ethics related to AI;

3. **Pillar three: talent and research**: Utilise the CIFAR programs to attract, retain and develop academic research talent, as well as maintaining centres of research, and academic training at Amii, Mila, and the Vector Institute. Another priority focus is Canadian compute capacity **f**or AI researchers to support the objectives of the strategy.

The Canadian government has considerable focus on the responsible use of AI and have developed directives, guidelines, tools (such as the Algorithmic Impact Assessment) and other support.

Canada - AI application to address a national priority – Healthcare

An area of particular interest to the Canadian government has been the use of **AI in healthcare and medical research**. The specific focus has been around how AI could transform healthcare delivery, improve diagnostics, and accelerate medical research.

An example of ongoing research into **AI assisted disease diagnostics** is underway at the Vector Institute for Artificial Intelligence and University Health Network (UHN) in Canada. Researchers at the Vector Institute and UHN have researched AI-powered disease diagnosis using AI algorithms, machine learning, and deep learning techniques to improve the accuracy of disease diagnosis. This research has targeted the diagnosis of cancer, cardiovascular diseases, as well as neurological disorders.

Italy

Key entities involved in the national AI strategy include the Ministry of Economic Development - strategy and policies; the Ministry of Education, University and Research - research and education; and the Agency for Digital Italy (AGID): Coordinates digital transformation. It is noted that are other organisations involved in the development of the Italian AI strategy not noted here.

Key themes from the Italian national Strategic Plan for AI 2022-2024 include:

1. **Strengthening frontier research in AI;**
2. **Reducing the fragmentation of AI research;**
3. **Developing and adopting human-centric and trustworthy AI;**
4. **Increasing AI-based innovation and AI technology development;**
5. **Developing AI-based policies and services in the public sector; and**
6. **Creating, retaining and attracting AI researchers in Italy.**

Areas of focus by the Italian government include the provision of AI competences at all education levels**,** professional development, upskilling and reskilling training programs in AI for the workforce. This will be complemented by building the Italian AI research ecosystem with national centres of excellence (such as the AI and Intelligent Systems Laboratory (AIIS) to increase the competiveness of the AI industry ability to attract international talent and investment. These efforts will be underpinned by the establishment of a regulatory and ethical framework for AI and the provision of digital and telecommunications infrastructure**.**

Italy – AI application to address a national priority – cultural heritage preservation

One area of focus for AI use by the Italian government has been **cultural heritage preservation**. This work has been exploring the application of AI technologies to preserve and restore cultural heritage artifacts and sites. Research has highlighted the use of AI for digital restoration, object recognition, and 3D modeling.

Examples of AI assisted heritage preservation in Italy include the use of AI-based digital restoration of artworks and cultural artifacts using AI algorithms, computer vision, and image processing techniques to restore and enhance deteriorated or damaged artworks.

Norway

Entities involved in the Norwegian national AI strategy include the Norwegian Ministry of Local Government and Modernisation: responsible for digitalization; the Norwegian Ministry of Trade, Industry, and Fisheries - innovation and industry development; and the Research Council of Norway – funding research and supports academic initiatives.

Key themes from the Norwegian National Strategy for Artificial Intelligence include:

1. **A good basis for AI -** The Government of Norway will build world-class AI infrastructure in Norway through digitalisation-friendly regulations, good language resources, fast and robust communication networks, computing power, and data sharing across industries and sectors;
2. **Data and data management** – Building significant datasets from many different sources with machine learning used to provide insights. The government will encourage access and the active sharing of data from the public sector so that business and industry, academia and civil society can use data in new ways;
3. **Language data and language resources** – development of technology that exploits Natural language processing (NLP) for virtual assistants and the analysis of unstructured data;
4. **Regulations -** Modernising the legal and regulatory framework to make it technology-neutral so it keeps up with rapidly changes technology and its application;
5. **Infrastructure: networks and computing power and deployment of the electronic communication networks** – Ensuring the mobile communication networks in particular are the backbone of the digital transformation of society. This includes fourth-generation (4G) mobile network and the deployment of nationwide 5G network for the application of technology such as for the Internet of Things (IoT).

Norway - AI application to address a national priority – smart energy use

An area of particular focus for **Norway** has been around **AI in energy and sustainable development.** How can AI technologies be used to optimize energy systems, support renewable energy integration, and promote sustainability? Norway has ongoing research underway around the use of AI for energy forecasting, demand response, grid management.

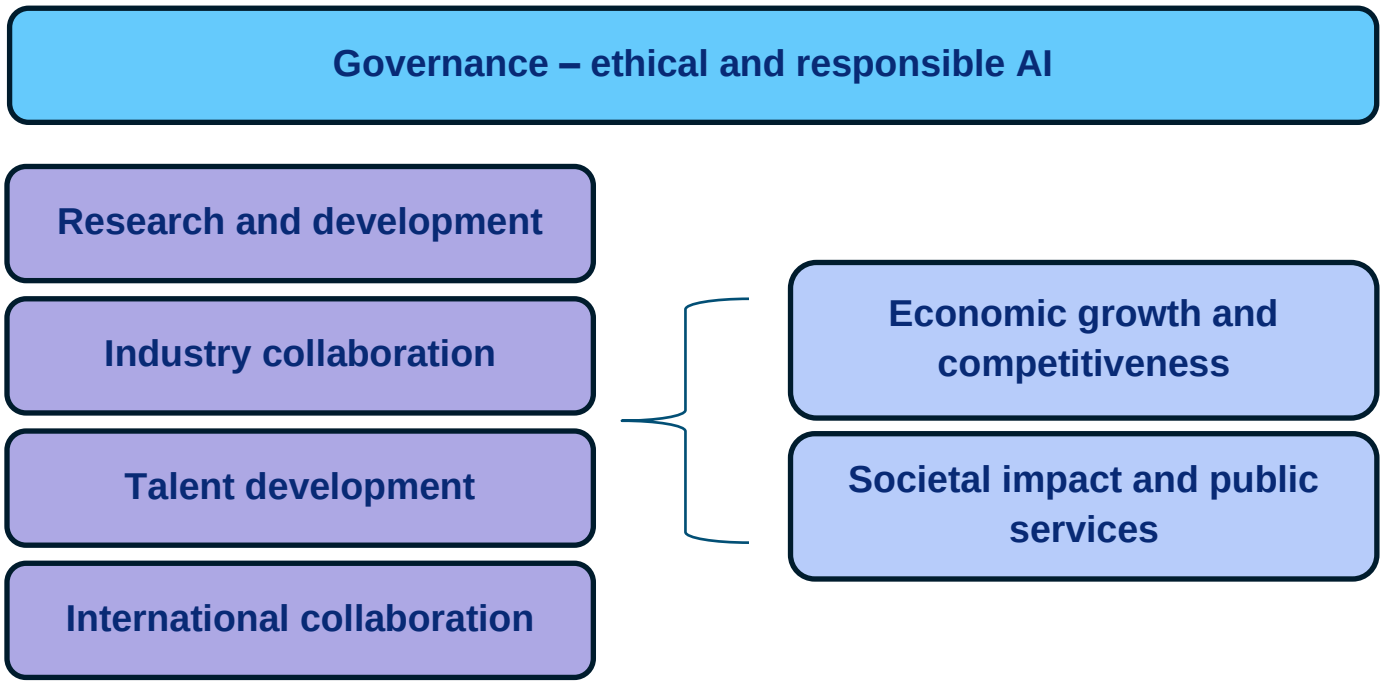
A specific application of this work has been **energy forecasting** research at the SINTEF (Foundation for Industrial and Technical Research), and Norwegian University of Science and Technology (NTNU). Researchers have utilised AI algorithms and machine learning to predict energy demand and production to enable better decision-making in energy planning and optimization.

Summary of themes from national AI strategies

The primary themes within the national AI strategies of the countries reviewed can be distilled down to the following (see Figure 3.0):

- **Research and development**: All countries prioritize investing in R & D to foster AI innovation.
- **Talent development:** Most strategies highlight the importance of nurturing AI talent through STEM education, training programs and reskilling to address the shortage of AI professionals.
- **Ethical and responsible AI:** Many countries emphasize the need for ethical and responsible AI development through guidelines, frameworks, and regulatory measures.
- **Economic growth and competitiveness:** All nations note the economic potential of AI to drive growth, enhance productivity, and foster innovation across industries.
- **Societal impact and Public Services**: There is a consistent emphasis on the use of AI to address societal challenges and improve public services in a wide range of areas.
- **Industry collaboration**: Collaboration between public sector, industry, academia, and research institutions is seen as essential to accelerate AI development, commercialization, and adoption.
- **International cooperation:** A number of strategies highlight the importance of international collaboration for research, development, and governance issues.

Figure 3.0 - Summary of themes from national AI strategies



AI risk areas identified by nations

New technology and the associated strategies utilized introduce risk that needs to be managed. All the countries reviewed as part of this report have identified a wide range of risks associated with AI. The level and nature of the risks identified are highly variable depending upon the national context, the specific application of the AI in question, and how mature the national level AI governance and risk management mechanisms are.

The most common risks identified with AI at the national level include:

- **Ethical concerns:** Many nations have highlighted ethical considerations as a key risk in AI development. This includes issues such as bias and fairness, privacy and data protection, transparency and general (public) understanding of AI systems, and the potential for AI to be used for malicious purposes.
- **Economic disruption and job displacement:** The potential for AI and automation to disrupt labour markets and lead to job displacement is a concern for many nations. Strategies often focus on ensuring a smooth transition for affected workers, upskilling and reskilling programs, and creating new job opportunities in AI-related industries.
- **National security and cybersecurity:** Many nations recognize that AI technologies can have implications for national security. Concerns include the potential for AI to be used in cyber attacks, the development of autonomous weapons systems, and the protection of critical infrastructure from AI-related threats.
- **Human control and accountability:** Maintaining human control over AI systems and ensuring accountability for their actions is a recurring risk. This involves addressing issues of responsibility when AI systems make autonomous decisions and defining legal and regulatory frameworks to govern their use.
- **International competition and strategic advantage:** A number of countries are concerned with maintaining a competitive edge in AI development and deployment. Strategies often aim to promote research and development, foster innovation, attract AI talent, and establish international collaborations to stay at the forefront of AI advancements.

Besides the application of (universal) human rights, each nations priorities will drive where the focus for AI risk management is. Areas where there is potentially significant impact upon safety, privacy, and wellbeing (such as AI healthcare) will require deeper attention. There are enormous opportunities for nations to learn from each other.

Steps to develop a national AI strategy

The approaches outlined in this report provide a good base from which a (new) national AI strategy could be developed. While each country will need to tailor its strategy to its own priorities and resources, key steps could be summarised as:

1. **Assess the current landscape**: Evaluate the country's current capabilities, strengths, and weaknesses in AI research, talent pool, infrastructure, and industry adoption. Identify sectors with potential AI applications and assess the ethical, legal, and social implications.
2. **Define the vision and objectives:** Establish a clear vision and strategic objectives for national AI development in alignment with the country's broader economic, societal, and innovation goals. Define the intended outcomes and impact of the AI strategy.
3. **Undertake stakeholder engagement:** Engage stakeholders from government, academia, industry, civil society, and the general public to gather diverse perspectives, insights, and expertise. Foster collaboration to ensure collective ownership and support.
4. **Develop policy and regulatory framework:** Develop policies and regulations that facilitate responsible AI innovation, security and privacy protection, data governance, and ethical considerations. Address challenges related to fairness, transparency and security.
5. **Review research and innovation ecosystem**: AI innovation requires an ecosystem that supports AI research and development. Invest in research institutions, centres of excellence, and collaborations between academia and industry. Promote knowledge exchange, open data, and access to computational resources.
6. **Prioritise talent development**: Focus on the development of a skilled AI workforce through education, training, and upskilling programs. Foster partnerships between academia and industry to bridge the skill gap and attract and retain AI talent.
7. **Build infrastructure and data resources**: Invest in robust and scalable infrastructure to support AI development and deployment. Foster data sharing frameworks, data accessibility, and interoperability while ensuring privacy, security, and protection of personal data.
8. **Support industry adoption and competitiveness:** Encourage AI adoption across industries through incentives, funding and support. Foster public-private collaborations to drive AI innovation, commercialization, and competitiveness. Support AI startups and scale-ups
9. **Embed ethical and responsible AI:** Establish ethical guidelines, standards, and frameworks for the development, deployment, and use of AI technologies. Promote transparency, fairness, and accountability. Address bias and other ethical concerns.
10. **Collaborate internationally:** Engage in international cooperation and collaboration to exchange knowledge, best practices, and lessons learned. Participate in global initiatives to shape AI governance, standards, and norms.
11. **Monitor and evaluate:** Implement mechanisms to monitor and evaluate the progress and impact of the AI strategy. Regularly assess the effectiveness of policies, initiatives, and investments. Iterate strategy based on feedback and changing technology landscapes.

Summary

The opportunities with Artificial Intelligence (AI) are incredibly wide and deep and offer nations the chance to accelerate initiatives to benefit their economies and societies. There are inherent risks too and sound governance and regulation based upon human rights and ethics will be required.

The development of a national strategy for AI is essential for nations seeking to make use of this rapidly evolving technology and its multitude of applications. This strategy work should be used to guide nations in the efficient and effective use of their resources and investment in AI in accordance with their national priorities.

Guidance material developed by the World Economic Forum (WEF), the OECD, and European Union (EU), provide nations with a good base to develop their own strategies. The AI strategies of a range of countries noted in this report also provide a reference point for information, comparison, and for examples of the specific application of AI. Further, more specific research is encouraged.

The need for international collaboration and cooperation across all aspects of AI development is critical for all nations. It is hoped this report will support build awareness of the value of ongoing comparative analysis and lead to new joint international projects.

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