TOWARDS AN AI STRATEGY IN MEXICO:

Harnessing the AI Revolution

British Embassy
Mexico City

OXFORD INSIGHTS

C MINDS

White Paper

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About the organisations behind the report

British Embassy Mexico City

British Embassy in Mexico through the Prosperity Fund
www.gov.uk/government/news/prosperity-fund-programme-in-mexico

In November 2015, the British government established a Prosperity Fund that will reach up to £1.2 billion in total over six years (2015/16 – 2020/21). The Prosperity Fund supports the broad-based and inclusive growth needed for poverty reduction to make development sustainable. The investments through this programme in Mexico may exceed £50 million in the following sectors: energy, future cities, financial services, and business environment.

OXFORD INSIGHTS

Oxford Insights
www.oxfordinsights.com

Oxford Insights advises organisations on strategic, cultural and leadership opportunities from digital transformation. It specialises in artificial intelligence (AI), helping governments to craft AI strategies and publishing the annual Government AI Readiness Index and a free online AI in a week course. Based in Oxford in the UK but working internationally, Oxford Insights combines new thinking on technology and leadership with experience getting things done in government.

C MINDS

C Minds
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C Minds is an impact innovation agency that designs and deploys strategies for economic and social development for developing countries. It enables cross-sector collaborations and harnesses the power of new technologies from its San Francisco and Mexico City offices. C Minds has more than 10 years of experience developing policies and implementing frontier initiatives in emerging economies with a wide range of stakeholders, including the national and local governments, academia, civil society and the private sector at an international level.

TOWARDS AN AI STRATEGY IN MEXICO:

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> “The development of artificial intelligence could have an effect on society and the economy that is greater than the invention of fire or the industrial revolution. This is why Mexico must be prepared to be a key actor of its development and not only an observer.”

DR. ENRIQUE SUCAR, MEMBER OF COALITION AI2030, NATIONAL PRIZE OF SCIENCE AND RESEARCHER IN THE NATIONAL INSTITUTE OF ASTROPHYSICS, OPTICS AND ELECTRONICS (INAOE).

CONTENTS

EXECUTIVE SUMMARY

Mexico faces a year of political transition during a time of change for the region and in the global economy. As more of the world's production is automated, Mexico has the opportunity to transform its economy and society by supporting local talent, innovation and growth in artificial intelligence (AI).

This report makes the case for Mexico to invest in AI now. It recommends that Mexico join countries including the United Kingdom, Canada, China, the UAE, Singapore, South Korea, France, and Japan and become one of the first ten countries in the world to deliver a National Strategy for AI.

This report was commissioned by the British Embassy in Mexico and funded by the UK Prosperity Fund. It was developed by Oxford Insights and C Minds with the collaboration of the Mexican Government and input from experts across Mexico. Its recommendations are based on a six week research period that included qualitative analysis of interviews with over 60 AI experts working in government, big technology companies, startups, academia and non-governmental organisations; a review and critical analysis of existing national AI strategies from around the world; and a quantitative analysis predicting the likely economic impact of AI on the Mexican labour market.[1]

Report Findings

Our interviewees stressed the potential of social applications of AI in Mexico, including uses in health and education which might help improve services for the lowest-earning 80% of Mexicans. While Mexico's manufacturing sector is growing, with employment and exports reaching record heights, productivity is stagnating.[2] This is preventing the economy from achieving even greater gains. AI could be one answer to Mexico's productivity problem.

Our analysis predicts that 19% of all jobs in Mexico (9.8 million jobs) will be affected by automation over the next two decades, ranging from tasks being made easier by automated systems to jobs being fully replaced. The largest impacts in Mexico will be on the manufacturing and construction sectors. Since these sectors predominantly employ men, automation has a gendered dimension in Mexico and will require careful management to mitigate possible social dislocation.

In Oxford Insights' Government AI Readiness Index, Mexico places 22nd out of 35 OECD countries. Mexico scores well for its digital infrastructure and open data policies but poorly in the areas of tech skills, digitalisation, and public sector innovation. These are crucial preconditions for implementing AI, and they are addressed in our recommendations.

Our recommendations

Based on the suggestions and advice of experts across sectors, and on our research into the key elements of national artificial intelligence strategies from around the world, we make recommendations in five areas: government & public services; data & digital infrastructure; research and development; capacity, skills & education; and ethics.

1. Several important areas were outside the scope of this report but should be included in a future National Strategy. These include cybersecurity, the judicial branch of government, and a more extensive analysis of impacts on economic growth and the labour market.
2. Moody's Analytics. (2017). *Mexico's Productivity Puzzle: What the State Economies Can Tell Us.*

The role of government will be critical: to set direction, provide support, and help different sectors collaborate. We recommend that the Government of Mexico creates a permanent office to implement and coordinate Mexico's digital and artificial intelligence policy. With elections set to take place in July 2018, we recommend that future administrations continues to see digital strategy as a national priority. Targeted use of digital tools will strengthen Mexico's economy and help realise the benefits of cheaper and better services for citizens.

Mexico's AI sector will develop faster if it works together more closely across sectors, and we recommend several ways to do this. Already, civil society groups are collaborating on projects and giving feedback to government, such as AI 2030 roadmap. We believe that creating a national Mexican Centre for Artificial Intelligence, modeled on the Turing Institute in the United Kingdom, would also help support collaboration between industry, academia, and government. It could help to commercialise the best ideas and to focus resources on areas with the highest potential.

With limited research and development taking place in big technology companies, the role of local AI startups is particularly important. Promising companies such as Krieger, Bluemessaging, Yalo, Data Wuki and Nearshore solutions are leveraging their own developments in machine learning, computer vision and natural language processing to create innovative solutions to a diverse range of issues. These entrepreneurs are important advocates during a period of political change and are early members of a vibrant AI startup community. Within larger companies, Mexico can encourage greater investment in local talent and technologies by increasing incentives for big tech firms to do applied AI research in their Mexican offices.

Education at all levels - in schools, at university and throughout citizens' lives - is important both to increase the AI expertise in Mexico and to ensure that the benefits of AI developments are shared. Along with recommending an increase in student numbers in artificial intelligence and data science courses, we suggest teaching computational thinking in Mexican schools and teaching AI concepts as part of social sciences and the arts, as well as mathematics and science. These will also support easier access to lifelong learning, including to help Mexican citizens retrain when they need to.

Supporting AI developments involves continuing to invest in the infrastructure that supports it - including good quality data, internet connectivity, and legal frameworks such as modern intellectual property law and privacy protections. Another essential part of this system is an ethics framework to help guide good decision-making by those who are finding new uses for AI technologies. Like other technologies, AI will need to be used thoughtfully, inclusively and ethically in Mexico to achieve the greatest benefits for citizens.

Recommendations in brief

Governance, government and public services

1. Set a clear strategic direction
2. Appoint Emergent Technology Innovation teams in selected Ministries
3. Government should act as a champion
4. Develop guidelines for smart AI procurement
5. Create a multi-stakeholder steering group to develop and promote Mexico's Government Strategy on AI
6. Create a network of AI practitioners from all sectors and disciplines - including national and local actors - to develop a multi-sector 2030 AI Road Map
7. Create an AI working group in Congress
8. Take a lead role in the global debate

Research and development

9. Create a national centre for AI research
10. Strengthen connections between academia and industry
11. Create a good environment for commercial research and applied AI in the private sector
12. Create an AI government fund

Capacity, skills and education

13. Develop tools for continued education in AI
14. Broaden AI learning beyond computer science and Mathematics students in public and private universities
15. Teach computational thinking approaches in schools
16. Increase the number of Masters and PhD students in AI and data science

Data infrastructure

17. Maintain a resilient open data infrastructure
18. Create Mexican training data to inform AI applications
19. Protect personal privacy

Ethics and regulation

20. Bring data assets inside the scope of competition law
21. Create a Mexican AI Ethics Council

INTRODUCTION
What is AI, and why is it important?

What do we mean by AI?

Artificial intelligence (AI) refers to machines, and generally computer systems, that can simulate the processes of natural intelligence displayed by humans. These processes include learning, reasoning, and self-correction.[3] The phrase 'artificial intelligence' is now an umbrella term that refers to a broad range of research approaches and technologies.

Developments in AI fall into two main categories: artificial narrow intelligence, or 'weak' AI, and artificial general intelligence, or 'strong' AI. Narrow AI systems are designed to form one particular task. Current AI applications using narrow AI or multiple narrow AIs include speech and image recognition, purchase prediction, targeted advertising, natural language processing, autonomous lethal weapons and interactive assistants such as Apple's Siri and Amazon's Alexa. This form of AI is the focus of this report. Artificial general intelligence refers to a system that can perform the full range of human cognitive tasks. This includes the capacity to understand thoughts, motives, intentions and expectations, and interact socially. Such a system does not yet exist.

The rapid rise of AI technologies over the past ten years has been largely due to advances in machine learning. Machine learning is a subfield of AI that involves building algorithms which learn from experience and make predictions about data, without being explicitly told what to do. Machine learning has enabled us to solve complex problems in situations where programming specific algorithms is difficult or infeasible. It is the fastest-growing area in AI, and one where many AI scientists are looking to for future developments.

AI for economic and social development

> *"Mexico should aim at being a global leader in AI and digitalisation as a way of promoting development, both social and economic, for our citizens."*
>
> **Enrique Zapata:** General Director for Open Data, National Digital Strategy Office, Government of Mexico.

The great economic and social potential of AI is a central theme in the discussion of its possible impacts. Current research forecasts that AI could add $15.7 trillion dollars to the global economy by 2030,[4] and double economic growth rates by 2035,[5] fundamentally changing the way we think about human work in the process.

In Mexico, micro, small and medium enterprises (MSMEs) are the backbone of the economy, generating 72% of employment and contributing to 52% of the country's GDP.[6] In 2015, out of more than 4 million

3. For the purposes of this report, "learning" refers to progressively improving performance on a specific task, without being explicitly programmed; "reasoning" refers to the ability to make inferences.
4. PwC (2017). *Sizing the Prize. PwC's Global Artificial Intelligence Study: Exploiting the AI Revolution.*
5. Accenture (2016). *Artificial Intelligence is the Future of Growth.*
6. Jose Sanchez– Condusef (2017). *Cuentos de Cuentas.*

companies, 97.6% were micro enterprises, and 74% of these did not use the internet or own a computer.[7] As noted by the OECD, the digitalisation of MSMEs is necessary to allow them to identify new business opportunities, and to access global markets and knowledge networks at relatively low cost. Moreover, Big Data, data analytics and AI can provide a wide range of opportunities for these companies, enabling a better understanding of their processes, the needs of their clients and partners, and the overall business environment.[8]

Although Mexico's manufacturing sector is growing, with employment and exports reaching record heights, productivity is stagnating.[9] This is preventing the economy from achieving even greater gains. AI could be the answer to Mexico's productivity problem.

Using AI systems, routine tasks which currently occupy a large amount of many peoples' working days can be automated, leaving them free to focus on more complex, high-level tasks which cannot yet be effectively performed by machines. This encourages human creativity and innovation, aspects that can increase productivity. These impacts are discussed in greater detail in our section on economic impacts of AI, below.

Future uses of AI may also enable cheaper, and more tailored, public services such as health and education. This will promote greater access to high-quality healthcare and schooling for the population, through applications that make medical diagnosis quicker and faster, or help teachers to assess the needs of learners more effectively.

The actors interviewed for this report, from all sectors, emphasised the importance of using AI for social impact. The use of emerging technologies should focus on how they can be used to provide better living conditions for the Mexican population.

What are other countries doing?

Governments around the world are waking up to the transformative power of AI for their economies, public services, and workforces. Building on the now-widespread trend of implementing national digital strategies, forward-thinking governments are increasingly recognising the need to have comprehensive national AI strategies.

According to our research, as of March 2018, there are seven countries who have publicly announced policy approaches that they describe as AI strategies: Canada, China, the UAE, Singapore, South Korea, France, and Japan. With the development of a national policy on AI, Mexico would be set to be the first nation in Latin America to join this elite club. India also recently announced its intentions to be a key player in the AI revolution, with the finance minister announcing in his budget speech in February[10] that the government think tank Niti Aayog will spearhead a national programme on AI.

Other countries have AI strategies under different names. The UK's AI policy is covered in two papers: Dame Wendy Hall's independent review of the country's AI industry,[11] and the more recent Industrial Strategy,[12] which identifies AI as one of four 'Grand Challenges' for the UK. The US' approach is similarly spread over three reports published under the Obama administration, including a specific research and development strategy paper,[13] as well as two broader policy documents covering the potential impacts and considerations associated with implementing AI.[14]

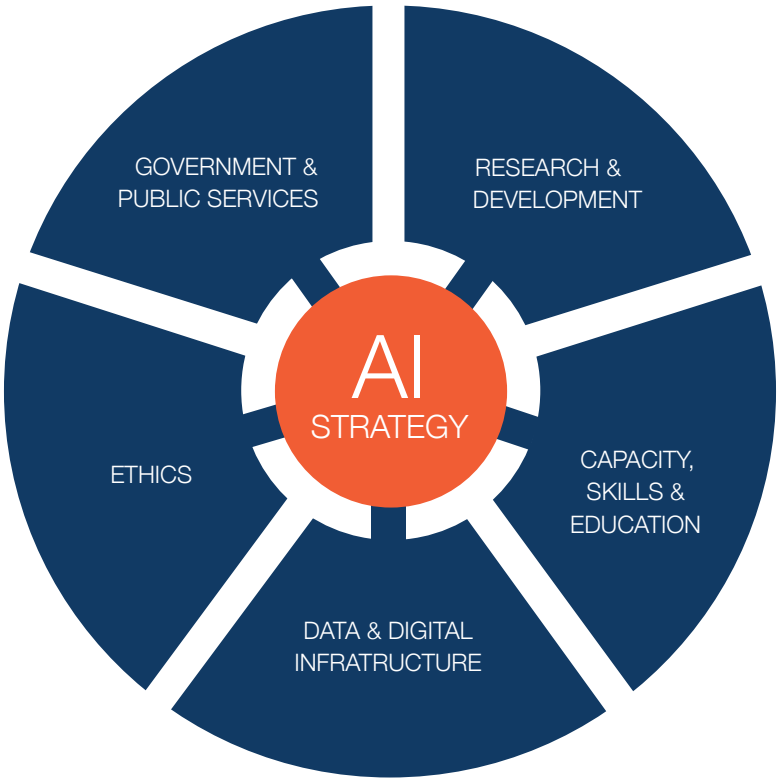
7. Lukas Canal (2017). *La evolución de las pymes en la era de la digitalización.*
8. OECD (2018). *Strengthening SMEs and entrepreneurship for productivity and inclusive growth.*
9. Moody's (2017). *Mexico's Productivity Puzzle: What the State Economies Can Tell Us.*
10. Quartz (2018). *India hopes to become an AI powerhouse by copying China's model.*
11. Hall and Pesenti (2017). *Growing the Artificial Intelligence Industry in the UK.*
12. HM Government (2017). *Industrial Strategy: Building a Britain Fit for the Future.*
13. National Science and Technology Council (2016). *The National Artificial Intelligence Research and Development Strategic Plan.*
14. Executive Office of the President (2016). *Artificial Intelligence, Automation and the Economy;* Executive Office of the President, National Science and Technology Council (2016). *Preparing for the Future of Artificial Intelligence.*

Although different in style, the content of the existing national AI strategies broadly capture a number of common themes. These themes, set out in Figure 1 and explained further below, are: using AI in government and public services; skills & education; research & development; data & digital infrastructure and ethics. The countries we examined had varied takes on these themes, reflecting differing values and priorities.

The majority of national strategies explicitly recognise the potential that AI holds for increasing government efficiency and the quality of public services. China's strategy, for example, proposes a system of public services underpinned by AI, from education, to healthcare, to justice, as well as AI having a key role in policy-making itself.[15] Other countries are creating new institutions and networks to oversee AI research and implementation. The UAE recently became the first country in the world to install a Minister for AI, while the UK is in the process of establishing an Office for AI, to coordinate government efforts on AI.

Every existing AI strategy contains sections examining capacity, skills, and education. These strategies vary in scope, but tend to recognise the importance of teaching digital skills from an early stage in the national curriculum, as well as emphasising the need for lifelong learning to enable workforces to adapt to new developments in technology. The majority of strategies recognised that developing high quality, in-country AI expertise is vital for a country to remain at the forefront of the AI revolution.

Figure 1: Key themes in national AI strategies



15. New America and China State Council (2017). *A Next Generation Artificial Intelligence Plan.*

Similarly, investment in research and development was widely acknowledged as key to ensuring a cutting-edge national AI industry. Different governments had different approaches to this, often dependent on how advanced their AI sectors are already. The USA, for example, notes that much of the long-term research required for AI is not necessarily attractive to the private sector,[16] while France recommends guaranteeing capital to allow businesses to consistently take risks.[17]

Given that advanced digital infrastructure and high-quality data is an essential precondition for widespread AI implementation, the majority of AI strategies were surprisingly muted on this subject. This may be because these preconditions are usually addressed in the precursors to national AI strategies, such as national digital strategies, and so were assumed to be already sufficiently in place in the majority of countries with AI strategies. Some strategies contained policy recommendations for enhancing existing data capabilities, such as the UK AI review's framework for 'data trusts', to enable confidence in data-sharing between organisations.[18]

Finally, ethics were a key theme in almost every strategy, in recognition of the complex social, economic and political issues associated with widespread AI implementation. Given that so much is currently unknown about the likely impacts of AI, a common theme, shared by China, the USA, France, Canada, and the UK, is a strong commitment to further research in AI ethics. France is set to interview over 200 industrial, academic, and legal experts on social and ethical questions, with the intention of sparking a 'national debate' on AI. France and Canada have already tasked specific teams to focus on ethical issues, while the UK is establishing a world-first Centre for Data Ethics and Innovation.

This AI strategy paper provides comprehensive and well-researched content for these themes and more, based on the unique strengths and challenges of the Mexican context.

16. National Science and Technology Council (2016). *The National Artificial Intelligence Research and Development Strategic Plan.*
17. Republique Française (2017). *Rapport de Synthèse, France Intelligence Artificielle.*
18. Hall and Pesenti (2017). *Growing the Artificial Intelligence Industry in the UK.*

GOVERNMENT READINESS FOR AI:
How does Mexico score?

In December 2017, Oxford Insights (OI) released their world-first government AI readiness index. This set out to answer the question, *how well-placed are the governments of the OECD countries to take advantage of the benefits of AI for their public service delivery?* A composite score was calculated for each government, derived from the average of nine input metrics covering areas ranging from in-country digital skills to government innovation.

Mexico was placed 22nd in the rankings out of 35 countries. Table 1 below details the breakdown of Mexico's ranking.

As the table below indicates, Mexico scores particularly well across the digital infrastructure cluster of indicators, notably coming fifth for data availability and ninth for data capability. These high scores reflect Mexico's high value projects in open data governance, and the outcomes of the current administration's National Digital Strategy (NDS). Given that the availability of high-quality data is an essential precondition for the implementation of AI, this is a highly positive indicator of Mexico's readiness for widespread AI adoption.

The AI readiness index also highlights areas for possible improvement. Mexico scores less well on public sector innovation, government effectiveness, in-country tech skills, and digitalisation. The recommendations in this report seek to remedy these areas with targeted policy recommendations such as visa schemes to incentivise homegrown talent to return, and training schemes to nurture future generations of tech talent. The successful adoption of AI by government should also serve to improve indicators such as public service innovation and government effectiveness.

Table 1: Breakdown of Mexico's score, by input metrics

Cluster	Metric	Ranking (out of 35)
Public service reform	Innovation	35
	Digital public services	17
	Government effectiveness	34
Economy and skills	Digitalisation	33
	Tech skills	35
	AI startups	22
Digital infrastructure	Quality of data	13
	Available data	5
	Data capability	9

ARTIFICIAL INTELLIGENCE IN MEXICO:
Building on strong foundations

Our Observations

To develop this report, Oxford Insights and C Minds met with more than 60 key stakeholders in government, industry, and academia at both the national and local levels. We hosted a workshop with representatives of startups and academics working in AI in Mexico City, and a dialogue with key actors from these fields in Jalisco.

The Mexican Government and experts in all sectors are committed to promoting AI in the country in a sustainable and scalable way, and ensuring that the benefits of AI are maintained across changing administrations. In particular, senior figures in the Mexican Government see AI as one of the key ways to improve the quality of services for the lowest-earning 80% of Mexican citizens. AI applications that are already being developed in other parts of the world in health and education, for example, will enable poorer citizens to access higher-quality and cheaper services.

> *"I believe now, in the world that we are living, that innovation needs to be a integral part of the strategy. And it needs to be considered not only as a technology topic, but as a solution topic. Innovation is not a toy, it is a solution."*
>
> **Martha González Pérez-Sandi:** Director, Cognitive Solutions IBM Mexico

The stakeholders we interviewed had significant overlaps in their responses. They proposed a formal mechanism for collaboration between sectors. Stakeholders explained that this would better coordinate research and application of AI in Mexico, and would help those working in AI to learn from one another more rapidly. Several of those interviewed expressed strong support for the creation of a national centre for AI, which we have included in our recommendations.

> *"One of the proposals we have been working on with the Scientific and Technological Consulting Forum (FCCyT for its acronym in Spanish)[19] is for the creation of a national research centre... we have many people interested in AI but we need coordinated efforts. This will ideally be a hybrid between government, academia, and industry ...The easiest model would [be to] make it a Conacyt[20] research centre while opening it up to industry participation. The Centre should also incubate and work with start-ups to develop local AI talent and industry. As for the academics, the centre should provide funding and an environment for mid to long term research projects… industry usually looks only at short term needs."*
>
> **Enrique Sucar:** Senior Research Scientist, National Institute of Astrophysics, Optics and Electronics (INAOE)

> *"Where should a Center for Artificial Intelligence be placed? I think that general guidelines should be centralized, but implementation should be local, and solutions contextualized."*
>
> **María Cristina Cárdenas Peralta:** General Coordinator for @prende.mx

19. The Scientific and Technological Consulting Forum's (FCCyT for its acronym in Spanish) objective is to promote the application of scientific, academic and technological research, to formulate proposals of policies and scientific research, technological development and innovation programmes.
20. Mexico's National Council of Science and Technology (Conacyt for its acronym in Spanish) is Mexico's entity in charge of the promotion of scientific and technological activities, setting government policies for these matters, and granting scholarships for postgraduate studies.

When asked about capacity, all interviewees agreed that there are many talented people working on AI in Mexico. However, there are not enough specialists to meet demand in industry, which is limiting the amount of R&D taking place in the country. Big tech companies like Google and IBM are doing much of their Latin American innovation in other countries such as Brazil. In addition, there is a pressing need to increase general digital literacy to help industry and government make good decisions about where AI can be best supported, developed, adopted, and deployed.

Given that big technology companies are not doing significant research and development on AI in Mexico, the role of Mexican AI startups is particularly important. This is a nascent community, there are several entrepreneurs such as Krieger, Bluemessaging, Yalo, Data Wuki and Nearshore Solutions among many others, with innovative, growing companies leveraging their own developments in machine learning, computer vision and natural language processing. These entrepreneurs are committed to growing the Mexican AI community, and include people who left opportunities abroad to return to Mexico. This community of entrepreneurs and academics will be important advocates during a period of political change.

> *"Innovation is not like creating the next Google or Uber... innovating is creating new ways of solving traditional problems, and we have many traditional problems...There is a lot of potential for creating a really big market."*
>
> **Sebastian Sposito:** Public Policy and Government Affairs Advisor, Google.

Context

National Digital Strategy

> *"Whoever wins the election, the message is clear, the world is digital, so you need to have the best team, at the cutting edge, to really make digital work for your people."*
>
> **Yolanda Martinez:** Coordinator, National Digital Strategy Office, Government of Mexico.

The National Development plan of the current administration has five major goals: to create peace; inclusion; quality of education; prosperity; and establish Mexico in its appropriate place reflective of its global responsibility. Within the framework of this plan there are three programmes with goals to:

1. democratise productivity;
2. create a modern government; and
3. promote gender equality.

The programme to create a modern government was the impetus for the creation of the National Digital Strategy (NDS). The NDS is the action plan being implemented to build a *"Digital Mexico,"* in which technology and innovation contribute to achieving the country's development goals.

The NDS has resulted in national policies in the areas of connectivity, interoperability, data, digital inclusion and digital skills, along with efforts to ensure the consistency of legislation governing digital government.

Connectivity

The Mexican Government has made advances to increase the coverage of mobile data and internet, including:

- *Red Compartida*[21] which will deliver 4G broadband connectivity to at least 92.2% of the population

21. Secretaría de Comunicaciones y Transportes (2015).

by 2024. This is the largest telecommunications investment project in the history of Mexico;
- *México Conectado,*[22] a programme through which free internet has been provided to more than 100,000 public spaces in the national territory; and
- *Red Troncalm,*[23] a programme that has seen the installation of more than 25,000 km of fibre optic cables.

Single portal and interoperability

The Government's efforts also include the creation of a single government portal and steps towards interoperability in government.

- *Ventanilla Única Nacional* is the single portal (gob.mx) for citizens to access information, services, and data. It also provides a platform for citizen participation with the Mexican Government.
- *InteroperaMX* is a platform composed of six components that give certainty and guidance for interoperability in government. These are: normativity,[24] the elite brigade,[25] technical guides,[26] sources of trust,[27] and reusable components.[28]

Data

Data availability and quality is vital to AI research and to the usefulness of AI programmes. The National Digital Strategy promotes the publication of open data via the datos.gob.mx platform.[29] This is to create a collaborative ecosystem of public services, encouraging innovation and entrepreneurship by turning information traditionally held by government into an asset of social value.

Mexico participated in the development of the international Open Data Charter,[30] which was signed by the Federal Government. It was also the first country in the world to publish information on the planning, tendering, awarding, contracting and implementation stages of procurement using the Open Contracting Data Standard,[31] as part of the Open Contracting Partnership. Mexico is also part of the Contracting Alliance 5 (C5) network of countries.

Digital inclusion and digital skills

The Mexican Government has several programmes to encourage digital inclusion and the development of digital skills. For instance:

- *@prende 2.0:*[32] an initiative which aims to promote the development of digital skills and computational thinking with the potential of impacting 25 million students enrolled at the basic education level in more than 220,000 schools and 1.5 million teaching staff in the public education system.
- *MéxicoX:*[33] an online platform of free courses administered by the Ministry for Public Education (SEP), in coordination with the NDS and operated by the General Directorate of Educational Television.
- *Código X:*[34] an initiative that promotes the inclusion of girls and women in Information and

22. Mexico Conectado (2017).
23. Telecomm (2018).
24. Normativity: this component publishes documents which promote information sharing between agencies and entities of the Federal Republic
25. The Elite Brigade: this component is to create a network to share knowledge, train and certify experts in the Interoperability standards that are part of the gob.mx Interoperability Platform
26. Technical Guides: the interoperability technical guides guide the agencies and entities in the integration of procedures and services to the interoperability platform of gob.mx
27. Sources of trust: this component administers reliable documents and data
28. Reusable components: this component facilitates the digitalization of procedures and services by providing dependencies and entities with generic technical components
29. Government of Mexico (2018). *Data.*
30. Open Data Charter (2018).
31. Open Contracting Partnership (2018). *Open Contracting in Mexico.*
32. @prende 2.0 (2017).
33. MéxicoX (2015).
34. Código X (2017).

Communication Technology (ICT) by coordinating the efforts of industry, civil society, academia, and government to disseminate knowledge and opportunities.

- *Mujer Migrante:*[35] a web portal that provides reliable and timely information for migrant women and their families in Mexico and abroad, but particularly in the US. Additionally, it provides free training in diverse ICT-related subjects, including e-commerce.
- *Industrial Innovation Centres (IICs):*[36] 17 centres throughout Mexico created by the Ministry of Economy, through the Programme for the Development of the Software Industry (PROSOFT), to assist in the adoption and development of new technologies based on industry and market needs, as well as to develop human capital.

Legislative framework

The national policies above have been further promoted by the development of a variety of complementary laws and regulations. The Mexican Government seeks to harmonise the legal framework in order to foster an environment of confidence and certainty that favours the adoption and promotion of emerging technologies. Some of the initiatives that have served as a backbone include:

Telecommunications reform

The telecommunication amendment of 2013[37] recognises internet use as a fundamental right for all Mexicans (Art. 6). As such, the state commits itself to creating a competitive business environment suitable for the promulgation of information technology. Specifically, the article reads 'the state will establish the effective conditions for competition of said services'. The law also creates scope for 'a public decentralised autonomous non-profit organisation', which resulted in the creation of the Federal Telecommunications Institute (IFT), to regulate and manage broadcasting and telecommunications (Art 6.5). The law also grants regulatory control to the Federal Commission for Economic Competition (COFECE for its acronym in Spanish) in Article 28. This reform increases competition, promotes the deployment of telecommunications infrastructure, and establishes the Universal Digital Inclusion Policy as an obligation of the state. It also establishes the goal of connecting 70% households to the internet along with 85% of MSMEs.

The Law for Science and Technology

Generally, this law establishes the basis for decision-making in the subjects of science, technology and innovation. Its main objectives are to:

- Regulate the support that the Federal Government is obliged to provide in order to boost, strengthen, develop and consolidate scientific research, technological development and innovation in general throughout the country; and
- Establish means of coordination with local governments, the scientific community, and academic institutions for the creation of policies for the promotion, development, and application of science and technology.

The law also creates the following three organisations:

1. The Scientific and Technological Consulting Forum (FCCyT for its acronym in Spanish), whose objective is to promote the application of scientific, academic, technological research into economic applications, and to help develop proposals of policies and scientific research, technological development, and innovation programmes;

35. Secretaría de Comunicaciones y Transportes (2018). *Mujer Migrante.*
36. World Bank. (2017). *Moving Toward a Knowledge-Based Economy: Improving Competitiveness in Mexico's Information Technology Industry.*
37. SEGOB (2016).

2. The National System for Science, Technology and Innovation (SNCTI for its acronym in Spanish) has the purpose of increasing scientific and technological capacity through the training of researchers and technologists to resolve fundamental national issues that have social impact and contribute to the development of the country; and
3. The General Council for Scientific Research, Technological Development, and Innovation (Consejo General de Investigación Científica, Desarrollo Tecnológico e Innovación) as a political coordination authority. It seeks to establish national science, technology and innovation policies.

Importantly, Article 9 of this law states that the annual budget for the state towards scientific research and technological development should not be less than 1% of the GDP of the country.

Data protection laws

The 'Federal Law for Data Protection held by Particulars' establishes that all necessary and sufficient measures must be taken to guarantee that the privacy statement provided to the owner of the data is respected at all times by the responsible authorities or any third party. This legislation establishes that the Federal Institute for Access to Information and Data Protection (Instituto Federal de Acceso a la Información y Protección de Datos) and the Ministry of Economy are the responsible authorities to safeguard the data of the people.

The 'General Law for the Protection of Personal Data in Possession of Obliged Subjects' dictates the basis of, and principles and processes relevant to, guaranteeing individuals' rights to the protection of their personal data. "Obliged Subjects" are any entity that benefits from public funds, including political parties and trusts, in addition to Federal, State and Municipal authorities. This law establishes the requirements and conditions and clear procedures that govern how personal data is treated by Obliged Subjects, including the exercise of the rights of access, clarification, cancellation, and opposition. Additionally, this law's objective is to protect personal data in possession of any authority, entity, arm or organisation from the executive, legislative, or judicial branches of government, as well as independent bodies, political parties, trusts and other publicly funded bodies, at federal, state, and municipal levels, with the purpose of regulating the proper treatment of such data.

The general law regulates the organisation and operation of the National System for Transparency, Access to Information, and Personal Data Protection (Sistema Nacional de Transparencia, Acceso a la Información y Protección de Datos Personales) and it also guarantees that every person can exercise their right to the protection of personal data.

These data protection laws line up with the judicial framework of the NDS in regards to the encouragement of privacy and protection of personal data. They also relate to the goal of interoperability, particularly through simplifying communication between citizens and the government. Article 57 of the law establishes that citizens have the right to grant access to their personal data.

Intellectual property law

In relation to intellectual property, computer programmes are not considered inventions in accordance with article 19 section IV of the Industrial Property Law. That is to say, they cannot be patented as such. However, the Federal Law of Copyright does grant protection to computer programmes in accordance with the International Treaties of which Mexico is a party, such as the The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS). In terms of the development of AI it will be important to have flexible intellectual property regimes.

Enabling Data Trusts: Example of The Fintech Law

The recently-passed law regulating financial services (commonly known as the Fintech Law) opens the possibility for the creation of data trusts for companies wishing to use real data to train their models and develop AI for impact. The law formally introduces into the regulatory framework several concepts used widely in industry. For example, it provides a 'regulatory sandbox' modelled on similar structures in the UK, allowing innovative companies to test out their business models with access to data and relevant tools. These companies must obtain a temporary authorisation (of no more than two years), during which time they can provide their services to a reduced number of clients. This should potentially allow for a flexible approach to regulation in a constantly changing environment. The regulatory sandboxes were intended for use primarily by Fintechs, but also open the possibility of creating data trusts.

Regional milestones

Mexico has also experienced important advances in technological innovation at the local level. Through *Regional and State Innovation Agendas*,[38] local governments have prioritized strategies and programmes that support the development of competitive advantages in key industries to each state's vocation. With technology industry clusters in place, and an existing degree of collaboration between government, academia and industry, Jalisco, Mexico City, and Nuevo Leon, are leading the way to incorporate new technologies, such as AI, into product manufacturing and service delivery. They are also investing in skills development and in creating highly-specialized jobs and trainings. Appendix 2 provides examples of existing technology and innovation policies, key institutions, and major economic sectors in these states.

Moving forward, it will be crucial for local governments to continue coordinating strategies under the Federal government's direction, as the social impact of AI will be measured to the extent that local authorities have both the technical capacity and human capital to implement and follow-through such action plans.

Achieving continuity

The NDS created the Office for the Coordination of National Digital Strategy (CEDN), which forms part of the office and administration of the President.

Mexico is set to hold elections in July 2018. The elections will result in a new President and administration, which may also change the structure of digital government within Mexico.

Many interviewees stressed the importance of creating an independent body to oversee the implementation and coordination of both digital and AI policies to ensure continuity. This is reflected in our recommendations.

38. CONACYT (2017). Agendas Estatales y Regionales de Innovacion.

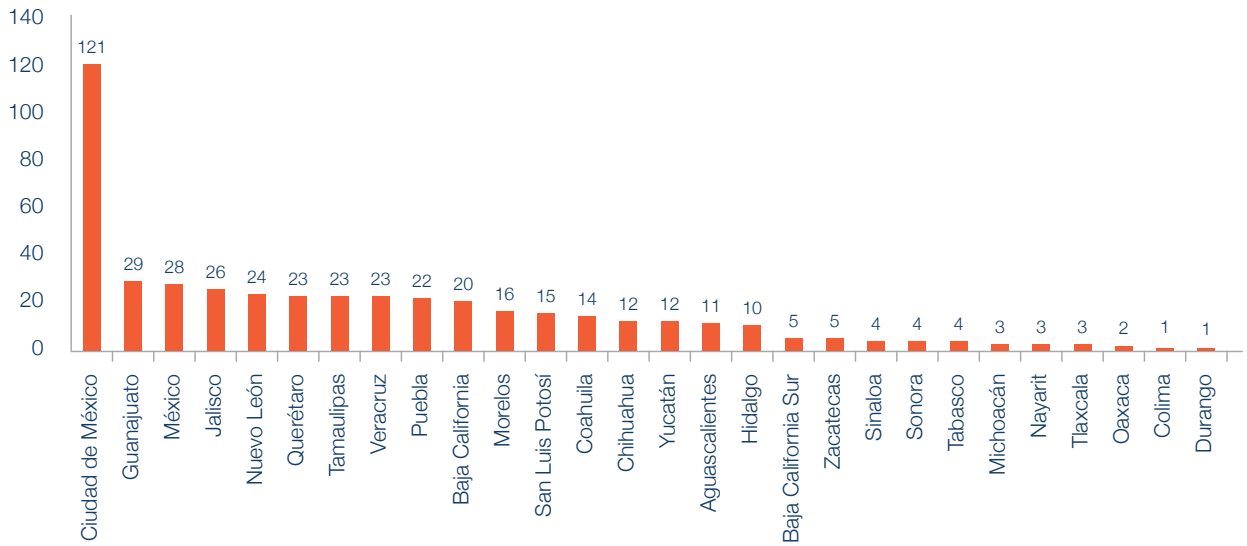
Academia: areas of research expertise

Between 2002 to 2017, Mexico's National Council of Science and Technology (Conacyt) supported 144 projects related to AI, with an investment of more than 432 million Mexican pesos. Conacyt has supported 16 projects on data mining and big data between 2011 and 2017. This accounts for about 10% of the total amount that has been invested in AI projects. The number of people in the National Network of Researchers (SNI in Spanish) in fields related to AI and Big Data is 464, of whom 141 specialise in AI. Most of these researchers live in Mexico City, Guanajuato, the State of Mexico, Jalisco and Nuevo Leon, as shown in Figure 2 below.

The purpose of the SNI is to promote and strengthen, through rigorous evaluation, the quality of scientific and technological research and innovation in Mexico. The SNI has seven "commissions" organised by thematic disciplines. Many of the academics with research specialities in AI and other associated disciplines expressed frustration that their work did not adequately fall within any of the seven commissions. Their work and publications are not being evaluated by the SNI using international standards for computational sciences or AI. We interviewed, for example, a computer scientist who is currently classified as a linguist under the current SNI structure. The academic community argued that this has an adverse effect on Mexico's ability to attract and retain top-level academic expertise and talent. Furthermore, many of those interviewed felt that professors are burdened with undue administrative loads and excessive teaching requirements. Under these conditions the production of new knowledge or innovative research becomes secondary.

Many interviewees agreed that Mexico has the potential to be very attractive for students. In particular, this is because of the scholarship funding available. Conacyt has a scholarship programme that recently awarded its 400,000th scholarship since the programme was created.

Figure 2: Geographic distribution of SNI member experts in Big Data and AI



Source: **Dr. Miguel Gonzalez Mendoza**, President of the Mexican AI Society

Talent development for R&D: postgraduate programmes in AI

Mexico has a growing number of postgraduate programmes related to AI. Those relevant disciplines are computer sciences, data and information sciences, electronics, and telecommunications.

As shown in Table 2, there is only one university programme which specialises in AI, with another soon to be formed. Postgraduate programmes in computer science are burgeoning and the total number is likely to double in the next few years. Meanwhile, more traditional cognate fields of electronics and telecommunications are well established. The key question for the future is whether these programmes will be able to meet international standards. This may require an increased emphasis on academia, including a restructuring of the SNI as well as increasing funding available for academics.

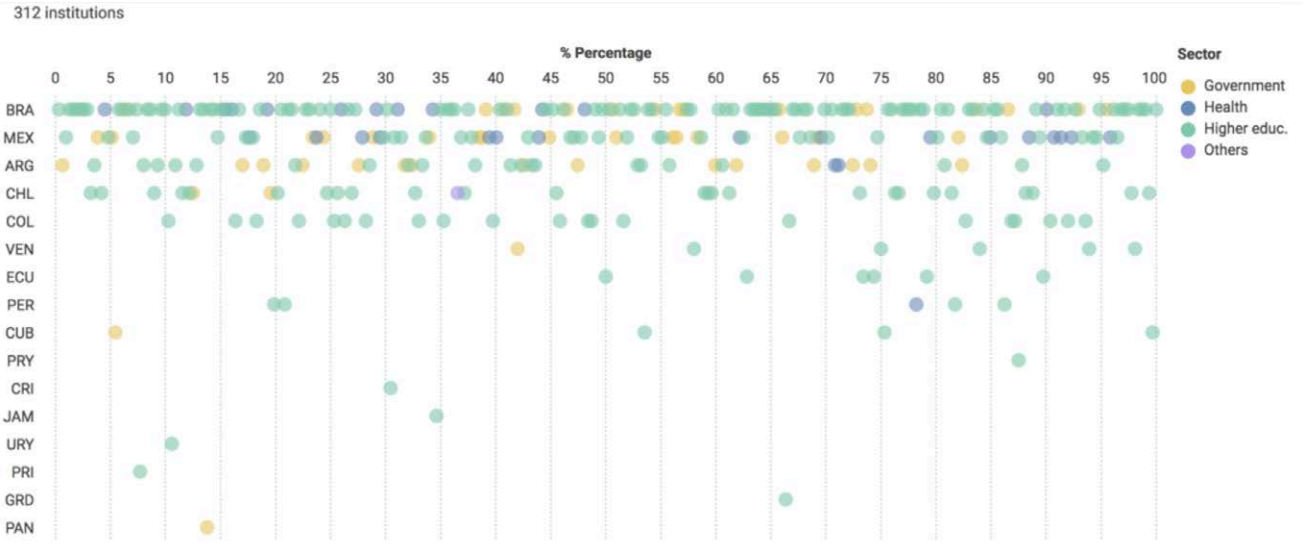
Table 2: University programmes in AI and associated disciplines

	Recently formed	Being formed	Consolidated	Of an international standard	Recently formed	Being formed	Consolidated	Of an international standard
Computer Science	4	8	8	3	4	3	4	1
Artificial Intelligence	1	1	1	0	1	0	0	0
Information Sciences	2	2	2	0	2	1	1	0
Electronics and Telecommunications	3	9	18	3	4	1	12	1

Source: Dr. Miguel Gonzalez Mendoza, President of the Mexican AI Society

According to SCImago, of the top 500 academic and research-related institutions in the world, four are in Mexico.[39] Brazil in contrast has eight. There are a total of 312 research related institutions in Latin America. Of these 312 institutions, 66 are in Mexico and 131 are in Brazil (see Figure 3).

Figure 3: Institutional Rankings by Country Latin America (2017)



Source: Dr. Miguel Gonzalez Mendoza, President of the Mexican AI Society

Figure 4: Institutional Rankings Mexico

As shown in Figure 4, The regional distribution of research related institutions in Mexico is not equitable, with the vast majority of academic production taking place in Mexico City. Some academics wanted to see more emphasis on decentralising knowledge generation.

Source: SCImago Institutional Rankings (2017). Mexico

39. SCImago Institutional Rankings (2017).

AI Use Cases

There are valuable examples of AI being developed and deployed across Mexico. Their applications include:

- making agricultural processes more efficient;
- improving transport mobility;
- developing technical skills;
- improving operational efficiency at the local levels;
- countering fake news in natural disasters;
- improving user experience on public transport; and
- improving government communication efficiency via chatbots.

This section highlights examples of where AI is currently being used in Mexico to improve public services and to make citizen's lives better.

Use cases at the national level

AI for better health public services: misalud, Ministry of Health

Misalud is a new health platform that enables patients to ask questions and receive advice through their cell phone. It was launched in June 2017 as a result of the government's Prospera digital pilot and focuses on maternal health. Beneficiaries of *misalud* receive SMS messages with advice to help improve their health and that of their babies. To date, more than 5,000 women have exchanged more than one million SMS messages through the platform. The CEDN is supporting the initiative to develop chatbots for government communication as a 'plug and play' innovation.

AI to detect fraudulent taxpayer operations: Tax Administration Service, Ministry of Finance and Public Credit

The Tax Administration Service has been trialling AI algorithms to detect companies that are conducting fraudulent operations, by identifying pattern disruptions in data analysed using R Studio, Python Language, and DBs in-memory Redis. Within three months of a six month pilot scheme, 1200 fraudulent companies were detected and 3500 fraudulent transactions identified. The identification and analysis of these irregular activities would have taken an estimated 18 months of work without the use of AI.

Use cases at the regional level

AI for more efficient agriculture: KYSO Agritech, Mexico City

KYSO is an agritech startup that uses geolocalisation to perform metadata analysis of soil pH levels, humidity, temperature, and overall weather conditions. The technology enables farmers to automate irrigation in response to weather conditions. This has optimised crop outputs by 54% in comparison to current processes. KYSO is training and piloting their algorithm in Milpa Alta (CDMX) and Cuernavaca (Morelos) and working closely with local farmers.

AI for optimising the flow of buses: Laboratorio para la Ciudad/Datank, Mexico City

Laboratorio para la Ciudad and SM1 are collaborating with the startup Datank in a project to use data from the GPS within SM1 buses to create a more efficient system for bus departures. The project will start with routes that start and finish in Santa Fe. If the tool is successful, the team will seek to replicate this for all of the routes in the city.

AI for skills development: Wizeline Academy, Guadalajara

Wizeline AI Academy offers engineers, computer scientists, mathematicians, and statisticians tuition-free coursework on AI, machine learning, and other advanced software engineering skills and technologies. Their short programmes also push talented students towards high-level professional roles through 1:1 mentorship focusing on leadership development.

AI for government efficiency: One Smart City, Guadalupe (NL) & Tlanepantla de Baz (State of Mexico)

One Smart City creates and curates software technology for governments to become more innovative, efficient, and transparent via the use of AI.

In 2016, One Smart City piloted their SmartUNO® software in the cities of Guadalupe, Nuevo León and Tlalnepantla de Baz, State of Mexico. The software generates algorithms that facilitate the understanding of digital discourse in social networks and creates actionable content for governments.

AI for better public services: URBEM, Nuevo Leon

URBEM, developed by Civica Digital, is a tool that uses an AI-enabled chatbot in Facebook Messenger to answer citizens' requests for information, provide documents, and gather feedback. It also provides a means of centralising data, and combines this with an internal administrative dashboard.

Nuevo Leon's Undersecretary of Legal Affairs and Citizen Services used URBEM in a pilot for their call centre to drive efficiency in the provision of information related to the Civil Registry. The Facebook chatbot provides all Civil Registry-related information to around 200 daily users with an 82% rate of service satisfaction. This has freed staff from routine requests and allowed them to focus on more complicated cases.

The Municipalities of San Pedro Garza Garcia, Nuevo Leon, and Hermosillo, Sonorawill use URBEM to provide a single portal for citizens to access information about the status of local utilities and to report any problems.

AI for countering fake news: Sismo 19s

On September 19, 2017, Mexico City was hit with a 7.1 magnitude earthquake. People used social media to learn about what was happening in their neighborhoods and coordinate aid activities. A team formed by Codeando Mexico, the National Autonomous University of Mexico (UNAM) and the Human-Computer Interaction (HCI) lab at West Virginia University focused on automating some of the critical bottlenecks that networks of volunteers experienced when verifying news. They also created a bot that used machine learning to identify and distribute verified citizen reports on social media and provide influencers with real-time information to post.

AI for an efficient flow of passengers: Metro CDMX

In 2015, PhD students from UNAM won the first prize at a technological innovation contest organized by CDMX's Ministry of Science, Technology and Innovation (SECITI) and the Metro transportation system. Throughout that year, they worked with Line 1 Metro staff using AI to analyse large datasets about passenger flow dynamics, coming up with a strategy based on computer simulations to reduce train boarding and alighting times. Given the success of the pilot in metro Balderas, the solution was expanded to other 14 metro stations, helping to minimize delays and contributing to a more efficient flow of passengers by 10 to 15%.

Fostering a technology innovation culture and digital skills: Jalisco Talent Land

This event brings together more than 30,000 digital natives, aged between 18-35 years old, and more than 600 Internet communities. Its programme offers training to develop digital skill-sets, seeks to catalyze the connection of young talent with industry and government, and highlights the role of emerging technologies, including AI, to solve social challenges collaboratively. Jalisco Talent Land is an example of collaboration for technology innovation at all levels: federal and local governments, academia, industry and civil society.

LIKELY IMPACT OF ARTIFICIAL INTELLIGENCE

Global overview and introduction

Recent research suggests that automation has the potential to add $15.7 trillion to the world economy by 2030. This is equivalent to a 14% gain in global GDP.[40] This will be driven by improvements in the productivity of processes and workforces through automation, and growth in consumer demand as a consequence of greater personalisation in the provision of products and services.

The distribution of these economic gains across countries and regions will be dependent on many factors, including the speed of adoption in the private sector, the sectoral constitution of economies and the extent to which such sectors are automatable, and government policies supporting innovation and research and development. The context particular to Mexico is explored below.

While enhanced GDP growth has the potential to raise living standards and generate new consumer markets, there remains a significant risk of job losses in certain sectors. Recent studies conducted by PwC and McKinsey identify manufacturing, accommodation and food services, the automotive industry, healthcare, and financial services as being particularly susceptible to widespread automation.[41]

These conclusions carry particular significance for Mexico. Manufacturing represents the largest component of the Mexican economy, at 20% of Mexican GDP in 2016. McKinsey's study suggested that 64% of global working hours in manufacturing are automatable,[42] which implies that Mexico is especially exposed to such risk.

This risk is exacerbated by the supply chains that drive the Mexican manufacturing sector: should automation become cheap enough that it is more cost-effective to produce goods automatically in the USA, rather than using Mexican labour, production could be relocated away from Mexico, meaning an even more severe loss of capital.[43]

As our analysis demonstrates, negotiating the trade-offs between job losses and enhanced sectoral growth as a result of AI will be a key challenge facing policy makers in the upcoming years.

Finding jobs and automation

Our research found that 19% of all jobs in Mexico (or 9.77 million jobs) will be affected by automation. We estimate that 16% of these 9.77 million jobs (1.54 million jobs) will be affected by automation in the next 5 years, and almost 75% of these jobs (7.19 million jobs) between the next 5 and 15 years.

40. PwC (2017). *Sizing the Prize. PwC's Global Artificial Intelligence Study: Exploiting the AI Revolution.*
41. PwC (2017). *Sizing the Prize. PwC's Global Artificial Intelligence Study: Exploiting the AI Revolution;* McKinsey (2017). *Artificial Intelligence: The Next Digital Frontier?*
42. McKinsey (2017). *Artificial Intelligence: The Next Digital Frontier?*
43. *Financial Times (2017). High-tech manufacturers fear robots and Nafta renegotiations.*

In our analysis, 'affected by automation' refers to a range of outcomes. For some jobs, automation will enhance the capacity of the individual worker to perform tasks, increasing labour productivity. Other jobs will be easier to fully automate, leading to either a transformation of the individual worker's role or even their full replacement by automated systems. This will still ensure productivity growth, but the overall gains here must be offset against the costs of providing benefits and re-skilling newly unemployed workers.

Of all the jobs that can be automated globally, we estimate that 51% will merely see tasks enhanced, 33% of automatable jobs will be transformed, while a final 16% will see full replacement of workers through automated systems. Applying these general figures to the the total number of jobs at risk of automation in Mexico's workforce, we estimate that 4.97 million jobs in Mexico stand to be enhanced by automation; 3.20 million will be transformed by automation; and 1.61 million will be fully replaced.

Sectoral analysis and the future of work

The impacts of automation on employment will be spread variably across sectors in Mexico. In terms of the number of jobs automated in some form, the top sectors affected will be manufacturing, construction, wholesale and retail, agriculture, accommodation and food services. This is because jobs within these sectors are made up of tasks that are especially amenable to automation, given the current and projected capacities of AI.

The highest overall impacts of automation on the Mexican economy are likely to come from automation in manufacturing and construction. Manufacturing and construction are the largest two sectors in terms of jobs exposed to automation (2.8 million and 1.75 million respectively; see Table 3), while comparatively high *proportions* of jobs will also be affected in these sectors. Construction will be affected most overall in terms of the share of jobs automated, at 41.08%, while manufacturing is ranked second, at 33.71%. Policy interventions must therefore target these sectors specifically in order to guide transformation and minimise social disruption.

Other sectors will see a high proportion of jobs affected, but their relatively small size in terms of overall employment will make the social and economic impacts less severe in terms of the overall economy. Mining is one such sector: it is the third-highest ranked sector in terms of proportion of jobs capable of automation (33.12%), but employs a relatively small number of workers in total (0.21 million workers).

Given these possible impacts of automation on jobs over the next 15 years, a far-reaching skills policy is required. One interviewee reflected that this is not simply a case of funding more science, technology, engineering and mathematics (STEM) programmes. Flexibility in re-skilling and education should be emphasised; one good option is to consider shorter educational programmes than those that currently exist. Broadly, this interviewee suggested, Mexico needs to recognise that new skills are needed in the country.

The changes in work brought by automation will also have consequences for Mexico's policies on tackling inequality. Coordinator of National Digital Strategy, Yolanda Martinez, remarked in our interview that "[e]verything we do needs to be measured in terms of how we reduce the inequality gap and how we use everything we do to make lives better". Where automation enhances jobs, the benefits of any productivity increases might be returned into wage increases or invested into further innovation in neglected sectors. Where jobs are replaced, there is an opportunity for widespread re-skilling targeted at those who have not previously gained from the proceeds of growth.

Table 3: Estimate of Mexican jobs affected by automation by sub-sector

Top five sectors for possible automation (no. of jobs)		Bottom five sectors for possible automation (no. of jobs)	
Sub-sector	**Automatable jobs**	**Sub-sector**	**Automatable jobs**
Manufacturing	2,809,944	**Management and self-employed**	29,448
Construction	1,750,676	**Information and communication**	32,382
Wholesale & retail	1,653,335	**Arts, entertainment & recreation**	42,769
Agriculture	942,705	**Financial and insurance activities**	47,047
Accommodation & food services	725,092	**Education services**	51,401

Gender and automation

There is a clear disparity between genders in terms of the proportion of jobs at risk from automation. Over twice as many jobs at risk of automation are held by men than by women: 9.8 million automatable jobs are held by men, and 2.8 million are held by women. This means that 12.8% of men's jobs risk being automated, compared to just 5.53% for women. Table 5 below breaks down these differences by sector.

Table 4: Top 5 employment sectors by gender

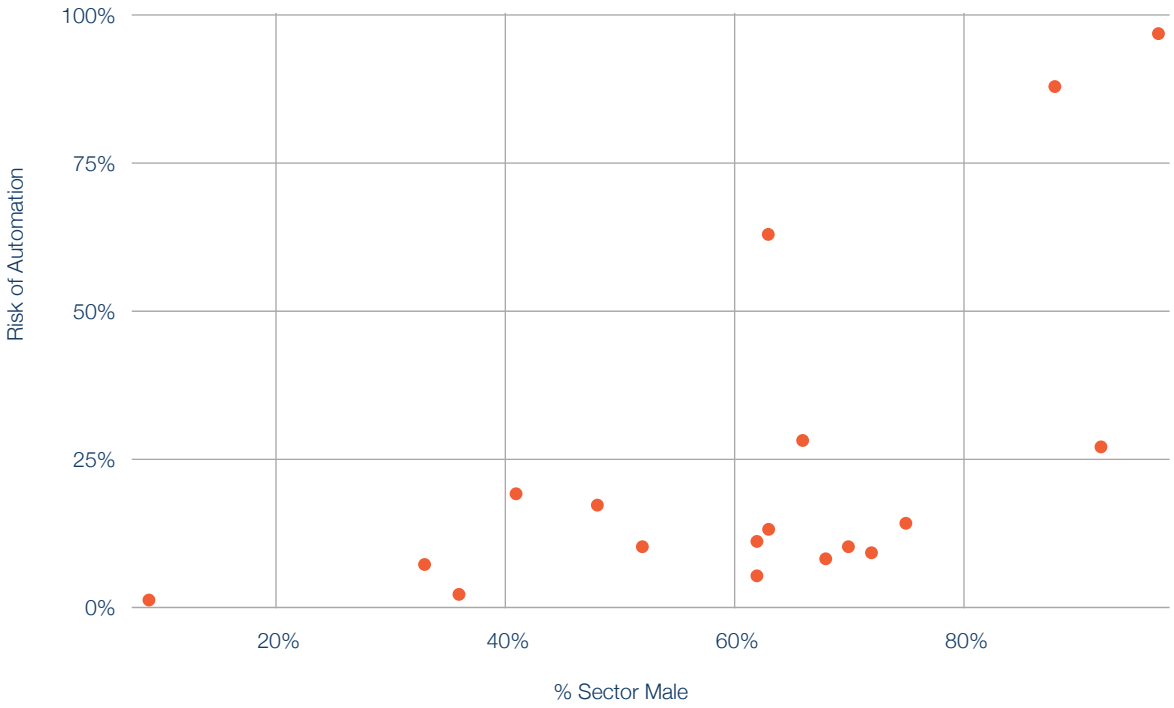
Women - top five employment sectors				Men - top five employment sectors			
Sub-sector	**Sector**	**% jobs held by women**	**% of jobs at risk of automation**	**Sub-sector**	**Sector**	**% of jobs held by men**	**% of jobs at risk of automation**
Management & self-employed	Services	90.51%	1.25%	**Construction**	Industry	96.91%	41.08%
Human health & social work	Services	67.41%	6.74%	**Transportation & storage**	Services	91.84%	26.97%
Educational services	Services	63.78%	2.00%	**Agriculture**	Agriculture	89.58%	14.25%
Accommodation & food service activities	Services	59.05%	18.75%	**Mining & quarrying**	Industry	88.22%	33.12%
Wholesale and retail trade	Services	51.84%	1.25%	**Arts, entertainment and recreation**	Services	71.60%	9.30%

Table 4 partly reflects the fact that more men are employed in Mexico than women: men make up 61.8% of the formal workforce, and women 38.2%. Nevertheless, in sub-sectors where women make up a higher proportion of workers, there is a relatively low risk of jobs being automated. For example, women make up 90.51% of self-employed workers (a sector that includes 'domestic workers'); in this sub-sector, just 1.25% jobs are at risk. This is the lowest risk of all sectors. Similarly, construction is the sector with the highest proportion of male workers (96.91%). Of all sectors, construction has the highest proportion of jobs at risk (41.08%). More generally, and as Figure 5 shows, there is a correlation between the proportion of male workers in a sector and a higher risk of job automation within that sector.

The methodology used in this section can be found in Appendix 3.

While, as stated, the observations detailed in Figure 5 must be balanced against the predominance of men in the workforce in general, and the relatively small size of some of the sectors particularly at risk of automation, the gender disparity has implications for Mexico's future social policy. If women continue to take jobs in service sectors rather than in industry and agriculture, and should the Mexican economy show a similar movement from industry to services as has been evident across the developed world, automation in sectors that are both declining and relatively automatable will affect male employment rather than female employment. To avoid high male unemployment, and likely subsequent social disruption, a concerted re-skilling effort will be required. Equally, as more women move into the labour market, it is crucial to ensure that they possess sufficiently high skills to insulate them against potential automation risks.

Figure 5: % Sector Male vs. Risk of Automation



RECOMMENDATIONS

Any recommendations that follow are only possible because of parallel work in related fields taking place in Mexico, including:

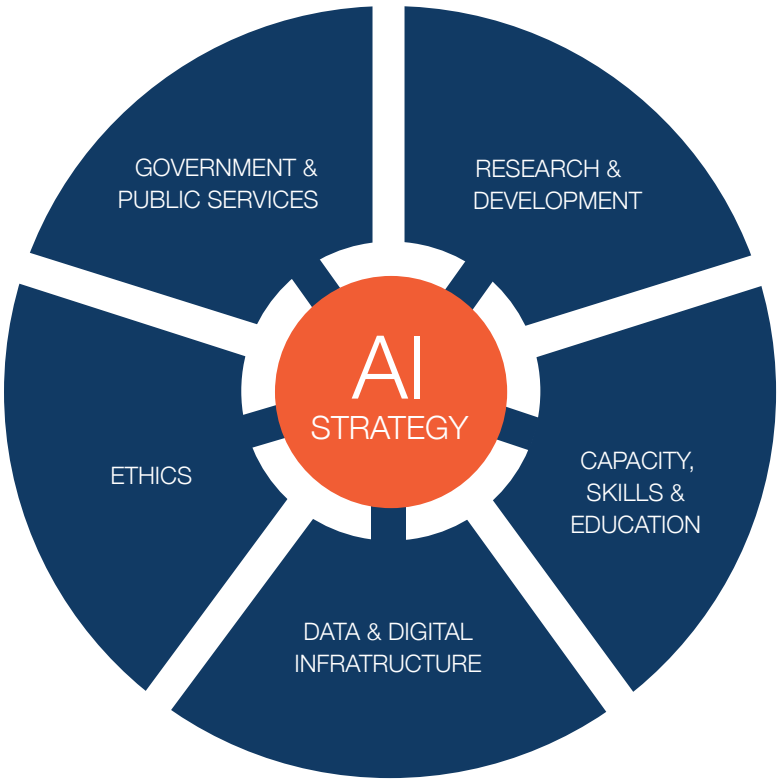
- investments in data and open data;
- efforts to digitise government;
- digital inclusion; and
- actions by academia, industry and civil society.

Mexico has a young and talented labour force, an early mover advantage if it is among the first countries to announce an AI strategy, and close economic and cultural relationships both with North and South American countries which are making strides in AI research and applications.

These recommendations also reflect on Mexico's starting position, which is different from other countries such as the UK, USA or Canada. There is not the same historic investment in connecting academic research and industry or as many examples of multi-million companies based largely on commercialising intellectual property.

Based on the suggestions and advice of experts across sectors, and on our research into the key elements of national artificial intelligence strategies from around the world, we make recommendations in five areas: government & public services; data & digital infrastructure; research and development; capacity, skills & education; and ethics. Many of these are recommendations for government; others concern universities or civil society actors. Wherever possible, we have stated the actor we think should be responsible for implementation.

Figure 6: Key themes in national AI strategies



Governance, government and public services

The role of government

The widespread application of machine learning, and the speed at which breakthroughs are occuring, gives government a critical role in shaping AI development, uses and applications. In order to support the Mexican economy and promote the use of AI in Mexico, we recommend that the Mexican Government should:

1. Set a clear strategic direction

A cross-cutting, central government department should own the National AI Strategy. AI is an enabling technology and touches on almost every department in government, either through government support, promotion or in delivery. That central department should have a 'Office for AI' to support implementation which will largely be done by departments. The Government should **appoint an official to lead on AI** who should act as a champion across government and help liaison between sectors.

a. Short-term recommendation T1 (current administration): Publication of the AI strategy by the Government; The AI Steering Group (proposed below) can enable a wide cross-sector consultation process on the recommendations for an AI National Policy.

b. Short-term recommendation T2 (transition phase): The new elected Administration designs the administrative framework of the Office for AI based on its administration strategy, lessons learned by the Mexican Government international case studies and the input of the Steering Group.

c. Medium term recommendation T3 (new administration): The new Administration develops and publishes an AI National Policy; deploys a 100 day AI action plan and continues to implement the AI National Policy in close collaboration with the AI Steering Group.

Table 5: Short to medium term priorities for strategic clarity

T1	T2	T3	T4
Short Term (Current Administration) • Publication of the AI strategy • Creation of AI Steering Group	**Transition Phase (New Administration)** • Design the administrative framework of the Office for AI.	**Mid Term (New Administration)** • deploy a 100 day AI action plan. • continue to implement the AI National Policy	**Creation of an Office for AI (New Administration)** • A central government department that owns the National Strategy for AI, responsible for supporting implementation across departments.

2. *Appoint Emergent Technology Innovation teams in selected Ministries (current and new administration)*

Develop official job descriptions and institutional conditions to attract experts in data science, algorithmic thinking, and machine learning. Include such profiles not only in the technical teams but in the programme development teams.

3. *Act as a champion (current and next administration)*

Government has enormous power to change the national conversation and direct attention. It should harness this power to champion Mexico as a strategic place to build and deploy AI technology through e.g. supporting the creation of an AI chamber of commerce, actively attracting the best talent to return or come to work in Mexico and ensuring that stories of successful Mexican AI deployments are shared internationally.

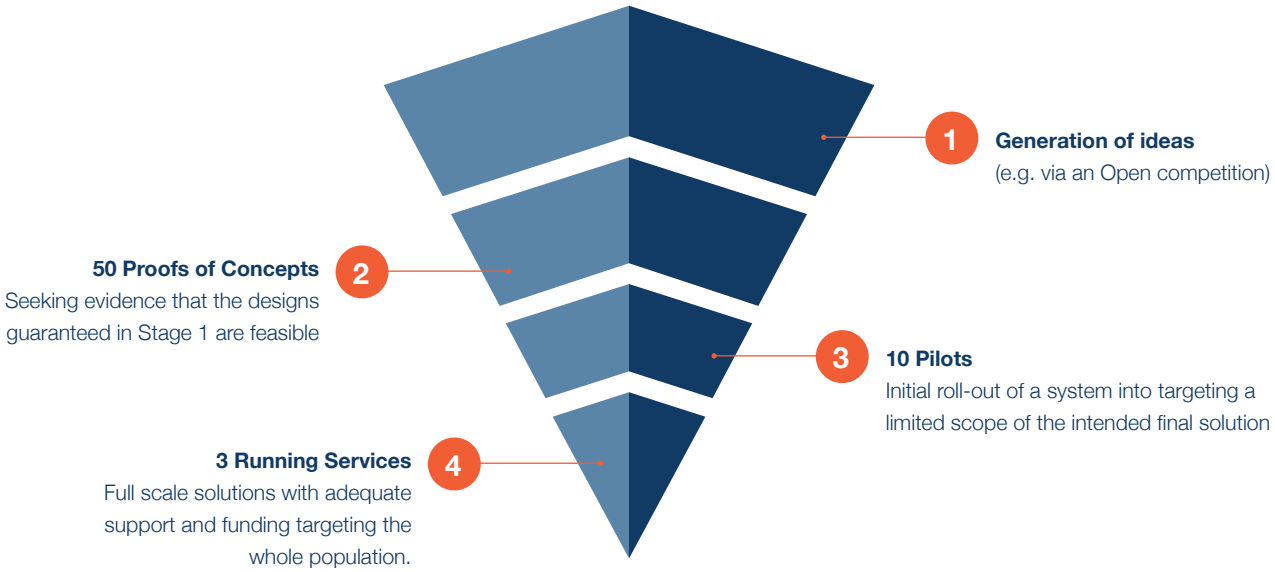
4. *Develop guidelines for smart AI procurement (next administration)*

In order to better provide high-quality services for citizens, government needs to embrace technology. In the right place AI is one of those technologies, and it will be increasingly useful over the coming years. As AI is so new it requires an approach to partnership and procurement which embraces that novelty, recognises that a lot of the expertise falls outside government, and minimises risk. In line with the digital strategy IT procurement guidelines, the Office for AI should work with departments to:

a. Talk to the emergent Mexican AI sector to foster mutual understanding and stimulate ideas on how AI could help government provide better services for less.

b. Take a portfolio approach to develop and procure AI products and services in government.

Figure 7: Portfolio approach to develop and procure AI products and services in government



Governance arrangements

1. ***Create a Commission that includes actors from all sectors as advisors to develop and promote Mexico's Government Strategy on AI (current administration and new administration continuation).***

   We recommend creating a formal and permanent AI commission within the government, which includes key actors of all sectors to advise on the development, implementation and promotion of Mexico's Strategy for AI towards a National AI Policy.

2. ***Create an AI Working Group in Congress (Deputies and Senate)***

   The promotion of AI should be included in all sectors of government. An AI Working Group in Congress, led by members of the Science and Technology Commissions at both the Chamber of Deputies and Senate, should work with the Executive and seek advice from experts to build capacity and understanding among legislators about AI challenges and opportunities. The AI Working Group would study other countries' best practices on AI laws being drafted and organise round-table discussions to start ideating a flexible legal framework suitable for Mexico.

3. ***Take a lead role in the global debate (current and new administration)***

   The Mexican government is a global leader in data and digital issues. The government should take a leading role in addressing the global challenges posed by AI - including at the G20, D7, The Pacific Alliance, UNECLAC etc., taking advantage of its current leadership position in these spaces. This cooperation between states is the only way to provide a coherent operational framework for the supra-national companies which are operating in this space.

While the above are recommendations for government, the final governance recommendation concerns civil society:

4. ***Create a coalition of AI practitioners from all sectors and disciplines - including national and local actors - to develop a multi-sector, integral 2030 AI Road Map (civil society)***

   This group would focus on creating an inter-sector long term AI Road Map that goes beyond government administrations and is based in the concept of mutual sector responsibility. This would enable a better coordination among sectors and different levels of government towards leveraging AI benefits in an integral way. It would work collaboratively with existing important research centers and networks such as the Mexican AI Society, Scientific and Technological Consulting Froum, and the government digital commissions, among others.

Research and development

AI is an emergent area, and like any new area it requires focus and investment both in primary research and the application of that to problems and challenges in the Mexican economy, as shown in the diagram below.

Figure 8: Fom pure research to market

In order to accelerate this journey, we recommend that Mexico:

4. Create a national centre for AI research (next administration)

Modelled on the Turing Centre in the UK but with a broader scope, Conacyt should fund the creation of a national centre for AI bringing together the leading scientists (including social scientists) and mathematicians researching AI. With dedicated funding, a physical campus and a model drawing on multiple campuses and centres of expertise, the national centre will help to provide a space and venue for cross-disciplinary work. As an internationally connected institution it will play a key role in positioning Mexico on the global stage. This new centre should play a leading role in creating a new eighth board on the national system for researchers (SNI), to govern research in computational sciences and artificial intelligence.

5. Strengthen connections between academia and industry (next administration)

Research and industry should have a symbiotic relationship. Industry feeds academic research; and academia provides novel techniques and insights for industry. There are three elements which can help:

a. Introduce sector councils - Tec de Monterrey has a model which brings in representatives from industry to help set the priorities for courses that give e.g. medical students the skills they need to operate in the digital world. This model should be used to assemble councils which look at the problems that the sector faces, and to set a framework under which some research funding is allocated, ensuring that research directly benefits Mexican business.

b. Support university spin outs - Universities in countries which do well in building IP businesses

support the commercialisation of primary research, and encourage bright young minds to create companies at the point when they have few commitments. Mexico should look to seed an angel investment fund for new startups out of university based on their growth potential. This should aim to be sustainable for the future by investing on a commercial basis and retaining a share of the company.

c. ***Allow academics to hold positions in private companies (Universities)*** - A number of academics who are world-leading researchers hold both university and private sector positions, for example Andrew Ng who was a Stanford professor and VP & Chief Scientist of Baidu. Mexico should support professors to hold joint positions in this way.

3. Create a good environment for commercial research and applied AI in the private sector

Businesses need certainty and confidence to be able to invest in intangible assets like intellectual property. Changes emphasised by our interviewees which would encourages businesses to choose Mexico for their R&D centres include:

a. ***Mapping (current administration, private sector)*** - map the current use and needs of AI and automated decisions in the private sector.

b. ***IP reform (next administration)*** - Update the Intellectual Property Rights framework for emerging technologies, for example, enabling AI programmes to be protected rather than requiring that only physical products can be patented.

c. ***Data sandbox (next administration)*** - The national centre for AI research should create a safe space for data to be exchanged to facilitate collaboration between researchers and industry. This could be based on the research in the UK's Turing Institute or the on work of Sandy Pentland at MIT.

d. ***Create new fiscal incentives for R&D and applied AI (next administration)***
This should be achieved by aligning requirements, evaluations and grants in main government funding mechanisms (Fondos Conacyt, FNE, e-México). This fund should prioritise riskier investments with high rewards, fostering new products and services that solve local challenges. This is to help avoid the current challenge of funding only those products or services that have already been successful.

4. Create an AI government fund (next administration)

This should be achieved by aligning requirements, evaluations and grants in main government funding mechanisms (Fondos Conacyt, FNE, e-México). This fund should prioritise riskier investments with high rewards, fostering new products and services that solve local challenges. This is to help avoid the current challenge of funding only those products or services that have already been successful.

Capacity, skills and education: taking the wide view

"Focus on education at all levels"

Miguel Gonzalez Mendoza: President of the Mexican AI Society.

Without the right skills in the economy, it is impossible to effectively harness the benefits of any innovation and new technologies. People need to be able to conceptualise how AI will work, how it will change assumptions on how problems can be solved, and how to deploy it. Given the large changes in the nature of work and workforce composition suggested by current research, there is an urgent need to create a more resilient workforce able to quickly adapt to rapid technological change.

A number of people respond to this by saying that AI should be a core part of the curriculum. We do not think it is that simple - technology moves on so quickly that if you teach a specific technique then there is a risk it will be out of date quickly. As a result, we propose complementary approaches at different levels:

1. Develop tools for continued education in AI (current and next administration)

People who are in the workplace will need to demonstrate that their skills are up to date. There are many providers of training, but quality can be difficult to assess.

a. MexicoX - The National Digital Strategy can use the MexicoX Platform to develop official programmes and certifications for Mexican civil servants (current administration). The next administration can include AI training programmes in their national training strategy for public servants.

b. The national AI centre - this should maintain a list of recommended vocational courses which can be taken and will promote their uptake to the public (next administration).

2. Broaden AI learning beyond computer science and Mathematics students in public and private universities (next administration, universities)

Creating AI programmes requires core skills in computer science and mathematics. However, to realise the full economic potential of AI, experts from other disciplines also need to understand AI. Tec de Monterrey, for example, includes a technology module in their non-technology courses. This prepares people for the labor market as it will be, not as it was. This approach should be introduced to other universities.

3. Teach computational approaches thinking in schools (new administration)

Children are emerging into a digital world in which technology is changing at an ever-increasing rate. As a result, children should be taught concepts and creativity - encouraging them to create tools which find new solutions to problems. We recommend that computational thinking and coding is placed on the national curriculum, teaching children applied logic and creative approaches to problem solving.

4. Increase the number of Masters and PhD students in AI and data science (current and future administration)

A consistent theme from interviewees was the shortage of Mexicans with advanced degrees in data science and machine learning. There should be a sustained investment in this primary resource for harnessing the potential of Machine Learning in Mexico.

Data infrastructure

AI is powered by data. Good quality big data is essential for the widespread implementation of AI technologies. Without this, the transformative power of AI is greatly limited, and its growth stunted. If the data is wrong, poorly structured, or incomplete, then there is potential for the AI to take the wrong decisions or have biases.

In order to create a data infrastructure that allows Mexico the best possible advantage of the benefits of AI, we recommend:

1. *Maintain a resilient open data infrastructure (current and new administration)*

Data is an important resource with special qualities. It can be expensive to collect and clean, but once it has been collected the onward dissemination is very cheap. The government should maintain and share core data services which: describe the country; and provide information relating to the delivery of public services. It should consider curating, funding and establish governance framework for data sets in priority sectors to support as part of the pre-competitive stage.

2. *Create Mexican training data to inform AI applications (next administration)*

Data is not neutral. It can carry with it conscious and unconscious biases. One of the unconscious biases occurs when an AI system is taught how to take decisions from a data set which is not representative. Data sets to train AIs can be very expensive to create as, for example, they require people to mark up tens of thousands of images or data items correctly. As Kate Crawford has highlighted, the majority of these data sets are created in Silicon Valley and reflect its norms and values.[44] The National AI Centre should produce training data sets for Mexico.

3. *Protect personal privacy (next administration, INAI)*

AI is hugely powerful and data hungry. This leads to organisations taking a 'collect it first, work out how to use it later' approach to data. While this is a sensible approach, it is important that it is not at the expense of personal privacy. The Mexican Institute of Access to Information and Personal Data Protection (INAI) should review, update and/or create new regulatory frameworks to keep pace with innovation and striking the right balance.

44. Kate Crawford (2017). *The Trouble with Bias, NIPS 2017.*

Ethics and regulation

Artificial intelligence and big data are new topics, and the businesses that are emerging have unfamiliar structures. They are capital intensive but employ few people. Instagram, for example, has more than a million users per employee. Facebook has 2.2 billion active users. If it were a country, it would be the largest country in the world. This is leading to a shift in power as large established companies are transformed or displaced, and digital companies accumulate large user bases across national borders.

Government needs to act to make sure that existing systems and controls are effective for the future. We recommend that the Government consider the following:

1. Bring data assets inside the scope of competition law (COFECE)

Data is a competitive asset - without access to data then it is not possible to build AI or other digital services. As data is a non-rival good and is difficult to value accurately, it falls outside the scope of anti-competitive legislation. The anti-competition law should be reviewed to ensure that the accumulation of data assets to the exclusion of other companies is within scope.

2. Create a Mexican AI Ethics Council (current and next administration)

There is a lot of debate about the 'ethics of AI' and concern over whether we are building tools which make everything easier - including making some harmful things more effective. Building on global work by organisations like the Institute of Electrical and Electronics Engineers, the Government, academia, industry and academia should enable the creation of a Mexican AI Ethics Council composed of leading ethicists, business leaders, and the Office for AI to:

a. Set guidelines and limits which reflect Mexican values;

b. Award a quality mark for AI companies who abide by the standards.

CONCLUSION

The rise of artificial intelligence technologies brings with it substantial economic and social opportunities for Mexico including in the areas of poverty reduction and gender equality. Its young and creative population, its connections with economies to its north and its south, and the talent and energy in Mexico's existing AI community are all important strengths. So too are existing investments in digitisation, e-government and data infrastructure, both at the national and regional levels.

An AI strategy that works for Mexico should build on these strengths and on the ambitions we heard in interviews across the country. This means a key role for government: to set a strategic direction, to invest in Mexican data and research to help build tomorrow's AI technologies, and to support the learning that will help citizens adapt to technological change. Civil society will also be critical, both in building momentum and in consolidating the efforts of AI experts across sectors in Mexico.

AI technologies will lead to big changes in the way Mexicans live and work. A strong ethical focus to help guide the actions of government, companies and citizens using AI tools will be very important to help guide these changes. The decisions we make about artificial intelligence research and applications will influence how we interact with technology for many years to come. Ensuring that these technologies are developed in safe, inclusive and ethical ways will help shape a better future for all Mexicans.

Appendix 1: List of participants who contributed to this report

Name	Job Title	Organisation	Sector
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Alonso Gutierrez	Intern	C Minds	Civil Society
Andrés Mendez Vázquez	Researcher	CINVESTAV	Jal Academia
Anjoum Noorani	Head of Prosperity	British Embassy in Mexico City	International Cooperation
Antonio Morales	AMS SC Business Applications Development Manager	HPE	Jal Industry
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Eduardo Clark	Public Innovation Deputy Director	CEDN	Government
Eduardo Farina Bluemessaging	CEO	Bluemessaging	Start-up
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Francisco Búrquez	Senator	Member of the Science and Technology Commission	Legislative branch
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Name	Job Title	Organisation	Sector
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José Cantoral	Researcher	CIATEQ	Jal Academia
Jose Franco	General Coordinator	Foro Consultivo Científico y Tecnológico	Academia / Civil Society
Juan Pablo Escobar	Director	Civica Digital	MTY Civil Society/Consultancy
Katie Allan	Associate	Oxford Insights	Consultancy
Laura Caccia	Consultant	Oxford Insights	Consultancy
Lorenzo Valle	Director - Center for Business Development in IT and Big Data Initiative	TEC	Academia
Lorenzo Valle Garcilazo ITESM	Big Data Center Coordinator	ITESM	Academia
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Luis Valtierra	President	IJALTI	Cluster
Manuel Avalos	IBM Storage Cloud and Solutions for IBM WW	IBM/ Watson	Jal Industry
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Mario Angel Siller Gonzalez	Researcher	CINVESTAV	Jal Academia
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Matt Pasiensky	VP of International Operations	Wizeline	GDL Industry
Miguel Gonzalez	President & Researcher	SMIA, ITESM	Academia
Miguel González Mendoza	President	Mexico's AI Society	Academia / Civil Society
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Tania Cruz	Digital Government Services	CEDN	Government
Victor Gutierrez	Industry	CCE	Industry
Yamin Ruiz Global Proteus	CEO	Global Proteus	Start-up
Yolanda Martinez	Coordinator	National Digital Strategy	Government

Appendix 2: Innovation in Mexico's Regions

Jalisco, CDMX, and Nuevo Leon are leading the country's science and technology scene. AI has not been addressed in these states' innovation agendas nor in their development plans. However, they are building strong digital foundations that will allow for AI experimentation and the potential scaling-up of current AI pilots outside of government's scope.

For each state, we examined the following: existing technology and innovation policies, key institutions, and major economic sectors. We also assessed their performance in the 2016 national State Competitiveness Index,[45] which measures the capacity to attract and retain talent and investments, the 2013 National Science, Technology and Innovation Ranking,[46] which provides an overview of the ICT capabilities and opportunity areas that each State holds, and the 2015 national Electronic Government Index,[47] which measures the percentage of population 18 years of age or older that had interacted with their State's government electronically.

CDMX

With a population of approximately nine million,[48] Mexico City is the capital of the country, its newest State, and strongest economy, contributing alone 16.82% of national GDP.[49]

Key sectors

Financial and insurance services, real estate and rental services of movable and intangible assets, business support services, and waste management and remediation services.[50]

Strategic areas of technology focus

Automotive industry, home appliances, and electronics.[51]

Key institutions

- **CDMX (Oficialía Mayor)** is responsible for digitizing government services, developing open data policies and driving the city's digital transformation. Both the General Coordination for Administrative Modernization (CGMA for its acronym in Spanish, and the General Direction for ICT Governance (DGGTIC) are two departments within the Oficialia Mayor leading all digitization efforts.
- **CDMX Secretariat of Science, Technology and Innovation (SECITI)** is responsible for establishing policies related to the study and development of science, technology and innovation. The Secretariat also promotes, develops and coordinates the resultant activities to generate greater economic growth and improve citizens' quality of life. SECITI seeks: 1) to build public policies based on technological solutions to the problems of the city; and 2) to encourage the application and development of ICT, and use them to manage the resources and services provided by the state in matters such as communications, education and digital government.

45. Indice de Competitividad Estatal (2016). IMCO
46. Ranking Nacional de Ciencia, Tecnología e Innovación (2013). Foro Consultivo Cientifico y Tecnologico.
47. Encuesta Nacional de Calidad e Impacto Gubernamental (2015). INEGI
48. Número de habitantes (2015). INEGI OECD Figures include the whole urban area and put the number at 21 Million people OECD Territorial Reviews: Valle de México, Mexico (en inglés)
49. PIB - Entidad Federativa, anual (2015). INEGI
50. Informacion Economica y Estatal del Distrito Federal (2015). Secretaria de Economia, p. 6
51. Estudio de pertinencia de la oferta educativa 2017, Unidad de Estudios e Intercambio Académico, Dirección de Prospección Educativa, CONALEP, 2017, p. 23.

- The **Mexican Society for Artificial Intelligence (SMIA)** is celebrating its 30th anniversary. This scientific community gathers AI professionals and academics to discuss their lines of research and share their projects.
- The **National Chamber for Electronics, Telecommunications and ICT Industries (CANIETI)** represents the interests of over 1000 enterprises across Mexico, seeking to promote economic development, innovation, and competitiveness.
- The **City's Lab (Laboratorio para la Ciudad)** is the experimental area of civic innovation and urban creativity of the Government of Mexico City. It has a wide mandate of working with data as a key element of innovation within Mexico City. It has also enabled the city's government to trial integrating AI into Mexico City's operations.

Existing technology and innovation policies

- In 2016, Mexico City made it a priority to "bestow the constitution project with a democratic, progressive, inclusive, civic and plural character." The 32nd Mexican State **crowdsourced its constitution** using Change.org and PubPub, an editing platform similar to Google Docs.[52]
- The Data **Laboratory**[53] is a repository of datasets and web services built from data provided by government entities to the City´s Lab (Laboratorio para la Ciudad), and structured by civic hackers. The Data Laboratory is the base repository of HackCDMX, data festival of the CDMX and CódigoCDMX. These are all civic innovation projects developed by the of the City's Lab.

State's vision for the future

Linking science, technology and innovation with society, academia, the business sector, and government to help address the main problems of Mexico City and thereby generate better living conditions for its inhabitants.[54]

Rankings	State's Competitiveness Index	Ranked 1st place.
	Electronic Government Index	35% of the population over 18 years old had interacted with government electronically; ranked 6th place.
	Science, Technology and Innovation Ranking	Ranked 1st place nationally.

52. Campoy, A (2016). Quartz.
53. Laboratorio de Datos. Laboratorio para la Ciudad.
54. Secretaria de Ciencia, Tecnologia e Innovacion. CDMX.

Jalisco

With a population of around eight million people,[55] and a median age of 26, Jalisco is a dynamic hub for economic development and innovation. Innovation and entrepreneurship culture are key components in the effective interaction between higher education institutions, the private sector, public authorities, and civil society organisations.

In Jalisco, there are over 9,000 technical and engineering graduates per year, of whom almost 6,000 specialise in cutting edge technology.

Key sectors

Automotives and auto parts, fashion, electronics, medical tourism and culinary tourism.[56]

Strategic areas of focus based on the state's innovation agenda

Agro-industrial, ICTs, automotive, electronics, aerospace equipment and services.[57]

Key institutions

- **Ministry of Innovation, Science and Technology of Jalisco** is the first of its kind. It seeks to create favourable conditions to promote, coordinate, and contribute to regional development through innovation and the educational, scientific, and technological development of the state.
- The **Center for Innovation, Technological Development and Internet of Things Applications (CIIoT)**, is a solutions hub for digital transformation. Here, ideation, design, prototyping, testing, and manufacturing are carried out in relation to IoT applications. In 2016, the consortium formed by two higher education institutions, one public (TMM Zapopan) and one private (ITESM Guadalajara), and a National Polytechnic Institute research center (CINVESTAV Guadalajara) was selected as the implementing body.
- **Ciudad Creativa Digital (Digital Creative City)** is a high-impact project for Jalisco's multimedia industry. It seeks: a) to develop a smart city that can become a replicable model for other cities based on the use of Internet of Things and big data technologies; and b) to catalyse the development of the multimedia industry through seed investment programmes and world-class infrastructure.

Existing technology and innovation policies

- **Industry 4.0 Enablers** is implemented by the Ministry of Innovation, Science and Technology. This programme prepares higher education students to face the challenges presented by the fourth industrial revolution. The programme focuses on scientific and/or technological disciplines such as artificial intelligence, data analytics, big data, the internet of things, cloud computing, 3D printing, embedded systems, sensory and intelligent robotics. Its particular objective is to train and certify students on topics related to sensors and connected applications in the context of the Internet of Things (IoT): a) programming of embedded systems; b) manipulation of sensors and actuators; c) solutions in the cloud; d) development of web and mobile applications.

55. Número de habitantes (2015). INEGI
56. Diagnósticos Estatales de Ciencia, Tecnología e Innovación (2014). Foro Consultivo Cientifico y Tecnologico, p. 18
57. Agenda de Innovacion de Jalisco. CONACYT, p.22

- The **Science and Technological Development Programme** seeks to promote scientific research, technological development, and innovation, through a quadruple helix model (academia, government, industry and civil society). It will catalyse technological development, seeking to use technologies strategically to enhance social welfare and strengthen the state's economy.
- The **Programme to drive Innovation, Science and Technology Policy** establishes a consistent strategy in line with the definition of short-term goals and objectives, linking the private, public, academic, and social sectors to provide Jalisco's population with better opportunities that translate into well-being for all.
- The **Business and Social Innovation Projects Programme** provides economic support for the development of initiatives with a high technological component and social impact potential. It also offers specialised training to develop skills among trainers (as per the 'train the trainer' model), entrepreneurs, and investors in Jalisco. The Programme's general objective is to develop a culture of innovation, contributing to Jalisco's economic and social development by boosting entrepreneurs' initiatives and creating high-impact companies.
- Jalisco's **cluster of ICT, microelectronics and multimedia** has become the most important cluster in the country, with more than 180 companies working in these sectors, 20,000 thousand highly paid jobs, and generating an added value of $1bn billion dollars.

State's vision for the future

Jalisco to be the most innovative state in Mexico, with the highest technological development.[58]

Rankings	State's Competitiveness Index	Ranked 8th place.
	Electronic Government Index	35% of the population over 18 years old had interacted with government electronically; ranked 6th place.
	Science, Technology and Innovation Ranking	Ranked 4th place nationally.

58. Ministry of Innovation, Science and Technology of Jalisco.

Nuevo Léon

Northeastern Mexican State with a population of over five million (2015)[59] and one of the largest state economies in the country, contributing to 7.58% of national GDP.[60]

Key sectors

Construction, automotives, machinery and equipment, home appliances, and electronic products.[61]

Strategic areas of focus based on the state's innovation agenda

Aerospace industry, agroindustry, automotive industry, biotechnology, home appliances, nanotechnologies, ICT and medical services, logistics and transportation, creative industries, sustainable housing.[62]

Key institutions

- Among its landmark technology initiatives, Nuevo Leon's **Software Council (Csoftmty)** was established as a partnership between academia, industry, and government to promote economic growth through the use of ICTs. Since its creation, this cluster has contributed to talent development, with the pool of engineers increasing from 2,000 to 14,000.
- The **Institute for Innovation and Technology Transfer** promotes technology that is oriented toward market needs. The Institute seeks to generate and support new products, assisting the creation of technology development companies, and help safeguard intellectual property. They do this by connecting academia and industry. The Institute also encourages the development of intellectual capital and manage strategic alliances with national and international organisations from the private and academic spheres.
- The **Research and Technological Innovation Park (PIIT)** is a strategy that falls under the State project, 'Promoting the Economy and Knowledge Society'. This looks to consolidate the core regional innovation ecosystem where financial resources, urban equipment, scientific infrastructure, and technology converge to revitalise urban and industrial areas.
- **Softtek** is a Mexican company specialising in software development, that has been successful in generating innovative solutions and exporting products and services globally.
- The **Home Appliances Cluster (CLELAC)** is made up of companies and academic institutions, as well as chambers and associations such as Mabe, Siemens, Whirlpool, CONALEP, Tecnológico de Monterrey and Santa Catalina Technological University. According to data from CLELAC, 48% of the home appliances in Mexico are produced in Nuevo León, and the number of jobs generated by the sector was over 30,000 in 2015.
- In 2016, the State opened an **Automotive Cluster (CLAUT)**, specialising in talent development, design, product development, and manufacturing process improvement. It is the first innovation center for the automotive industry in Mexico.

59. Número de habitantes (2015). *INEGI*
60. PIB, Entidad Federativa, anual (2016). *INEGI*
61. Diagnósticos Estatales de Ciencia, Tecnología e Innovación (2014). *Foro Consultivo Cientifico y Tecnologico,* p.18.
62. Parque de Investigación e Innovación Tecnológica (PIIT), Estado de Nuevo Leon.

Existing technology and innovation policies

- Nuevo Leon's Special Programme for Science, Technology and Innovation, which is part of the State's 2016-2021 Development Plan, has two main strategies: a) to strengthen research and development in the academic, scientific and productive sectors, as well as skills training in strategic areas; and b) to promote and facilitate the generation of companies based on technological innovation and scientific research.[63]

State's Vision for the future

- To increase GDP per capita from $20,000 USD to $35,000 USD (the OECD average) by 2030.
- To consolidate Nuevo Léon as one of the 25 most competitive regions (WEF, IMD, OECD).
- To disseminate a knowledge-based culture and promote the impact of science, technology and innovation in everyday life.

Rankings	State's Competitiveness Index	NL ranked 2nd place nationally.
	Electronic Government Index	29% of the population 18 years of age or older had interacted with the government electronically. NL Ranked 22nd place nationally.
	Science, Technology and Innovation Ranking	Ranked 2nd place nationally.

63. Programa Especial Ciencia, Tecnología e Innovación (2016-2021), Estado de Nuevo Leon.

Puebla

With a population of 6 million people,[64] Puebla has a strong focus on the automotive industry. In 1965, Volkswagen began operations in the State, with a large industrial complex that remains in operation and has driven the growth of the industry in the region. In 2016, a new Audi plant began operations, fostering job creation.

Key sectors

Real estate services, manufacture of machinery and computer equipment, and construction.[65]

Strategic areas of focus based on the state's innovation agenda

Automotive industry, textile, and agro-industry.[66]

Key institutions

- **Center of Specialisation of High Level Human Resources in the Automotive Sector.** This centre's goal is the formation and training of high-level human resources in the automotive industry.
- The **ICT Cluster** is an association of companies in the ICT sector. It includes research centres and higher education institutions, and seeks to develop technological solutions and generate new sources of employment.
- **Puebla Science and Technology Council (CONCYTEP)** advises and supports innovation in science and technology in Puebla. It promotes collaborative networks between the public, productive and academic sectors.
- **iCluster Puebla** is an innovation ecosystem that helps government, academia, and industry work together.
- The **National Institute of Astrophysics, Optics and Electronics (INAOE)** specialises in pattern recognition and computational learning. INAOE develops algorithms, programmes, and systems that allow computers to improve in carrying out certain tasks, learn from experience, and adapt to changing environments.

Existing technology and innovation policies

- The programme **Itinerant Communities** supports ICT's diffusion in all state municipalities.
- A pilot programme was carried out by the Ministry for Tourism in Puebla around the **'Productive use of big data and social networks in the tourism sector'.**[67]
- Conacyt' promotes of **Scientific and Technological Research.** They provide support to projects that generate the knowledge needed to address Puebla's problems, needs and opportunities, form highly qualified human resources, consolidate research and technology groups, and strengthen the scientific and technological competitiveness of the academia and industry sectors of the State.
- **Puebla's Digital Government Agenda 2011-2017** focuses on promoting economic and social development through ICT's potential to improve the quality of education, increase transparency, increase productivity and competitiveness, and improve governance through greater citizen participation.[68]

64. Número de habitantes (2015). INEGI
65. PIB - Entidad Federativa, anual (2015). INEGI
66. Agenda de Innovacion de Puebla. CONACYT.
67. Uso productivo de "big data" y redes sociales en el sector turismo (2014). Secretaria de Turismo Puebla.
68. Agenda Digital. *Gobierno de Puebla*, p. 56.

State's Vision for the future

Puebla's vision is to articulate policies to increase the competitiveness of strategic sectors, and to strengthen an innovation ecosystem that incorporates SMEs, centres of research, and educational institutions. This is based on the identification of current and emerging markets that allow the development of products, projects, and programmes that generate added economic value, favouring more jobs and attracting investment.[69]

Rankings	State's Competitiveness Index	Ranked 14th place.
	Electronic Government Index	33% of the population over 18 years old had interacted with government electronically; ranked 10th place.
	Science, Technology and Innovation Ranking	Ranked 17th place nationally.

69. Agenda de Innovacion de Puebla. *CONACYT.*

Yucatan

With a population of two million,[70]] Yucatan is a southeastern State in Mexico known internationally for its gastronomy and the prehispanic city of Chichen Itza, a UNESCO heritage site named one of the new seven wonders of the world.[71]

Key sectors

Services, tourism, food industry, and construction.[72]

Strategic areas of focus based on the state's innovation agenda

Logistics, tourism, agroindustry, and renewable energies.[73]

Key institutions

- The State's **Ministry of Research, Innovation and Higher Education (SIIES)**, establishes the direction of higher education. It promotes the interconnection between scientists and technologists to solve social, environmental and economic challenges.
- The **Scientific and Technological Park of the State of Yucatan** develops a comprehensive vision to connect industry, academia and government. It seeks to become the state's pole of economic and social development, through the formation of high-level human talent and investment in scientific-technological infrastructure. The goal is to meet the industrial vocations of the region and encourage the creation of new economy enterprises.
- **CIMAT Unit** (Research Center in Mathematics) fosters an innovation ecosystem to promote scientific-technological vocations and develop new products, technologies and services through knowledge-generation
- The **Special Economic Zone** (ZEE) focuses on ICT, knowledge development, the creation of design centers, prototype innovation and developing human capital[3].
- The **Punto Mexico Conectado** (Digital Inclusion Center) promotes basic competencies and skills related to ICTs.

Existing technology and innovation policies

- The Human Capital Programme[74] focuses on establishing links between the public, academic, industry and social sectors to optimise resources in science, innovation and technology and disseminate knowledge within Yucatan.

State's Vision for the future

- Yucatan's vision is to leverage its geostrategic advantages. It is located in a world-class tourism zone and at the centre of the American continent. Therefore, it can anchor investment from global manufacturing and services companies within the State.[75]

70. Número de habitantes (2015). INEGI
71. Chichen Itza. National Geographic.
72. PIB - Entidad Federativa, anual (2015). INEGI
73. Agenda de Innovacion de Yucatan. *CONACYT.*
74. Capital Humano Yucatan. Secretaria de Investigacion, Innovacion y Educacion Superior.
75. Una realidad, ZEE (2017). *Yucatan Gobierno del Estado.*

Rankings	State's Competitiveness Index	Ranked 10th place.
	Electronic Government Index	35% of the population over 18 years old had interacted with government electronically; ranked 7th place.
	Science, Technology and Innovation Ranking	Ranked 12th place nationally.

Appendix 3: Methodology

Existing technology and innovation policies

In order to calculate the proportion of jobs that might be affected by automation, we used OECD data describing the number of jobs in each sector and sub-sector in Mexico in 2016.[76] We then followed O*Net's analysis of how each sub-sector breaks down into its constituent occupations in the USA, where this data also offers an account of the tasks required to perform each occupation successfully.[77] (We therefore assume that the distribution of occupations within sub-sectors is the same as in the USA, which is a weakness in this model. Additionally, our analysis of the proportion of automatable Mexican jobs is based on 2016 jobs data, and is not adjusted for future projections of job growth in Mexico.)

We assessed how likely it was that each task within each occupation would be automated over the short-, medium- and long-term, according to our understanding of the likely development of artificial intelligence over the next 15 years. This provided us with an analysis of the overall risk of automation for each sub-sector in Mexico. We manually adjusted any highly counter-intuitive results. The final short-, medium-and long-term automation figures are cumulative over time.

Gender figures are binary and based on OECD data from 2016.

76. https://stats.oecd.org/Index.aspx?DataSetCode=ALFS_EMP
77. https://www.onetonline.org/find/industry?i=0&g=Go

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