The National Council
for Artificial Intelligence

Egypt National
Artificial Intelligence
Strategy

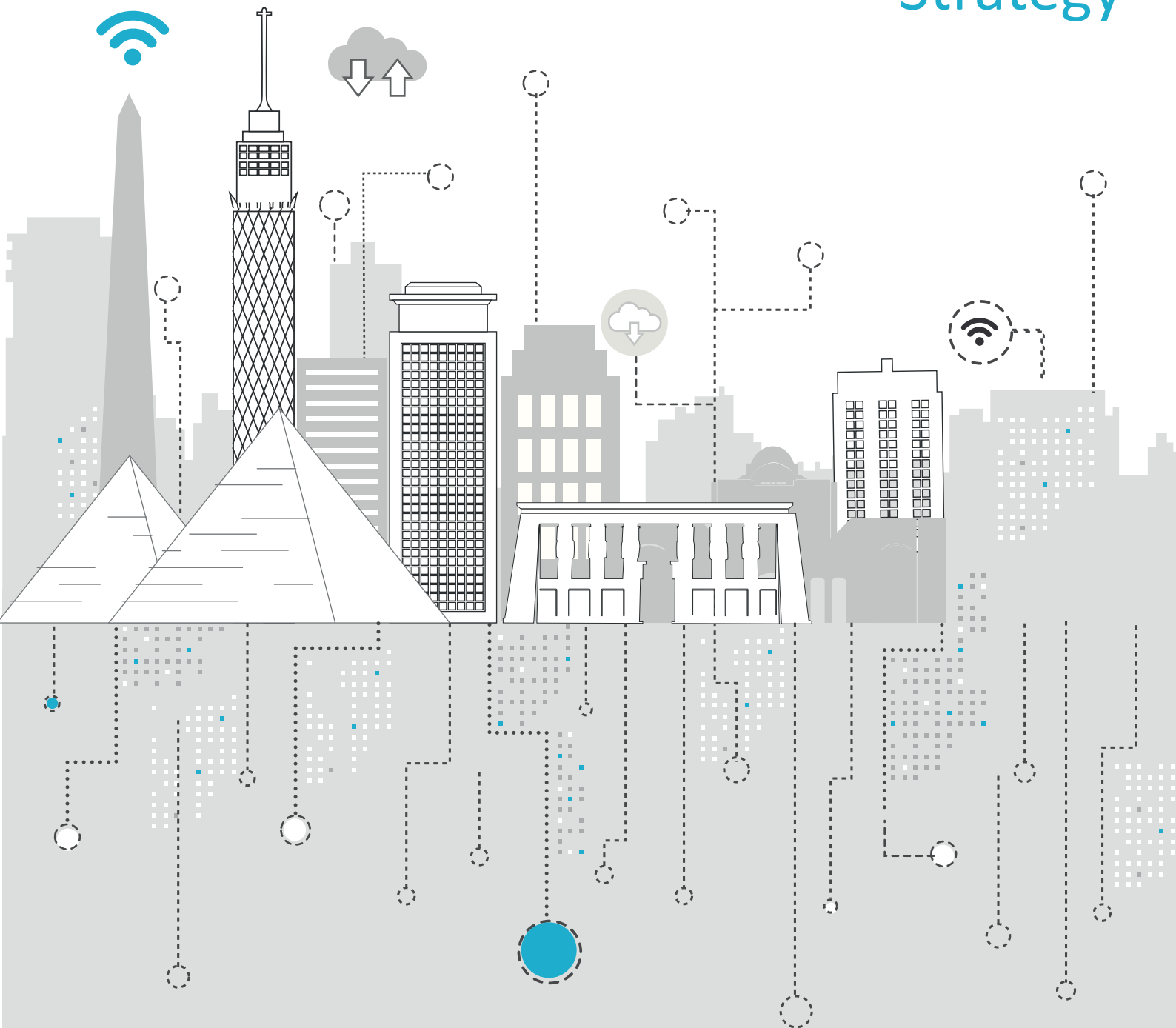


Table of Contents

1
President's Statement

2
Executive Summary

3
Background
3.1 What is an AI System?
3.2 AI Strategies and Initiatives around the World

4
AI in Egypt
4.1 The Case for an AI Strategy
4.2 SWOT Analysis

5
Strategy Overview
5.1 Vision and Mission
5.2 Pillars and Enablers

6
AI for Government

7
AI for Development
7.1 Agriculture, Water Management and Environment
7.2 Healthcare
7.3 Economic Planning and Growth
7.4 Manufacturing and Smart Infrastructure Management
7.5 Arabic Natural Language Processing
7.6 Finance and Banking

8
Human Capacity Building
8.1 General Awareness
8.2 Formal Education and Training
8.3 Promoting AI Research in Egypt

9
International Activities

10
Strategy Enablers
10.1 Governance
10.2 Data
10.3 Infrastructure
10.4 Ecosystem

11
Implementation Methodology
11.1 Implementation Framework
11.2 Implementation Phases

12
Phase 1: Implementation Plan
12.1 EPE
12.2 Operational Model
12.3 Main Initiatives

13
Monitoring and Evaluation
13.1 Total Strategy Impact
13.2 Strategy Thought Leadership
13.3 Strategy Execution Effectiveness

14
Conclusion and Next Steps

Appendix A: List of Main Contributors
Appendix B: References

1 President's Statement

Egypt is keen to embrace the digital era, as advancements in technology continue to evolve every day. These developments create promising opportunities for laying the foundation for a national economy that is based on the emerging technologies of the Fourth Industrial Revolution, most notably Artificial Intelligence. This necessitates intensifying efforts to adopt such technologies, and developing clear strategies to utilize those technologies in building a modern state and achieving Egypt's development goals, aiming to improve Egyptians' quality of life.

Therefore, I have mandated the National Council for Artificial Intelligence to develop a comprehensive national plan, aiming to pave the way for indigenizing the AI industry and strengthening Egypt's leading role at the regional level to become an active global player in this field.

The National AI Strategy has been drafted according to a model that promotes effective partnerships between the government and the private sectors to create a dynamic work environment that spurs innovation, supports building Digital Egypt, and achieves the digital transformation led by AI applications. This is in addition to encouraging investment in Research and Development (R&D) in such technologies, raising awareness of its significance, and developing human capital to create a generation of young Egyptians capable of developing AI applications, in line with the national needs and the country's priorities.

We strongly believe that as emerging technologies create opportunities, they also pose challenges that we should be prepared for. Thus, we aim, through the National AI Strategy, to open the door to dialogue with stakeholders and promote international cooperation to exchange views on the best practices for developing and using AI to build the common good. This is in addition to adopting and leading strong stances on AI ethics and the social and economic impact of using AI applications in African and Arab countries, under the umbrella of the African Union (AU) and the League of Arab States (LAS) to reach a common vision that reflects our needs and aspirations, and conforms to our values and principles.

Egypt gives its full support to the Strategy to ensure a successful implementation. I trust in the Egyptian competence, capable of mobilizing all energies to transform the Strategy into action plans, which can be translated into tangible, real-life results. We endeavor to keep up with AI developments to reach a new cultural milestone and create a promising future for our great country.

Abdel Fattah Al–Sisi

President of the Arab Republic of Egypt

2 Executive Summary

In November 2019, the Egyptian Cabinet approved the formation of the National Council for Artificial Intelligence (NCAI) to include representatives from all relevant government entities as well as independent experts in the field of Artificial Intelligence (AI). The Council's main objective is to formalize and govern the implementation of Egypt's National AI Strategy.

The present document is the culmination of efforts by the Technical Committee of the National Council, and builds on previous work carried out in 2019 by the Ministry of Communications and Information Technology and the Ministry of Higher Education and Scientific Research, along with input from independent experts and private sector companies. The Technical Committee would like to extend its thanks to all parties for the roles they have played in producing this document.

Recent studies and economic indicators all point to the net positive effect that can be realized from absorbing AI into international economies. Egypt is no exception; given the right investment climate and upskilling/reskilling strategy for its labor, the country stands to benefit substantially from the opportunities AI affords while avoiding its risks, most notably the rise of unemployment.

To this end, Egypt is embarking on developing a national strategy for AI, which aims to realize the following vision:

1. Exploit AI technologies to support the achievement of Egypt's sustainable development goals, to the benefit of all Egyptians.
2. Play a key role in facilitating regional cooperation within the African and Arab regions and establish Egypt as an active international player in AI.

The mission statement emerging from this vision is to:

Create an AI Industry in Egypt, including the development of skills, technology, ecosystem, infrastructure, and governance mechanisms to ensure its sustainability and competitiveness.

To achieve the vision and mission above, Egypt will work on the following dimensions:

1. Embed AI technologies in government operations to make them more efficient and transparent.
2. Utilize AI in key developmental sectors to make an economic impact and to solve local and regional problems in support of Egypt's sustainable development strategy and in line with the UN's SDGs for the benefit of all Egyptians.
3. Encourage investment in AI research and innovation through public-private partnerships and initiatives with universities, research centers, and the private sector.
4. Become a regional hub for AI education and talent serving local, regional and international market needs.
5. Support lifelong learning and reskilling programs to contribute to workforce development and sustained employability
6. Create a thriving AI ecosystem by supporting local entrepreneurship and innovation efforts, and fostering an academic scientific environment full of ideas, inventions, and discoveries.
7. Promote a human-centric AI approach where people's wellbeing is a priority and facilitate multi stakeholder dialogue on the deployment of responsible AI for the benefit of society and to inform related policy discussions.
8. Capitalize on AI as an opportunity for inclusion of the marginalized, not only for safety net programs, but also in initiatives that promote human advancement and self-development.
9. Facilitate cooperation on the Arab and African levels, working to unite Arab and African voices and efforts in AI for the benefit of all.
10. Actively contribute to global efforts and playing an active role in AI different international fora, especially around topics of AI Ethics, future of work, responsible AI and the social and economic impact of AI.

The strategy consists of the following four pillars

1. AI for Government: The rapid adoption of AI technologies through the automation of government processes and embedding AI into the decision-making cycle to increase efficiency and transparency.
2. AI for Development: Apply AI in different economic sectors based on a phased approach, with the aim of realizing efficiencies, achieving higher economic growth and better competitiveness. Key projects will be identified and implemented through domestic and international partnerships, and will always include a capacity building element, to foster technology and knowledge transfer, and help grow the local ecosystem. Priority sectors for phase 1 include: Agriculture/ Environment/ Water Management - Healthcare - Arabic Natural Language Processing (NLP) - Economic Planning and Development - Manufacturing and Smart Infrastructure Management.
3. Capacity Building: Prepare the Egyptian population for the age of AI at all levels, from general awareness to school, university and equivalent education, to professional training for technical and non-technical disciplines.
4. International Activities: Play a key role in fostering cooperation on the regional and international levels by championing relevant initiatives, representing African and Arab positions, and actively participating in AI-related discussions and international projects.

Supporting the four pillars are the following four enablers

1. Governance: including ethics, laws and regulations, tracking and monitoring

2. Data: including collection, management and monetization strategies

3. Ecosystem: including private sector, research and academia, and civil society

4. Infrastructure: including fair access to compute, storage, networking, and other assets

The strategy will be implemented in a phased approach; the first phase started in 2020 and lasts until the end of 2022. It focuses on training graduates and professionals to fulfil market needs and proving the value of AI in the different strategic sectors by starting pilot projects within government in partnership with local and foreign entities. This phase will further focus on building regional bridges to unify AI efforts on the African and Arab levels, as well as active participation in international organizations on topics such as AI Ethics, AI for SDGs, and the impact of AI on labor markets and education. During the first phase, preparations for the second phase will take place, which will include an assessment of further priority sectors and paving the way for a focus on growing the ecosystem, especially startups. Details of phase 1 are included in this document, and an operational plan will be issued regarding further phases in due course.

The National Council for AI (NCAI) will oversee the implementation of this strategy and will set and track the relevant KPIs to measure progress and make adjustments where needed.

3 Background

AI and specifically, data-driven methods such as Machine Learning, are promising a radical transformation of the economic and social systems worldwide. By 2030, AI is forecast to add $15 trillion to the global economy, with countries that manage to fully absorb AI into their economies expecting to see up to 25% of their GDP growth driven by AI.

From computer vision techniques allowing real-time analysis and understanding of videos and images, to Natural Language Processing (NLP) algorithms enabling the creation of chatbots capable of carrying out human-like conversation, to probabilist Deep Learning systems used in complex decision-making processes such as medical diagnosis - to list but a few applications - it has become impossible for nations to ignore the promise and impact of AI.

AI has therefore gained increasing priority on the policy agendas for governmental institutions, at both national and international levels. Many national government initiatives to date focus on using AI technologies for development and economic growth, fostering research and strengthening the ecosystem, in particular AI startups. International and regional organizations have also started paying due attention to AI and each has started to carve out a niche for itself based on its competencies and membership composition.

Applying AI to areas such as education or healthcare can facilitate access, overcome staff shortages, and reduce risks and costs. On the other hand, concerns are growing about increasingly automated and autonomous AI systems widening the technological, economic, and social gaps due to the lack of basic infrastructure and human capacity capable of exploiting this technology, especially in countries with a large proportion of low-skilled or unskilled labor.

AI promises the biggest labor market transformation since the industrial age and threatens to marginalize groups not adequately prepared for its arrival. There are also growing concerns about the ethics of AI systems and issues such as bias, gender equality, insufficient regulation, and the loss of nuances in culture and language, for example due to the use of Natural Language Processing (NLP) systems. No single country or actor has all the answers to these challenges. Therefore, there is a need for international cooperation, broad dialogue and multi-stakeholder responses to exchange knowledge and best practices and guide the development and use of AI for the wider good.

On the national level, countries need to work on developing their own stances towards AI, capitalizing on their comparative strengths and ensuring a minimization of adverse effects generated by AI to ensure they are not left behind in the global race for technological dominance.

3.1 What is an AI System?

An AI system, as explained by the OECD's AI Experts Group (AIGO), is "a machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations or decisions influencing real or virtual environments. It uses machine and/or human-based inputs to perceive real and/or virtual environments; abstract such perceptions into models (in an automated manner e.g. with ML or manually); and use model inference to formulate options for information or action." AI systems are designed to operate with varying levels of autonomy.

The term AI in itself has morphed over the years since it was coined by John McCarthy et al at Dartmouth University in 1956. It was initially thought to act as an umbrella term encompassing all actions which, if performed by a machine, the machine can be termed "intelligent". Early efforts in AI development focused on creating machines and software systems which could mimic the human brain. This led to the inception of the "expert systems" of the 1960s, which were based on hierarchical rules programmed by domain experts, for example in medicine or agriculture. However, such systems were always limited by: a) the knowledge of the experts involved in programming them; b) the cost of developing such systems, especially the high cost of computing and storage hardware; and c) the complexity of the software tools and systems required to model highly intricate processes. This led to two phases of so-called "AI winters" during which relatively little research was done.

The dawn of the third millennium brought significant advancements in data search and retrieval algorithms. Coupled with exponentially decreasing costs of storage and compute hardware, as well as the advent of startups such as Google which managed to create a business model based on the analysis of user data, the scene was set for a resurgence in a long-dormant field of AI, that of Machine Learning (ML). ML is a subfield of AI, which relies on complex analysis of large datasets to infer rules and extract features, then use those to "predict" new values for unknown data. Having a proven business model for using data commercially encouraged many organizations to fund research in ML both in academia and in the private sector itself, to the point where the latter has now leapfrogged academic research in most areas of ML.

Since then, many subfields of ML have emerged, including Deep Learning (DL), which is based on Artificial Neural Networks, which are structures comprised of small software nodes that mimic the neurons in the human brain and are governed by complicated differential equations; Reinforcement Learning (RL), which uses feedback loops and the concept of reward to simulate a "learning" mechanism; Transfer Learning (TL), which relies on the ability to apply rules learnt in one domain to another without a large investment in retraining, and many other subfields that emerge every day. However, the one common thread is the importance of data and the algorithms (called "models") utilized to analyze them. With the prevalence of cloud computing, many of these models have now become off-the-shelf modules that can be accessed on platforms such as Amazon's AWS, Google's GCP, or Microsoft's Azure, without the user having to develop any of them from scratch. However, there is still a need for custom algorithms that solve specific problems.

Despite the prevalence of data-driven techniques, the world is currently experiencing a revival of the methods of old, known as "rule-based" or "symbolic" AI. Some of the world's most powerful AI products have managed to combine both techniques to achieve optimal results.

An important distinction to be made is that between "weak" and "strong" AI or "general" and "narrow" AI. General AI (sometimes referred to as "AGI" or "Artificial General Intelligence") is a hypothetical concept which revolves around a machine fully replicating the functions of a human brain to the point that it is indistinguishable from a real brain, and by which it is able to perform any task a human being can. AGI remains the subject of science-fiction films to this day and there is no current path which can lead to it despite some attempts. Weak or narrow AI on the other hand refers to a system which is capable of performing one task at or even above the level of a human-being. Most of these systems utilize data-driven methods and are deployed within one specific setting. All systems we currently refer to as "AI" fall under this classification.

3.2 AI Strategies and Initiatives Around the World

According to different studies and reports, an AI strategy can be defined as a set of synchronized government policies that have an objective of maximizing potential benefits and minimizing potential costs of AI for the economy and society. Each strategy outlines a number of initiatives the government plans to undertake, usually over a period of 3-10 years.

Currently AI is one of the top priorities of policy agendas for most countries at both national and international levels. Most AI strategies share common characteristics, such as a focus on talent development, while considering the needs, the economic, social, ethical, and political context and the development goals of each country.

A survey of over 30 national AI strategies around the world shows that some countries focus on AI applications or scientific research, while others also cover initiatives to promote open data, ethical standards, digital infrastructure and labor market redesign. However, all strategies aim to promote the use and development of AI.

AI is also one of the top priorities on the agendas of International and Regional organizations such as the Group of Seven (G7), Group of Twenty (G20), UNESCO, OECD, WIPO, the European Union, League of Arab States the African Union, etc. This international dialogue aims at building a common understanding of emerging AI technologies. The UN also has numerous ongoing initiatives related to AI with the objective of identifying principles and policy priorities for AI with the aim of accelerating progress towards the UN Sustainable Development Goals (SDGs).

Therefore, in order to find an optimal strategic direction for the introduction of an AI Strategy, Egypt should focus on two levels:

- International Level: Different national AI strategies and international efforts around the world to learn from them with the aim of solving problems and producing actual solutions for the benefit of Egypt.
- National Level: Egypt's needs and development goals.

4 AI in Egypt

4.1 The Case for an AI Strategy

Since 2014, the Egyptian Government has adopted a structural economic and social reform program Egypt Sustainable Development Strategy that depends on diversity in its plans and expenditure efficiency, besides directing projects toward achieving Sustainable Development Goals, as well as structural adjustments that aim to rectify macroeconomic imbalances, and achieve high, sustainable and well-diversified growth.

This Sustainable Development Strategy represents a fundamental step in Egypt's extensive development road map that aims to maximize its competitive advantages. It also seeks to achieve prosperity in Egypt through sustainable development, social justice, and ensuring balanced growth. The government of Egypt recognizes the importance of AI to advance human knowledge and technical capabilities and to encourage the digital transformation in Egypt, both of which are crucial for the country's development.

The vast opportunities that AI offers to the entire economy and its impact on accelerating the socioeconomic development is one of the driving forces to embark on an AI strategy and consider it as a top priority on the national ICT agenda. There should mainly be a focus on boosting Egypt's skills and competitiveness in these fields, in order to reap the multiple benefits of these emerging technologies. This will be achieved through different programs of building human capacity through increasing the efficiency of education and training in various educational stages including vocational and professional training. This is in addition to consolidating continuing education to meet the rapid development of the nature of jobs required in an AI-driven economy. Also, steps will be taken to support the nascent Egyptian AI industry, and get it on the road to international competitiveness.

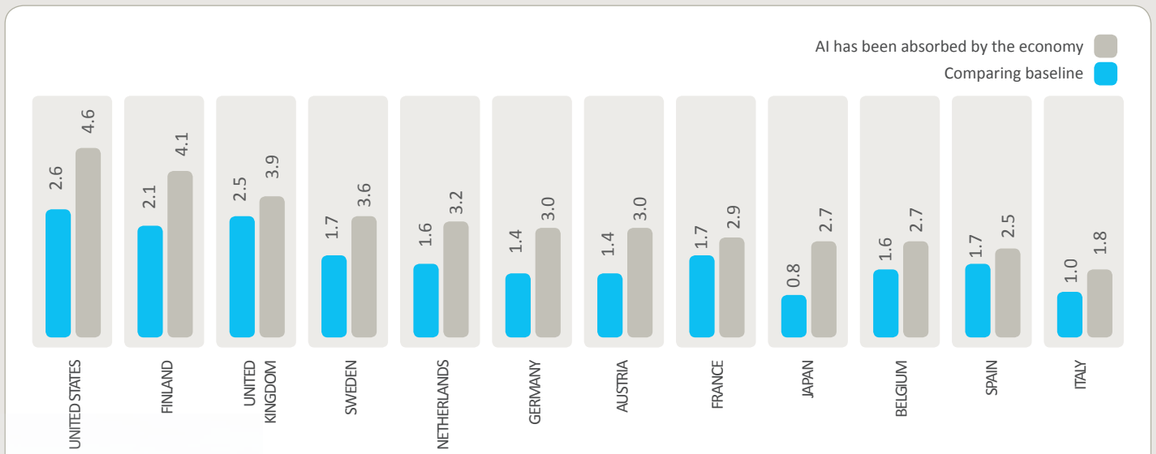


Figure1: Predicted annual growth rates in 2035 of Gross Value added (a good predictor of GDP) comparing baseline to a scenario where AI has been absorbed by the economy (Source: Accenture)

AI is expected to be the driving force of economic growth in decades to come and in all regions of the world. Egypt is on the map, but not in a prominent enough place yet.

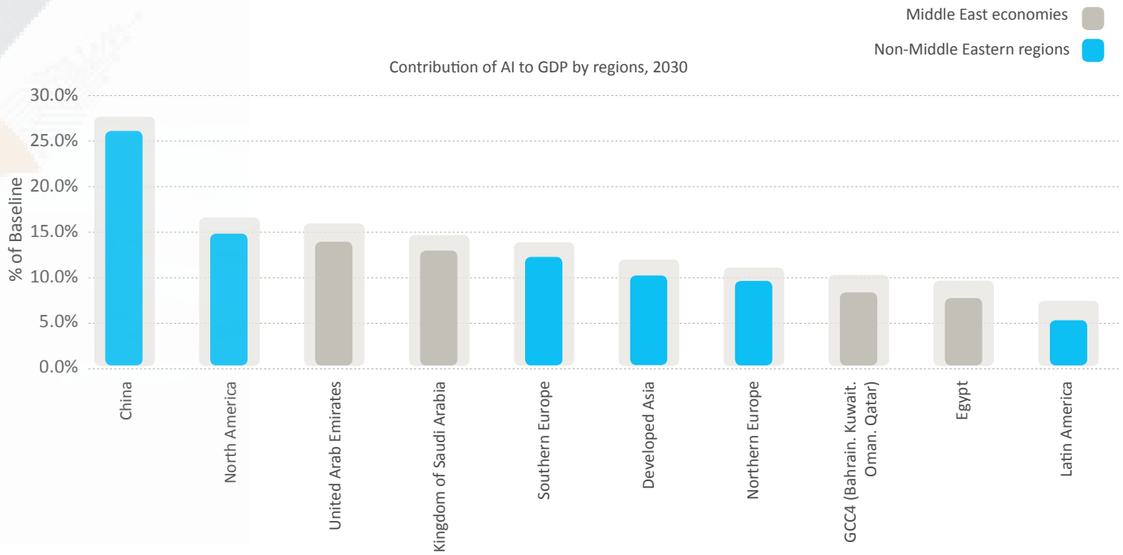


Figure2: Comparison of AI contribution to GDP between the Middle East and other regions by 2030. (Source: PwC)

Figure.2 shows that countries of the Middle East fare positively compared to other nations with the integration of AI. Egypt is currently in 7th place regionally, lagging after all the Gulf countries (excluding Iraq). According to PwC estimates, AI is forecasted to contribute around 7.5% to Egypt's GDP by 2030. While higher than many countries and regions, e.g. Latin America and Africa, this is still conservative compared to Egypt's capabilities and the opportunities AI can afford. One of the main objectives of a national AI strategy for Egypt should therefore be to explore ways in which this GDP contribution can be increased.

Some of the capabilities Egypt should exploit in order to bridge that gap include:

- A growing interest in AI education and research, with 7 new AI faculties opening or re-branding between 2019-2020, and at least 10 more on the way, injecting over 3,000 new graduates into the market each year.
- The Science and Technology Development Fund (STDF) has started issuing AI-specific calls with substantial amounts of grant money, leading to a stimulation in academic AI research across the country. A substantially sized diaspora of scientists and professionals in major universities and companies all over the world, many of whom are willing to contribute to Egypt's efforts in AI.
- The Egyptian startup scene has been booming since 2011, with substantial investment being attracted into the country and startups offering a viable employment option for recent graduates and experienced professionals. Many of these startups have grown into successful companies regionally and internationally, and most of them look at AI as a potential tool to optimize and grow their businesses, or even build a new business model around, with the services sector being such a strong value driver for Egyptian startups.
- Some of the major international ICT companies operating in Egypt have started introducing AI and data science teams in the country, which employ Egyptian scientists and engineers to develop advanced products.

From a sector-specific perspective, AI is expected to drive substantial growth and value across most sectors, as shown in the figure below. Many of the sectors mentioned, such as Tourism, Agriculture, Healthcare, and Public Sector, form a substantial part of the Egyptian economy, which stands to benefit hugely from AI adoption in these sectors.

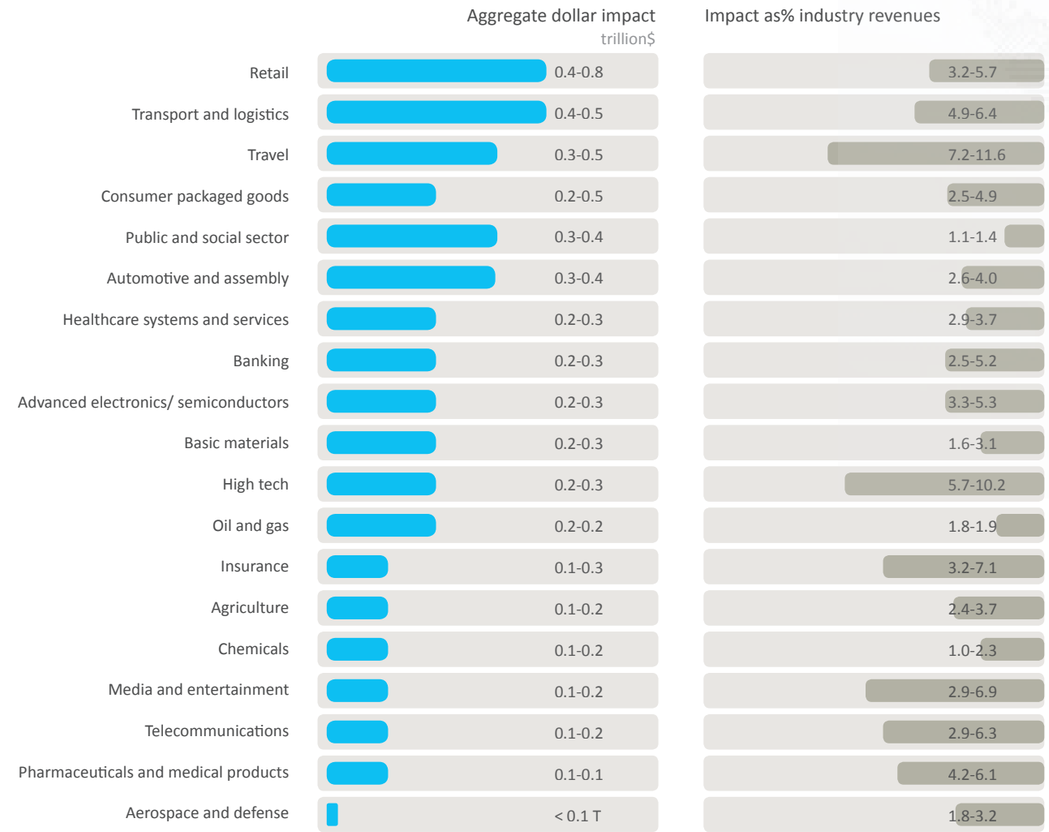


Figure 3: Potential value of AI across different sectors (Source: McKinsey & Co.)

Therefore, the Egyptian reform program also seeks to launch a series of large-scale developmental projects in different sectors, where AI will be one of the major supporting tools to accomplish them.

On the other hand, there are some common challenges any AI strategy could face when it comes to execution. These challenges include:

- Brain Drain of AI talent: Trained workforce leaving the country to work in other economies post training.
- Slow adoption of AI and resistance from the private sector, which contributes to around 60% of national GDP, further to having an employment share of ~74% according to the latest figures from the European Bank for Reconstruction and Development (EBRD).
- The large capital investments required for many AI projects and the slow, uncertain ROI associated with them serve as a deterrent for many investors.
- Relative monopolization of AI research by so-called "AI superpowers" which includes few countries, as well as large technology companies makes it difficult for a country like Egypt to put its stamp on the map of international AI research.

To overcome these challenges and others, it is important to set clear KPIs for AI adoption and impact.

When it comes to **adoption**, the challenges are numerous. The figure below highlights the major challenges faced by organizations around the world.

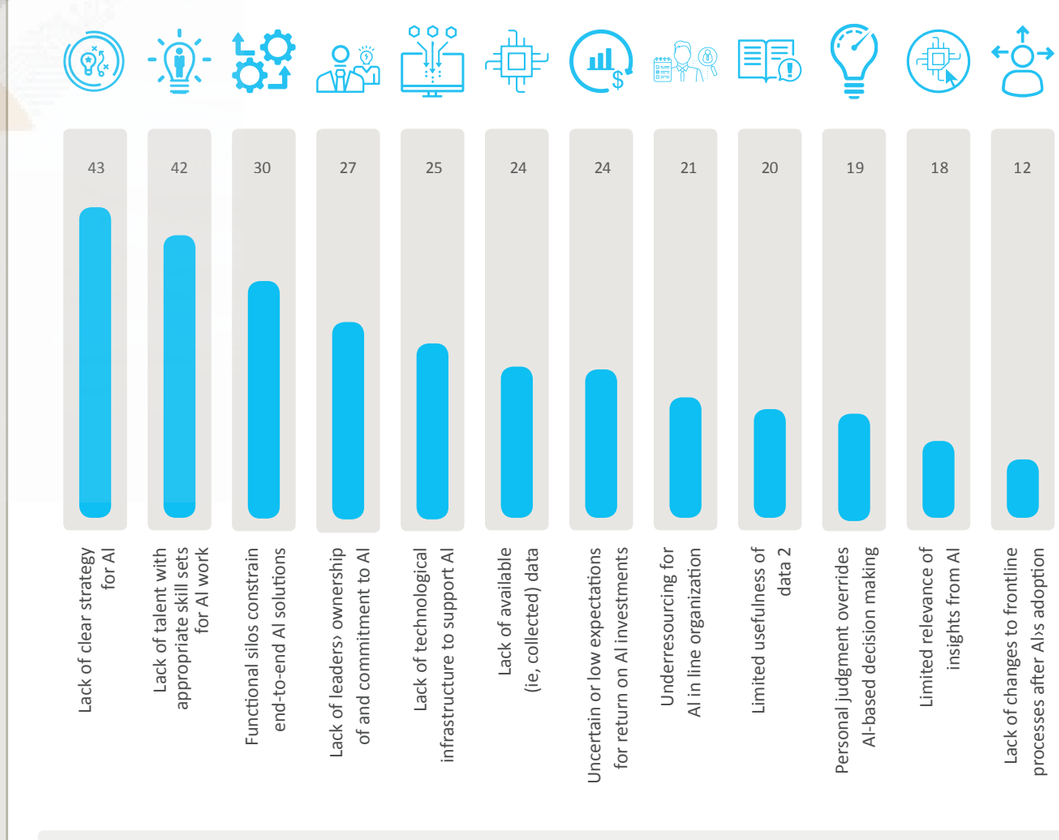


Figure 4: Most significant barriers organizations face in adopting AI (Source: McKinsey& Co.)

The lack of a clear **impact** AI model can negatively affect motivation for AI adoption, and hence, disengage businesses and organizations from adopting such technologies. The following are the main key areas to measure impact for any AI adoption:

- Cash, by which AI and ML algorithms can help decision makers to effectively use, and allocate cash, to maximize turnover, optimizing inventory and spending.
- Time, by which AI algorithms can reduce order processing, hiring, satisfying customer requests in a fraction of the time it could have been processed without AI, to expediting Go to Market (GTM) times.
- People & Labor, by which a business can hire effectively and efficiently, and utilize resources to maximize productivity. Furthermore, matching the right labor with the right company, or role in fast and easy manner
- Growth, in which businesses can better acquire, retain and serve their customer through intelligent recommendation engines, ad-optimization, etc.
- Assets, AI can help business owners, to better utilize their facilities, machinery or intelligently allocate their inventory through smart algorithms.
- Profits, at the end of the day, AI algorithms should significantly contribute to a business profitability and effectiveness.

4.2 SWOT Analysis

To accurately determine the elements of an Egyptian AI strategy, it is important to conduct a status quo assessment of the state of AI in Egypt and the country's readiness to embark on a journey of AI adoption.

4.2.1 Strengths

Human Resources

- Egyptian scientists and engineers with expertise in AI are employed by universities, research centers, and industrial companies alike. Hundreds of AI researchers are employed by the National Research Center, the Academy of Scientific Research and Technology (ASRT) and its affiliates, Agriculture Research Center, etc.
- Many Egyptian students are choosing ICT-related subjects to study at the university level.
- As the governmental Faculties of Computers and Information are the areas associated with AI, the following (Table 1 and Figs. 5-13) show the statistics of the students, graduates, and academic staff in those faculties (2018/2019). These figures demonstrate the increasing interest of Egyptian youth to study ICT related subjects at the university level.

	Academic Staff and Teaching Assistants	Graduate Students	Undergraduate Students
Faculty of Computers and Information	1232	3357	24093
Computer Engineering, and Electronic and Communication departments	897	515	12187
Computer science departments, the Faculties of Science	350	454	2739
Private Universities	270	250	10800
Total	**2749**	**4576**	**49819**

Table 1: The statistics of academic staff and students in Egyptian universities in 2018/2019

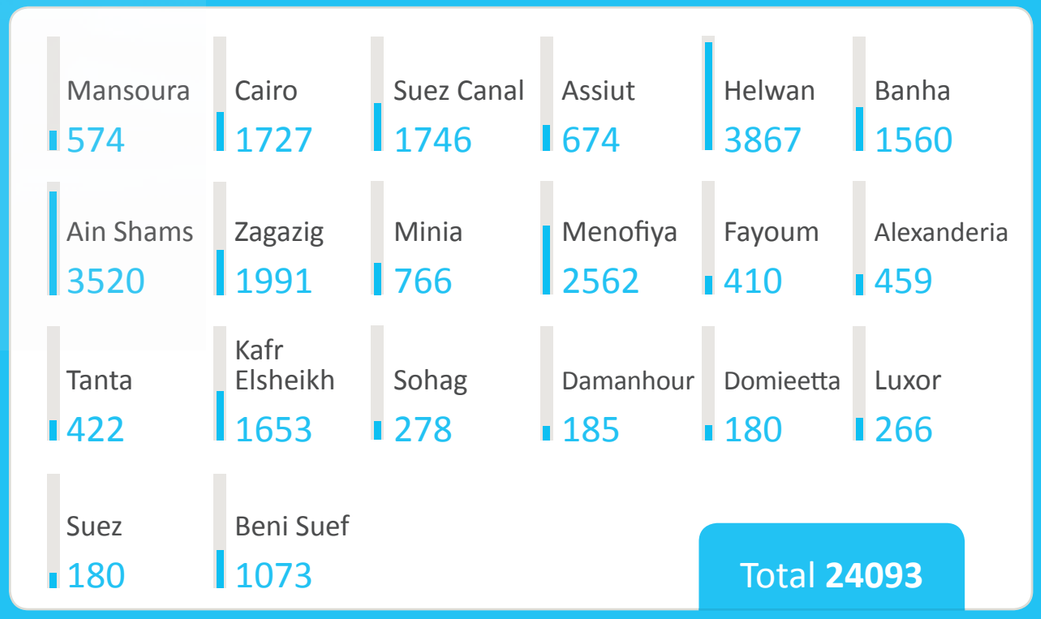


Figure 5: The undergraduate students in Faculties of Computers and Information versus the Egyptian universities enrolled in 2018/2019

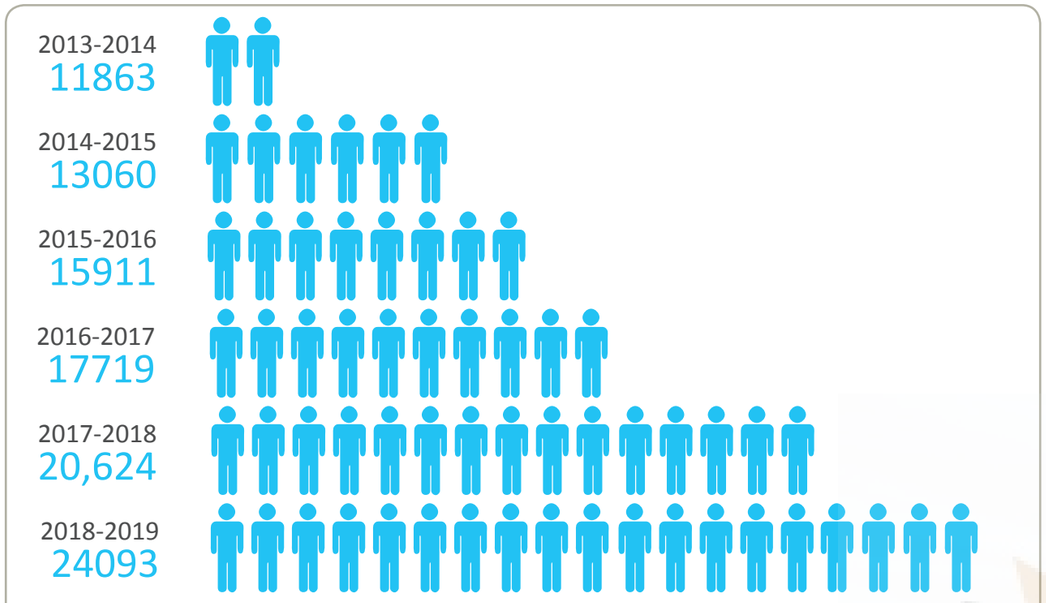


Figure 6: The total numbers of undergraduate students in Faculties of Computers and Information during the past six years (2013-2019)

	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Computer Science	1043	1256	2250	1850	1955	3070
Information Systems	1329	1033	2041	2541	2369	2302
Computer Systems	46	14	31	48	0	186
Information Technology	679	681	1180	1384	1503	1170
Operation Research &DSS	72	54	110	124	86	347
Scientific Computing	64	57	90	244	0	380
Software Engineering	127	187	132	432	607	1553
Bio-informatics	71	74	136	200	244	935
Bio-Medical						372
Basic Sciences						564
Multimedia						42
Cyber Security						62
Artificial Intelligence						65
Network Technology						49

Figure 7: The statistics of undergraduate students in Faculties of Computers and Information according to their specializations during the past six years (2013-2019)

Mansoura 590	Cairo 518	Suez Canal 164	Asuit 279	Helwn 383
Benha 127	AinShams 506	Zagazig 302	Minia 104	Menofiya 280
Fayoum 104	Alexanderia 0	Tanta 0	Kafr Elsheikh 0	Sohag 0
Damanhour 0	Domietta 0	Luxor 0	Beni Suef 0	Total 3357

Figure 8: The graduates of Faculties of Computers and Information versus the Egyptian universities graduated in 2018/2019

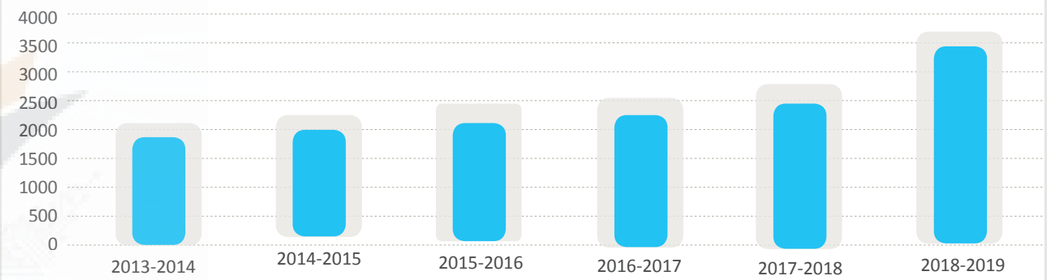


Figure 9: The total numbers of graduates of Faculties of Computers and Information during the past six years (2013-2019)

	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Computer Science	773	723	763	745	855	1016
Information Systems	673	700	729	790	843	1412
Computer Systems	44	60	411	41	42	41
Information Technology	363	367	88	340	470	664
Operation Research &DSS	36	40	23	82	20	82
Scientific Computing	54	60	81	122	50	142
Software Engineering	23	50	25	69	32	40

Figure 10: The statistics of graduates of Faculties of Computers and Information according to their specializations during the past six years (2013-2019)

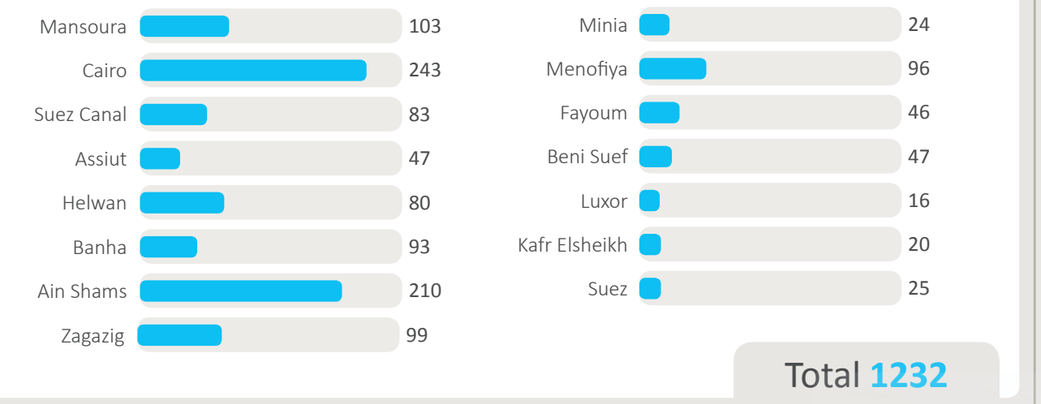


Figure 11: The numbers of academic staff in Faculty of Computers and Information versus the Egyptian universities in 2018-2019

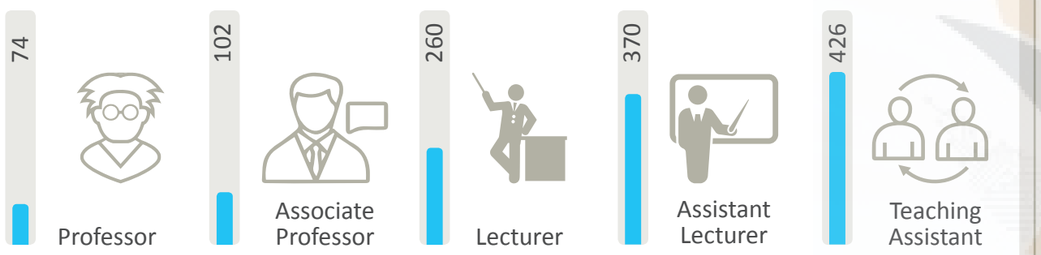


Figure 12: The statistics of academic staff in Faculty of Computers and Information according to scientific degrees in 2018-2019

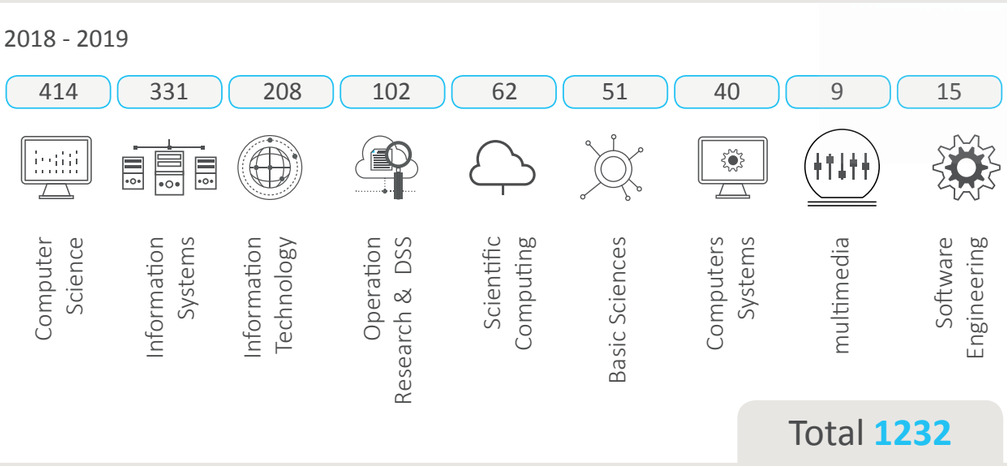


Figure 13: The statistics of academic staff in Faculty of Computers and Information according to their departments in 2018-2019

ICT Sector

- The Information and Communications Technology sector in Egypt is one of the drivers of innovation. The annual growth rate of the number of companies operating in ICT communications is 13.5%.
- The Ministry of Communications and Information Technology (MCIT) supports research and projects in AI applications. It also encourages many graduates to apply for government grants to benefit from online courses in AI.
- MCIT's Technology Innovation and Entrepreneurship Center (TIEC) provides full-fledged support for innovation and incubates start-ups in advanced technologies, including AI.
- An increasing number of multinational companies operate AI R&D centers in Egypt.
- About 60 companies are actively working on AI applications in Egypt.
- Since 2019, some of the digital transformation initiatives in Egypt are supported by AI that provide timely critical insights for new operating and monetization models.
- The government's focus on building technology parks across the entire country will encourage multinational companies to establish local operations using best-in-class technologies and facilities.
- The Egyptian government is committed to improving telecommunications efficiency and accessibility, whether in infrastructure or services for the citizens.

Data Resources

- A comprehensive database for citizen data has been gathered by the Egyptian government, including health and social data.
- Arabic language data repositories have been created by several organizations.
- A number of national data banks have been created, including the National Gene Bank Database, the Database for the Numbering of Cattle across Directorates.

Research and Development

- STDF supports research projects in different areas of AI technologies and applications.
- Many Expert Systems have been developed in different domains.
- AI research activities in Natural Language Processing, Machine Translation, Speech Technologies, Image Understanding, Computer Vision, Social Media Analysis, and Autonomous Driving cars are being conducted at several universities and research organizations.

4.2.2 Weaknesses

Insufficient AI Research and Education:

- Insufficient number of experts and skilled engineers capable of developing, implementing, maintaining, and operating AI systems.
- AI education is not provided in pre-university education.

Research Planning, Management, Social Needs, and Innovation:

- No specialized national body is responsible for integrating and/or coordinating demand driven AI research efforts.
- Lack of a comprehensive mechanism connecting knowledge with innovation.
- The current legislative system does not cover the emerging challenges that AI presents, e.g. ethical issues, liability, data bias.

Data Availability and Quality:

- Non-availability of data collected by institutions for research purposes.
- The poor integration of databases raises many problems, such as redundancy, inconsistency and inaccuracy of the data needed to mine and extract useful knowledge.

Universities and Research Institutions Physical Infrastructure:

- Internet bandwidth is not wide enough for big data, especially when required to be processed remotely.
- Universities and national research institutions do not have enough computing power to run AI applications.
- Inadequate awareness of the importance of intellectual property and its protection.

4.2.3 Opportunities

- AI and Machine Learning could solve many governmental problems, such as inferring knowledge from data, detecting and averting security threats, fake news detection, etc.
- There are many problems related to lack of technical expertise that knowledge-based systems could solve in many domains, such as healthcare, transportation, agriculture, etc.
- There are social and business needs for better tools related to Arabic Natural Language Processing such as Machine Translation, Text Summarization, and Semantic Information Retrieval.

4.2.4 Threats

- Decreased availability of data due to limiting changes in open data policies.
- Inability to retain capable domestic researchers, who are attracted by employers in other countries.
- Negative impact of AI applications on the Egyptian workforce.

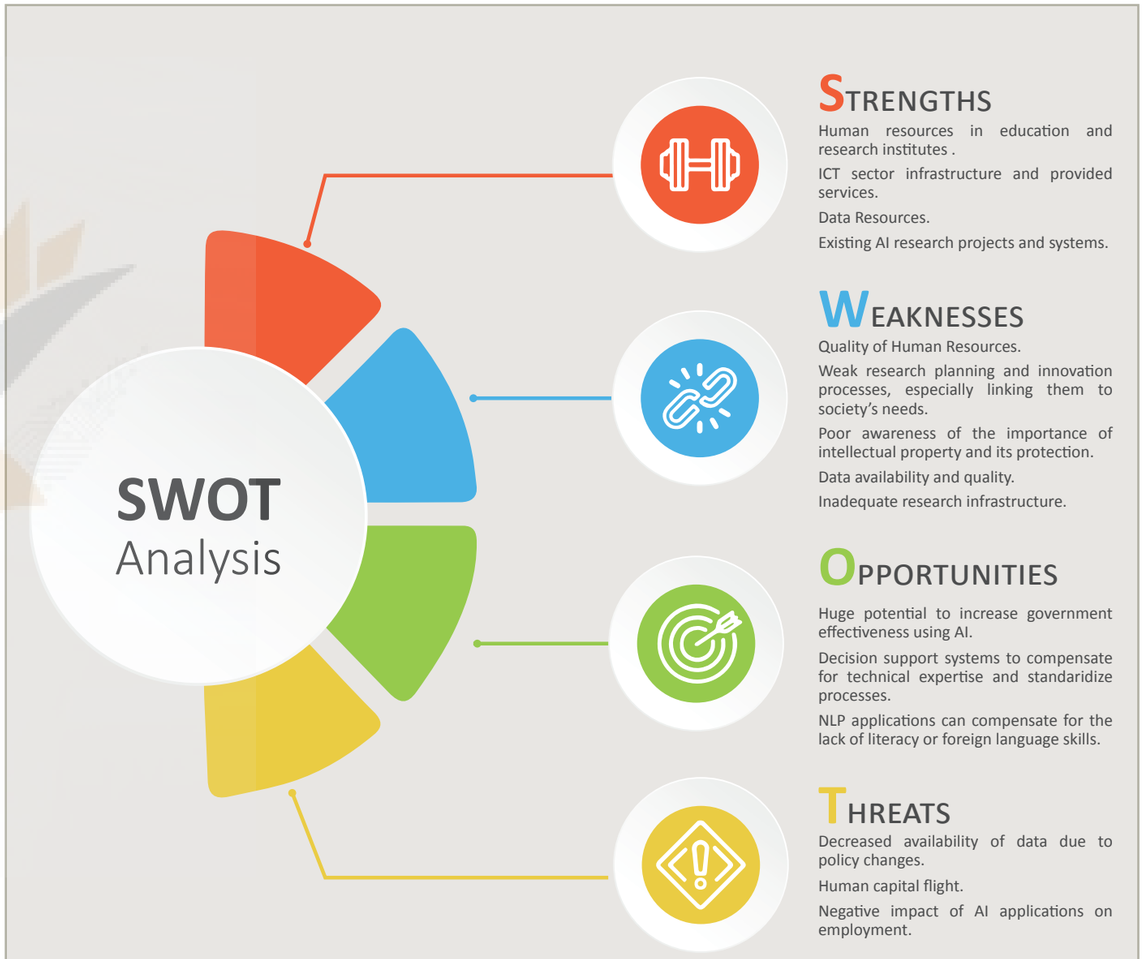


Figure 14: A summary of Egypt's AI readiness SWOT analysis

5 Strategy Overview

This section translates the above findings into a strategic framework that capitalizes on the strengths and opportunities and attempts to address weaknesses and minimize threats. It is important to note that Egypt is currently undergoing a massive digital transformation of the government sector, which inevitably has to move in parallel with the execution of the AI strategy. In addition, being a country of relatively limited resources, it is important to prioritize areas where the most gain can be achieved in the short term in order to prove the value of AI in different domains, and maximize the return for the Egyptian taxpayer. Therefore, the starting point has to be defining a clear vision and mission statement to identify exactly what Egypt hopes to achieve by adopting AI, where trade-offs will be made, and how this can translated into an implementation plan, as outlined in the following sections.

5.1 Vision and Mission

The National AI Strategy is a key priority for helping Egypt achieve relevant UN Sustainable Development Goals as they pertain to Egypt (in numerical order 4, 5, 8, 9, 10, 11). The relevant SDGs address inclusive and equitable education (4), gender equality (5), inclusive and sustainable growth and decent work opportunities (8), fostering innovation via inclusive and sustainable infrastructure (9), reducing inequalities within and between countries (10), as well as working toward sustainable and resilient cities and settlements (11). It spells out the country's plans to deepen the use of AI technologies to transform the economy, going beyond just adopting technology, to fundamentally rethinking business models and making deep changes to reap productivity gains and create new areas of growth. The 1st phase of the strategy is to be implemented in the next 3 years.

VISION

Egypt's **AI Strategy Vision** is:

1. Exploit AI technologies to support the achievement of Egypt's sustainable development goals, to the benefit of all Egyptians.
2. Play a key role in facilitating regional cooperation within the African and Arab regions and establish Egypt as an active international player in AI.

MISSION

Therefore, the Mission Statement **of Egypt's AI strategy is to:**

"Create an AI Industry in Egypt, including the development of skills, technology, ecosystem, infrastructure and governance mechanisms to ensure its sustainability and competitiveness for purposes of promoting Egypt's development."

To achieve the vision and mission above, Egypt will work on the following dimensions:

- Embed AI technologies in government operations to make them more efficient and transparent.
- Utilize AI in key developmental sectors to make an economic impact and to solve local and regional problems in support of Egypt's sustainable development strategy and in line with the UN's SDGs for the benefit of all Egyptians.
- Encourage investment in AI research and innovation through public-private partnerships and initiatives with universities, research centers, and the private sector.
- Become a regional hub for AI education and talent serving local, regional and international market needs.
- Support lifelong learning and reskilling programs to contribute to workforce development and sustained employability
- Create a thriving AI ecosystem by supporting local entrepreneurship and innovation efforts, and fostering an academic scientific environment full of ideas, inventions, and discoveries.
- Promote a human-centric AI approach where people's wellbeing is a priority and facilitate multi stakeholder dialogue on the deployment of responsible AI for the benefit of society and to inform related policy discussions.
- Capitalize on AI as an opportunity for inclusion of the marginalized, not only for safety net programs, but also in initiatives that promote human advancement and self-development.
- Facilitate cooperation on the Arab and African levels, working to unite Arab and African voices and efforts in AI for the benefit of all.
- Actively contribute to global efforts and playing an active role in AI different international fora, especially around topics of AI Ethics, future of work, responsible AI and the social and economic impact of AI.

5.2 Pillars and Enablers

To achieve the objectives above, the strategy has been divided into 4 pillars and 4 enablers, as outlined below.

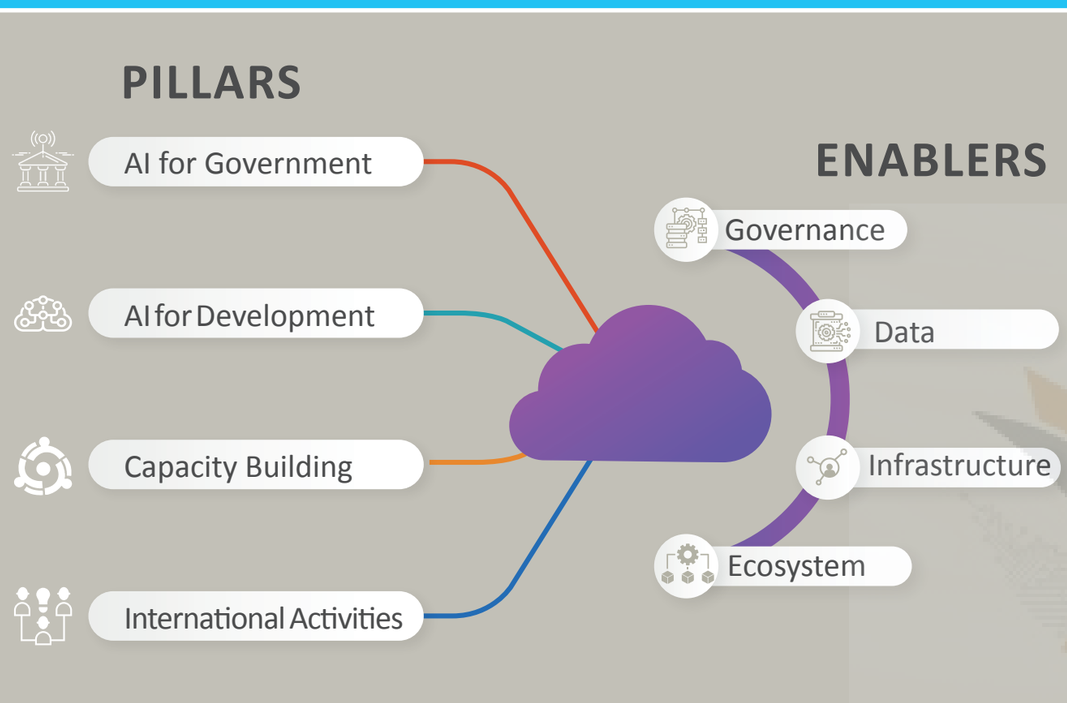


Figure 15: Pillars and enablers of Egypt's AI Strategy

The following sections will provide an in-depth view into each of these pillars and enablers, the high-level goals for each, as well as some of the initiatives to be undertaken.

6 AI for Government (AI4G)

AI has the power to transform the way that governments around the world deliver public services. In turn, this could greatly improve citizens' experience with government services. Governments are already implementing AI in their operations and service delivery to improve efficiency, save time and money, and deliver better quality public services.

As part of its ongoing "Digital Egypt" strategy, already underway since 2017, the digital and data infrastructure already built and still being further developed, will be utilized to create new AI applications and add layers of AI functionality on top of existing ones. This is to serve two main goals:

- Increase the efficiency, quality, and speed of government-to-citizen services
- Improve the performance of the entire government by utilizing AI to improve the quality, efficiency, and transparency of decision-making processes

However, there are many challenges that hinder the ability to reach such goals, both in Egypt and in other countries around the world, among them are the following:

- The unavailability of a coherent mapping scheme for different governmental sectors where AI applications should be applied.
- The long and time-consuming procedures for collecting data from government officials, which hinders the ability to reach decisions in a timely manner.

Figure 16: General and public sector challenges of implementing AI solutions (Source: Capgemini consulting)

In order to successfully realize the potential of AI in the public sector in general, an implementation strategy following the steps of Discover, Develop, Implement, Innovate and Transform (DDIIT) is recommended.

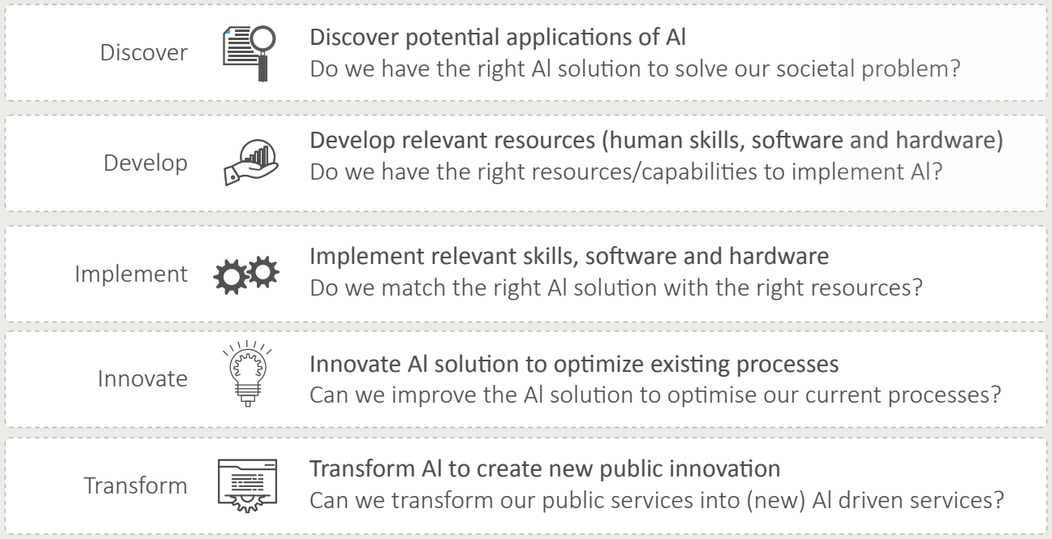


Figure 17: A potential AI in public sector implementation model (Source: Capgemini consulting)

Public sector bodies need to discover and realize how AI applications can add value to their internal organizational processes and/or provide high quality services to citizens. During the development phase, public sector organizations seek to develop employee skills, software and hardware in order to implement the chosen AI solution. Countering inequality biases and employment challenges are vital during the development stage.

Employment concerns can be mitigated by investing the money saved by AI applications in public sector employees and retraining them. Investing in education improves the employability of public sector workers. Facilitating innovation hubs also would help to leverage AI solutions and offers employees new, creative job opportunities.

Key areas where AI can support government operations

- Make better decisions – AI can provide timely analytics and data-driven insights to make better decisions, for example in procurement and sourcing.
- Identify new opportunities – shifting through vast amounts of data, AI can uncover new saving or consolidation opportunities.
- Improve operations – AI has the potential to streamline or align internal business operations, even in large and complex organizations with many business units such as the Egyptian government
- Automate manual tasks – AI can automate many time-consuming tasks, such as monthly processes, or performance reporting.
- Free up time – by taking care of more routine tasks, AI can free up resources for more creative or strategic tasks like key supplier relationship management.
- Capture or apply scarce knowledge – AI can help capture relevant, up to date sources of data, for example, from public sources like the Internet.
- Identify new suppliers or markets – with access to vast amounts of external data, AI can help identify new suppliers.
- Optimize supplier relationships – AI has the potential to make supplier relationship management more data-informed.
- Prepare briefing reports to be reviewed and presented by key executive to decision makers.
- Automate correspondence generation and routing.
- Text mining, especially for complex documents such as financial and legal texts.
- Citizen policy participation and feedback, public sentiment gauging.
- Understanding and drafting documents: a system to help parliament member offices respond to citizen questions by drafting answers using AI.
- AI-enabled process improvement: using insights gained from AI and ML to propose and implement process improvements within government and detect anomalies.
- Smart succession planning and HR management.
- Crisis preparedness: scenarios of crisis detection and management.
- NLP services to detect and correct e.g. data entry errors.

7 AI for Development (AI4D)

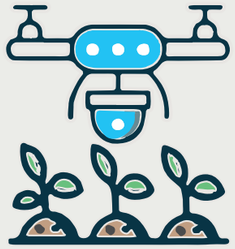
“Foster the use of AI in vital developmental sectors using partnerships with local beneficiaries and local or foreign tech partners to ensure knowledge transfer while addressing Egypt’s development needs. Identify and execute key projects in those sectors either directly or through the ecosystem, e.g. startups.”

With the rapid development and implementation of AI, all actors including governments, NGOs, companies and international organizations should encourage and prioritize the use of AI in areas of sustainable development such as healthcare, agriculture/food supply, environment, water management, education, infrastructure management, economic planning and growth, and others which are in line with the priority sectors that have been identified according to Egypt Sustainable Development Strategy and in line with the UN’s Sustainable Development Goals.

This pillar aims at using AI and other advanced technology in key priority sectors to solve the problems facing society, while, at the same time, building the capabilities of human cadres.

7.1 Agriculture, Water Management and Environment

One of the most important features of the recent Egyptian reform program is how it focuses on some areas that have not been reformed for decades such as the agricultural sector, which is one of the main economic sectors in Egypt. The agricultural sector in Egypt accounts for 15% of GDP. It employs over 8 million people or 32% of the total workforce.



Therefore, Egypt is currently launching a series of mega developmental projects in the agriculture and food supply sectors. Research on the use of AI in agriculture is among the main fields of development of the AI Strategy of Egypt.

The use of AI in agriculture helps farmers gain insights from analyzing data such as temperature, precipitation, wind speed, and solar radiation, and optimize them for maximum conditions for crops, soil, and consumers. It is worth noting here that Egypt’s emphasis will not be on automation per se, which in many cases means sacrificing jobs, but on enhancing the process and reducing problems such as child labour. Ways in which AI has been proven to help in agriculture include the following:

- AI provides more efficient ways to produce, harvest and sell essential crops.
- AI implementation emphasis on checking defective crops and improving the potential for healthy crop production.
- The growth in AI technology has strengthened agro-based businesses to run more efficiently.
- AI is being used in applications such as automated machine adjustments for weather forecasting and disease or pest identification.
- AI can improve crop management practices thus, helping many tech businesses invest in algorithms that are becoming useful in agriculture.
- AI solutions have the potential to solve the challenges farmers face such as climate variation, an infestation of pests and weeds that reduces yields.

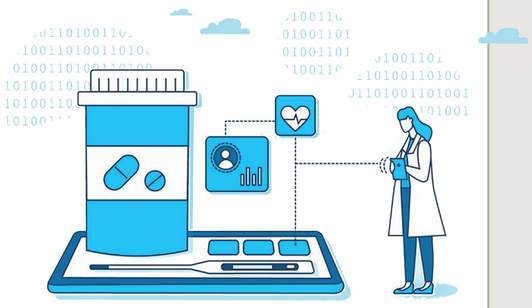
Impact of AI in Agriculture

AI technology is used in agriculture to improve results while reducing the environmental cost; for example by helping farmers optimize crop yields by identifying variables such as humidity, light and temperature.

- Forecasted Weather Data: AI is helping the farmer to stay updated with data related to weather forecasting. The forecasted/ predicted data help farmers maximize yields and profits without risking the crop. The analysis of the data generated helps the farmer to take essential precautions.
- Monitored Crop and Soil Health: AI can be used to monitor and identify possible defects and nutrient deficiencies in the soil. With computer vision, AI identifies possible defects through images captured by the camera mounted on vehicles, drones, or through satellite imaging. Deep learning algorithms are developed to analyze flora patterns in agriculture. Such AI-enabled applications are supportive in understanding soil defects, plant pests, and diseases.
- Decreased Pesticide Usage: Farmers can use AI to manage weeds by implementing computer vision, robotics, and machine learning. With the help of AI, the data gathered is analyzed to keep check on weeds, which helps the farmers to spray chemicals only where the weeds are. This reduces the usage of the chemical spraying, instead of traditional methods of spraying the entire field.
- AI Agriculture Bots: AI-enabled agriculture bots assist farmers in finding more efficient ways to protect their crops from weeds and enable optimize irrigation based on crop needs at any given time.

The implementation of such applications will be done through partnerships and co-development projects, specifically related to studying the effects of climate, flow of waterways, data-gathering procedures, agricultural monitoring, irrigation, spot spraying and identification of crops which will maximize the yearly harvest, in addition to capacity building and skills development to enable new generations of developers and users of these AI applications.

7.2 Healthcare



The potential for AI in healthcare is vast. AI is increasingly becoming a part of the healthcare eco-system. AI is already being used to detect diseases, such as cancer in their early stages. The use of AI is enabling review and translation of mammograms 30 times faster with 99% accuracy, reducing the need for unnecessary biopsies. Additionally, AI increases the ability for healthcare professionals to better understand the day-to-day patterns and needs of the people they care for, and with that understanding they are able to provide better feedback, guidance and support for staying healthy.

In Egypt, specialists as such as pathologists and radiologists are very few in number relative to the overall population (especially in the rural areas), therefore Egypt should focus on AI applications for early diagnosis and detection of diabetic retinopathy and cancers.

Additionally, the following areas could be of high value within healthcare for Egypt: chronic disease management, mental health support, combating social issues such as domestic violence and addiction, pediatric triage, drug-drug interaction, and establishing an Egyptian biobank.

7.3 Economic Planning and Growth

AI and data science can be very beneficial in dealing with economic planning. Advanced algorithms can be used to forecast economic numbers. This can provide useful tools for the government and the central bank to alleviate economic downturns, by providing economic stimulus or adjusting the interest rates, based on the economic forecasts.

Macro-level and micro-level activity can be recorded, and analyzed using data science, in order to discover trends and alleviate potential problems. Demographics can be forecasted, as a tool to gauge population increase.

The economic impact of AI is likely to be more severe on the developing countries than other parts of the world. Developing countries are determined to be very selective about the AI technologies they deploy, focusing on the applications that contribute to the growth of the country while empowering its workforce.

Multinational companies and other foreign entities operating in Egypt are encouraged to explore ways to mitigate any potential economic impact resulting from introducing AI into their operations.

Companies are encouraged to think outside the box and work hand in hand with local governments, communities, NGOs and other bodies to explore programs of safety nets, and transition mechanisms when deploying AI systems.

On the other hand, the positive economic impact for Egypt can be significant. More research is needed to determine ways of maximizing this impact, for example by determining the most appropriate job categories of the future and associated skills, as well as ways to maximize job creation through AI.

More partnerships and cooperation are needed with entities that have expertise in using AI in large-scale data analysis to determine the right mix of economic activities, infrastructure planning, education, transportation needs and other services the region needs to optimize the use of its natural and human resources.

Crucial to this pillar is reliance on accurate, inclusive and disaggregated data that accounts for every member of society and captures the nuances of realities on the ground. In that respect, there needs to be out of the box tools of data collection methodologies that accounts for every member of society including informal workers and the marginalized. The adoption of well-designed data classification and insight monetization strategy can help enable startups in data driven innovation initiatives that offer win-win scenarios for development planning as well a thriving business community.

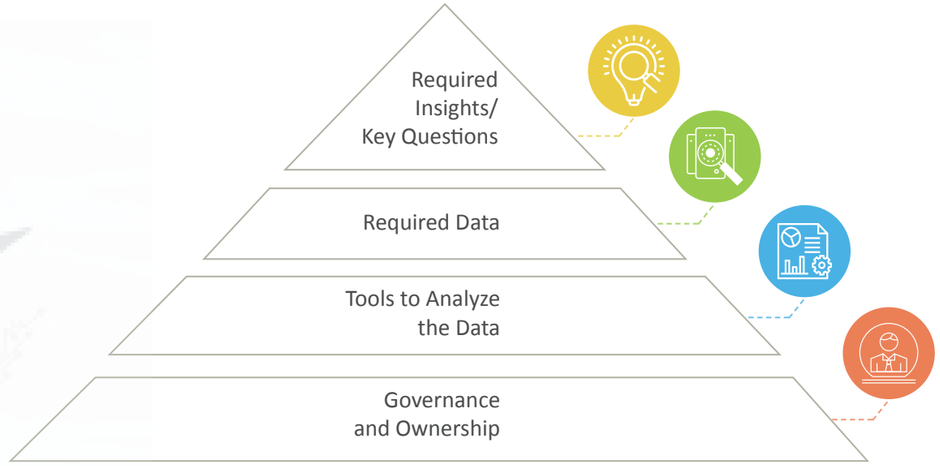
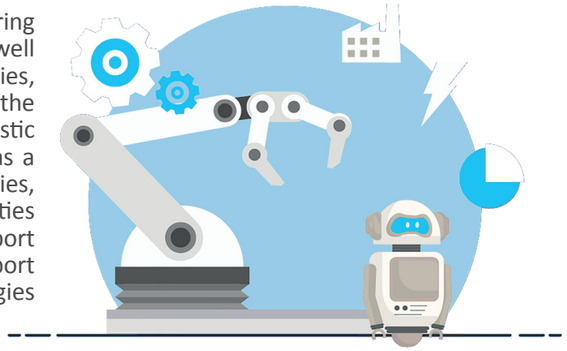


Figure 18: Economic planning framework

7.4 Manufacturing and Smart Infrastructure Management



While the most prominent applications of AI in manufacturing center around robotics and full-factory automation as well as predictive maintenance of equipment and factories, Egypt's focus should be more on areas that help increase the competitiveness of Egyptian products for both the domestic and foreign markets, without reducing human labour as a goal. Examples include promoting small local industries, shortening the innovation cycle, establishing testing facilities for advanced industrial production or advanced transport systems and creating an application development support system for industry needs, especially with regard to synergies and outputs from the public, private or PPP sectors.

On the infrastructure side, potential use cases include predictive maintenance of public assets, using predictive analytics in public safety, crime prevention, and traffic management.

7.4.1 The Fourth Industrial Revolution

Given the close ties between AI and its applications in manufacturing, and the other technologies of the so-called "Fourth Industrial Revolution", this section serves as a sidebar to introduce the concept and give an overview of its implications for Egypt. A more thorough study will be conducted elsewhere.

The name "Fourth Industrial Revolution" was launched at the World Economic Forum in Davos, Switzerland, in 2016. It is characterized by a set of features as it combines the physical world, the digital world and the biological world, which affects all economic sectors, and compared to previous industrial revolutions, the fourth industrial revolution is developing at a tremendous speed, leading to the transformation of entire production systems, management, and governance.

The First Industrial Revolution used water and steam power to mechanize production. The Second used electric power to create mass production. The Third used electronics and information technology to automate production. Now a Fourth Industrial Revolution is building on the Third, the digital revolution that has been occurring since the middle of the last century (The world Economic Forum): Internet, enormous processing capacity, the ability to store information, and the unlimited potential for access to knowledge.

The 4th industrial revolution refers to the new industrial wave that is mainly based on the industry in terms of its use of technology, especially modern technology in new areas, such as robots, artificial intelligence, 3D printing, the Internet of Things (IoT), etc., and the use of this technology in everyday life (Harvard Business Terminology Guide Review).

Today, and with the advent of the 4th industrial revolution, a discussion of the impact of new technologies such as AI and the overwhelming role that data plays in this context is crucial.

AI and the 4th industrial revolution will have a great role in shaping the future of humanity. Most studies have confirmed that the 4th industrial revolution will impose a new reality, full of opportunities and challenges, as the concept of the "4th industrial revolution" revolves around the automation of the industry and the reduction of manpower in it, as the role of the individual in it is limited to supervising only the industry, which necessitates the use of Scientific capabilities to possess an advanced technical and digital infrastructure.

Therefore, the main concern of the fourth industrial revolution is the possibility of losing jobs in favor of robots and AI, so many studies were done and there was a marked discrepancy in statistics between one study and another about the percentage of jobs that could disappear.

One of those studies is a study conducted by OECD in 2015, which included 34 countries, most of them from the developed countries, the results were that 14% of the jobs are exposed to great risk, 32% are exposed to less risk, and the study concluded that 210 million jobs in 32 countries are at risk.

A comparison of lost jobs between developed and developing countries indicates that jobs in developing countries are at greater risk than those in developed countries because the production level and management is different between developing and developed countries.

With the advent of the 4th industrial revolution, and concerns over its impact on work, it is of utter importance that Egypt works to develop a vision of future work markets- global and local, and a strategy for the impact of the 4th industrial revolution on Egypt's economic and jobs.

In light of this, human skills development becomes a key priority issue and crucial in mitigating the effects of these technological shocks. This need to re-skill workers to adapt to the Fourth Industrial Revolution is also in line with the fourth sustainable development goal which stresses on the need to increase the number of youth and adults that have relevant skills and acquire the knowledge and skills needed to promote sustainable development, employment, decent jobs and entrepreneurship.

Then, developing countries including Egypt should:

- Have innovation policies compatible with the Fourth Industrial Revolution, it is important that these innovation policies be coupled by socioeconomic policies (including safety nets) to mitigate the potential negative effects of the Fourth Industrial Revolution on jobs.
- Encourage innovation and scientific research in the field of AI and other components of the Fourth Industrial Revolution.
- Create AI Capacity building and training programs.
- Organize awareness campaign to educate the business sector on the importance of AI applications as one of the main components of the Fourth Industrial Revolution.

7.5 Arabic Natural Language Processing

While digitization is a first step towards improved information access, great value can be extracted from enriching this data and linking it to other data and information sources. Natural Language Processing (NLP) can play a vital role in this, allowing not only a more user-friendly way of interacting with such systems in natural language (text or speech), but also a powerful tool for extracting contextual information and presenting it directly to the user, or as input to other systems.

NLP is the field that targets the analysis and processing of large amounts of natural language (or the language used by humans).

NLP can automate analysis of Arabic text on the internet, search for certain content, apply opinion mining, perform text summarization, and other tasks.

Arabic is spoken by more than 400 million speakers. It is recognized as the 4th most used language of the Internet and it uses its own set of characters.

Recently, Arabic and its dialects have begun to gain ground in the area of research within Natural Language Processing. NLP is used to create Arabic chatbots that use machine learning to understand the structure of the language as well as to understand the "meaning" of the words.

In addition to that, NLP is used for text recognition. Optical Character Recognition (OCR) is the main technology for automatic text recognition, which helps to translate printed or handwritten documents into a machine-readable format, and extract valuable information from it through Named Entity Recognition (NER) and classification technologies.

While some efforts have been put into developing NLP systems for the Arabic language, there is still a massive untapped opportunity in both text and speech, including various dialects, nuances, and domain specific applications. Therefore, it is important for Egypt to work towards establishing a full NLP stack for use by government and other entities, which also circumvents the need for using cloud services that can compromise data locality.

7.6 Finance and Banking

With more than 70% of the population still to have formal financial accounts, 22.4% of SMEs have access to financing and with the rise in mobile wallets and payments, AI provides an unprecedented opportunity to expedite financial inclusion for both businesses and individuals.

AI Credit Scoring can create score cards to the informal financing sectors, creating access to financing, and thus empowering un-bankable individuals and small businesses to contribute greatly to the Egyptian economy.

Creating a formal credit bureau for the informal sector, that utilizes the power of AI to score people and businesses with no credit history, to access financing, and then providing creditors access to such services, could have great impact on micro financiers, lenders and farmers as well who could opt for seed financing.

Certainly, it is just scoring that hinders lenders from giving loans. There is a lot of bureaucracy involved that disengages askers, and there is a long Know Your Customer (KYC) processes that could be cut short using AI based KYC as well.

To enable such a technology, a well-regulated consortium of data sharing needs to be built, from telecom providers, banks, consumer lenders, to create a nationwide alternative scoring bureau, that enables such an ambitious project.

8 Human Capacity Building (AI4H)

Human capacity building is arguably the most important pillar of Egypt's AI strategy, and possibly also the most difficult to fully implement. Due to the wide range of AI actors and the roles they play across an AI system's lifecycle, it is prudent to develop a full framework for capacity building that will take into account not just the more traditional roles of a data scientist, a Machine Learning developer, researcher and others, but also adjacent roles needed on AI development teams, as well as within society at large. The following chart shows a rough distribution of technical and non-technical roles typically associated with AI. The width of the rung indicates the relative number of people who fall into each category. This framework will then be used to derive and develop appropriate programs and courses at the various levels.

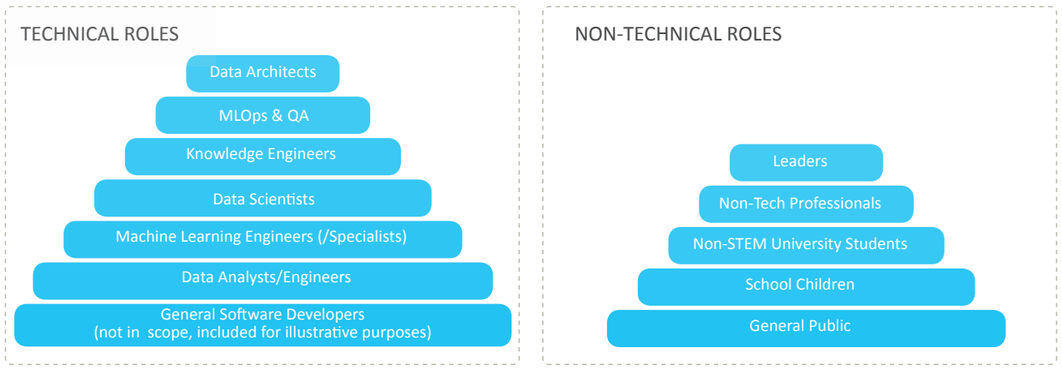


Figure 19: Relative distribution of technical and non-technical AI-related roles

The types of audiences can be roughly classified into those that require: general awareness, formal education, or professional training. The following sections will shed light on the requirements for each type of programs, with a special section dedicated to boosting AI research in Egypt.

8.1 General Awareness

Raising public awareness of AI, its uses, benefits, risks and limitations, has been recognized as a gap not just in Egypt, but in most parts of the world. The confusion about using the term “intelligence” associated with what are essentially Machine Learning applications, fueled by science fiction books and films, have created a lot of public uncertainty and in some cases fear of AI. However, if the Egypt (and the world at large) stands to benefit from the gains AI promises, we need to start by educating our general public and create a base of educated, knowledgeable users of AI systems. Over time, it is this wider base that will ultimately also produce the technical professionals and highly skilled specialists the country needs to implement and boost its ambitious AI plans.

General awareness must start at the very basic levels of society, and programs and content must be accessible to even those with limited or no formal education. Different levels of courses and training programs must then be designed to help recipients “climb up” the rungs of the capacity building pyramid shown above.

General awareness programs will be easily consumable, mostly in the form of short videos or interactive games to help the audience grasp the basic concepts of AI and separate myth from fact.

8.2 Formal Education and Training

8.2.1 Schools

AI is a rapidly evolving field, and starting to teach it at the university level puts students under significant pressure to absorb a huge amount of knowledge at once. It is therefore essential to start exposing students to the basics of AI during their school education. This will also broaden the “base” from which future AI experts at all levels can emerge.

In the Egyptian education system, preparatory years and the first year of secondary school are the best times to teach students about AI. The second and third years of the secondary stage are the ones leading to high-school diploma which puts students and families alike under stress, and unless AI becomes a mandatory subject in those years, enrollment will be very low.

Teaching AI to school students needs to happen in a fun, interactive way, and take into account their level of numeracy and technology knowledge. The following are some sample modules that could be incorporated in school curricula, inspired by the AI4k12 initiative and AI + Ethics course for middle school.

Computers with Intelligence:

- What is AI and how is it different from other programs?
- Why do we need AI?
- You are using AI without noticing (examples from real life).

Societal Implication of AI

- AI use cases: Students are given examples from real life, in business and government, on the use of AI to solve problems or enhance the wellbeing of people.
- What can go wrong (threats)? And what to do about it?

How does AI work?

- Computer parts
- Sensors
- Processing
- AI programs
- The concept of Algorithm

Advanced AI

- How to train a simple classifier?
- Applying AI to different problems
- AI and Ethics

Each one of the above modules can be expanded to be taught in a full academic year or as summer boot camp during school holidays, and can also be complemented by student competitions and challenges. Companies such as Google have already developed dedicated programs for this age group.

In to deliver these modules; Egypt needs to have an important enabling factor: teachers who can teach students about AI in the most exciting and efficient way, therefore a TOT program is highly needed.

8.2.2 Universities

University students are classified into technical and non-technical majors, according to the framework above. “Technical” majors include Computer Engineering (CE), Computer Science (CS), and other related fields which should teach AI as a core subject during undergraduate studies. Egypt has already taken a step forward in this regard by opening new, dedicated “Faculties of AI” in universities such as Kafr El Sheikh, Monoufeya, and the Arab Academy of Science and Technology. Others, such as Cairo University, have renamed their Faculties of “Computers and Information” into “Computers and AI” to stress the emphasis on AI as a core subject. They have also strengthened their teaching and research capabilities to match this focus. Most other Faculties of Engineering and Computer Science have added AI departments or at least have started teaching the basics of AI and Machine Learning in the final years of undergraduate studies. In most cases however, these courses are too theoretical and do not prepare graduates for the job market. It is therefore necessary to complement them with postgraduate courses (both degree and non-degree programs) to give them the deeper knowledge and practical experience they need. These courses should also be accessible to non-CE and CS graduates with adequate levels of mathematics and programming knowledge, such as graduates of the Faculty of Sciences and related fields. Postgraduate programs will be divided into two categories: “broad” programs, offering a wide range of topics related to AI and data science, and more specialized ones, for example focusing on one technology such as NLP or Computer Vision, or one industry such as Machine Learning applications in financial services. These programs can vary in duration from weeks to a whole academic year, but differ from traditional postgraduate programs in that their focus is more on the practical aspects than the theory. As part of the longer programs, students should be required to develop at least one end to end AI project, including learning how to deploy an AI system into production, and how to assess its ethical, social and economic impact. Such programs will ideally be developed together with specialized institutions, such as world-leading academic entities for longer degree programs, and leading AI companies in Egypt and abroad for shorter, more specialized courses. This will achieve the dual benefit of also producing graduates who already fulfil the job requirements those companies are looking for.

In addition to formal courses during the academic year, the summer holidays can be used to give more hands-on experience. Here are some examples:

- Boot-camp: teaching new languages and packages and using them in small projects and introduce them to the world of AI and data science through for example gamification.
- AI Hackathon: competition in using AI in solving some real-life programs.
- Internship in public and private sectors where they evaluate the potential of using AI in different settings and help in implementing them.
- The government can introduce small funds for students targeting solving small problems needed in Egypt using AI.

Students in other fields will not have the computing background that allows them to appreciate and use AI in their respective fields. Therefore, they need two courses: one is an introduction in computing and the other is the use of AI in their respective field.

- Introduction to Computing: components of a computer system, concepts and basics of Algorithm, basics of data structure, and Python programming language (or Julia programming language if it becomes the norm).
- Specialized AI: The pre-requisite of this course is the previous course in this list. Then this course is designed based on the background of students: AI in law, AI in literature, AI in history, etc.

Each one of these courses can span one or two semesters depending on the depth. It is advisable to give them in 3rd and 4th year of university study so they have a good grasp of their field of expertise and, hence, can have a clearer idea on how to use AI in it. Also, it is advisable that these two courses be given in two consecutive semesters or years.

As a further measure to bridge the gap between theoretical knowledge and practical training at the university level, the Egyptian Ministries of Communications and Information Technology (MCIT) and Higher Education and Scientific Research (MHESR) have teamed up to establish a dedicated technology university in the New Administrative Capital. Egypt University of Informatics (EUI) will offer both undergraduate and postgraduate programs in several technical disciplines including AI, and will offer a unique opportunity for students to apply their learning to real-life projects and problems throughout their education.

Furthermore, MCIT has also embarked on an ambitious initiative called the Digital Egypt Builders Initiative (DEBI), which offers professional masters degrees to outstanding graduates of technical disciplines. The course of study, lasting for one year post graduation, will cover the latest topics in the discipline of choice (AI being one of them), in addition to managerial and soft skills needed in the workplace such as teamwork, project management, presentation, communication, planning, among others. Students will be granted full scholarships and will also be offered unique training and internship opportunities by leading companies working in Egypt.

8.2.3 Technical and Vocation Training (TVET)

In 2018, students who joined the technical schools in Egypt represent 55% of the total number of students. This large number, totaling about 2 million students as per the Capital Center for Economical Studies and Research (CCESR), represents a great potential for Egyptian workforce.

However, technical schools face many challenges including lack of resources, low student motivation, and the lack of qualified teachers. Any curriculum design for TVET schools must therefore start with a strong teacher enablement program and adequate funds allocated to hardware and software resources. It is also important to specify the exact goals we aim to achieve by introducing AI into TVET schools. These goals include:

- Being able to discover talents among students regarding computing in general and AI in particular and make the best use of them.
- Train the students on how to use AI to enhance their work. This mainly involves process automation.
- Encourage innovations, pick the innovations that can be used on a larger scale, and implement them nationwide. This will help the economy and also serves as inspiration to students.
- Having a workforce of educators who can train students in technical schools on AI techniques.

Metrics to measure progress towards these goals include:

- The number of students who showed great talent in using AI in innovative ways.
- The percentage of students who end up using AI in at least one aspect of their job.
- Having one AI educator for every 25 students.
- The number of innovations generated by the alumni of technical schools who have been trained to use AI in their jobs.

The table below summarizes some of the challenges facing TVET schools and suggests ways of overcoming them in order to deliver high-quality AI education:

Challenges	Suggested Course of Actions
■ Students in those technical schools are less familiar with computing in general.	■ Start with a semester-long course about "Introduction to Computing". ■ Also, summer camps that give introduction to computing can be useful.
■ Computing, especially AI, requires some theoretical education. Students in technical schools are more hands-on and hence more theoretical studies is not easy for them.	■ AI-related courses must be more hand-on, such as: ▪ How to automate a process? ▪ How to know whether a process can be automated? ▪ How to use AI techniques to detects faults in a product. ■ The software tools used must have Arabic interface.
■ Students needs inspiration to be able to digest this advanced material. This is because students join technical schools because they just want to get any degree and could not get into traditional schools. Therefore, they are not very enthusiastic about education in general.	■ Introducing a course about "AI and Society". This course has the following goals: ▪ Explain the importance of AI to the different fields, with concentration on the fields related to the technical school. ▪ Explain how AI can complement their artifact does not replace them as workers. ▪ Give them inspiration stories from advanced countries, like Germany, Japan, and Singapore, whose technical education was a decisive factor to the advancement of these countries, and who AI was used in that context.
■ Some of them may have heard about AI and are afraid of AI to take over their jobs.	■ The course of "AI and Society" mentioned in the above row will solve this problem.
■ Technical schools, in general, face financial problems. Training them on using AI in their work requires advanced, hence expensive, equipment.	■ Fund raising from private sectors, who will benefit from those educated students in the future, can be a good source of funding.

Table 2: Challenges with TVET schools and education in Egypt

8.2.4 Professionals

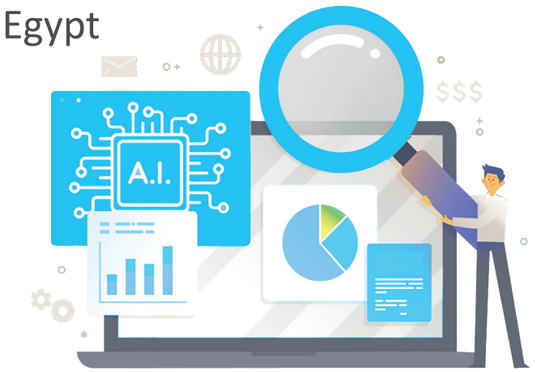
For professionals already in the market, at any level below leadership, the same classification used above for university students also applies. Those working in IT-related jobs, specifically around software development, will require upskilling programs to allow them to specialize in AI system development, or apply their knowledge to an AI-specific project (for example, a DevOps engineer learning how to do MLOps). Some of these specialized roles are listed in the capacity building pyramid at the beginning of this chapter. These upskilling courses will typically be short in duration (one week up to three months at most), and are better designed and delivered by companies working in the field of choice.

Non-technical professionals are potential "Domain Experts". The Domain Expert is one of the most important roles on any AI development team, as he/she contributes much-needed expertise in applying AI to the problem at hand. Their expert knowledge is invaluable on many levels: in identifying the exact problem to be solved, showing how it is solved today and what benefits can be gained from using better techniques (such as Machine Learning). They also contribute advice on data collection, if they don't do it themselves. Once initial results are produced, they are the ones who can validate them from a "business" perspective, judging for example, whether a 5% improvement in performance is adequate, or is a 95% accuracy is acceptable. An AI or data science team without a domain expert is tapping in the dark and might end up producing results that are irrelevant at best, or wrong and misleading at worst. It is therefore imperative to produce a generation of strong domain experts to complement the technical experts in all fields where we hope to apply AI. Teaching domain experts can be done in a similar way to introducing non-technical students to AI. An introductory course in AI and data science, followed by a domain-specific, hand-on course that culminates in a joined project with technical experts, are the right combination to produce professionals who are ready to engage with a technical team in a real-life project setting. The rest of the required knowledge will be acquired over time as their hands-on experience grows.

For executive-level professionals, in startups as well as government and private sector, special versions of these programs need to be created, in the form of "AI Business Schools" or workshop-style settings where real-life use cases in their domains can be discussed, and non-technical aspects of AI projects taught, such as financial, HR, management, and others. Startups specifically could benefit from mentoring on building knowledge and institutional capacity in AI.

8.3 Promoting AI Research in Egypt

Research in AI in Egypt has two paths. Both of them must be pursued but at different paces. The first path is "applied research", doing research to solve a problem already existent in Egypt. The second path is to focus more on basic research, leading to publications in leading journals or conferences. In order to realize tangible benefits from AI and prove its value, the immediate focus should be on applied research, while building a solid base to enable basic research in the medium to long term.



There are several advantages to that. First, it will address challenges relevant to Egypt's development goals today. Second, these solutions can, later, take the form of startups or knowledge transfer to other countries. Third, it will serve as a very good public-awareness about the usefulness of AI and that it is an opportunity not a threat.

The second path must be pursued in the medium to long term, after the first path has already started. This will train Egyptian researchers to pursue high-quality research and establish Egypt as a scientific hub in the region. This, in turn, will pave the road for possible collaboration with top-notch research centers and universities worldwide. It will benefit the first path by providing the tools and the base that allow them to solve outstanding problems.

Most researchers will try to pursue the second path because, as pure academics, the incentives of higher prestige and funding, are more prevalent in basic research. Therefore, there must be some measures from the government to encourage researchers taking also the first path, as a short-term goal. This encouragement can take the form of a fund dedicated only to the first path, using work generated from that path for evaluation and promotion of academic researchers, etc.

Another problem facing all countries in their standing in AI research and competitiveness is insufficient talent. Egypt's position would be considerably enhanced if it can retain ICT talent and tempt them to stay, in service for their country. Also, many Egyptian ICT students are studying abroad for undergraduate or graduate degrees. Active recruitment of these students and expatriates to return and participate in the AI workforce would be very beneficial.

It worth mentioning here, that in the last few decades the fields of AI, machine learning and data analytics have attracted a lot of research in Egypt. Nowadays there is a large number of productive and competent researchers at different universities and research institutions. Egyptian AI researchers are among the leading ones in the greater Middle East. In some topics such as Arabic NLP they are the top in the world. According to Google Scholar statistics, the top 50 AI scientist in Egypt produced 8545 publications (as of 11/2020). They have an average H-Index of 20.9 (The H-Index means that the researcher has H papers that are cited H times or more). So Egypt seems to have some readiness to innovate and engage in high-technology AI projects. According to a study by Stanford University researchers (see https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.3000918) the top 2 % scientists of the world (using a measure that consists of the number of publications and the citation numbers) have 16 scientists in Egypt specialized in AI.

To promote research in Egyptian universities, the following policies are suggested

- Increase AI research funding through local and international funding agencies.
- Have a track to fund applied research that focuses on solving some of Egypt's problems or participates in some of the national projects. These projects could be in collaboration with Egyptian ministries, or public or private sector companies.
- Actively recruit Egyptian students working on their PhD degrees abroad to come back and join faculties of Egyptian universities, including giving incentives to encourage them. Recruit some renowned Egyptian expatriate researchers to join or have visiting positions in newly established centers for AI research in Egypt.
- Establish new centers for AI research. This will boost AI research output, will improve the ICT and AI echo-system, and will provide a vehicle to hire researchers from abroad. Establish research centers of excellence that span several universities and can spur cooperation among researchers.
- Link universities or research centers in Egypt with corresponding foreign entities, which are currently undertaking research on policy and regulation related to data and AI.
- Promote the development of international research networks to advance AI and to distribute its knowledge and transformation potential to countries in the very early stages of AI capacity.

9 International Activities (AI4X)

Play a key role in fostering cooperation on the regional and international levels by championing relevant initiatives, representing African and Arab positions, and actively participating in AI-related discussions and international projects.

For developing countries, AI represents both an opportunity and a threat. International cooperation promises the narrowing of innovation and industrialization gaps, offers the possibility of addressing some of the countries' most challenging problems, and opens up new fields of cooperation and partnerships.

Therefore, Egypt believes in the worldwide transfer of knowledge, which exists through building a network of relations with relevant and related entities. It also acknowledges the importance of setting and developing regional capacity building programs and joint AI strategies.

Egypt is working actively on the international level to bring the perspective of developing countries to international discussions, helping narrow the gap in AI knowledge and development, and foster the use of AI applications that focus on economic and social development.

Encouraging international cooperation in AI development and deployment in general helps to bridge geo-technological lines and necessitates a multi-stakeholder effort at the national, regional and international levels. Technological exchanges/consultations should take place between governments and their populations, between the public and private sectors, between and among international governments.

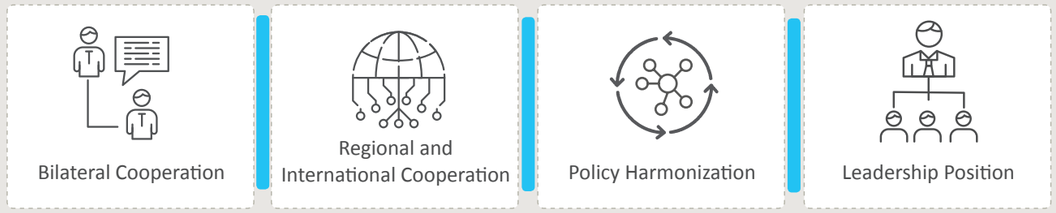


Figure 20: Scope of international cooperation

Cooperation and collaboration with other countries, international bodies and relevant consortia and fora are key to keeping Egypt at the forefront of the latest advancements in technology, policies and partnerships while generating more investment opportunities in the country.

International/Regional Cooperation: Egypt intends to share its know-how and experience through the appropriate regional and international platforms in order to support capacity building programs, development efforts, and the adjustment of policies and laws to keep pace with the international digital evolution and to be one of the main voices worldwide helping to bridge the gap between developed and developing countries.

This cooperation will be done through:

- Active participation in international conferences and relevant consortia and fora
- Launching initiatives on the regional level to unify voices and promote cooperation
- Contribution to international initiatives promoting AI research, ethical considerations, capacity building, socio-economic impact, and other relevant topics
- Strongly pushing "AI for Development" as a theme and a priority across all regional and international fora, to promote the responsible use of AI to attain tangible benefits for humanity

Bilateral Cooperation: Egypt intends to strengthen its bilateral cooperation with different countries with the aim of exchanging experience and best practices.

This cooperation will be done through:

- Government-to-government collaboration agreements
- Study visits and workshops
- Inviting experts from different entities to present their experience at events organized by Egypt
- Identifying and launching projects of mutual interest and benefit with friendly countries on a bilateral or multilateral basis

10 Enablers

10.1 Governance

10.1.1 National Council for AI

The Cabinet of Ministers, during its meeting on Thursday 21 November 2019, chaired by Prime Minister Dr. Mostafa Madbouli, approved a draft resolution on establishing a national council for AI.

The National Council for AI (NCAI) is chaired by the Minister of Communications and Information Technology and includes representatives from government entities, private sector and independent experts and heads of several bodies concerned.

The Council is in charge of outlining, implementing and governing AI strategy in close coordination with the concerned experts and entities.

The Council responsibilities are as follows:

- Outlining the National AI Strategy.
- Devising a follow up mechanism for the implementation of the National AI Strategy in a way that adheres with the international best practices in this field.
- Identifying national priorities in AI applications.
- Recommending national policies and plans pertaining to the technical, legal and economic framework of AI applications.
- Reviewing any kind of cooperation both regionally and internationally which includes exchanging best practices and expertise.
- Identifying AI applications that provides smart, safe and sustainable solutions and services.
- Reviewing international protocols and agreements in the field of AI.
- Recommending programs for capacity building and for supporting the AI industry in Egypt.

10.1.2 Responsible/Ethical AI Policies

Despite the undeniable benefits of AI, its misuse can potentially cause harm to individuals or communities. The existence of policies, regulations, and legislations to mitigate potential misuse whether ethical, legal, or socio-economic, can promote and enable the widespread adoption of AI solutions. Raising awareness as to what responsible AI and ethical AI is, could also serve as a powerful enabler.

Towards this end, the following steps should be taken:

Develop a dedicated track within NCAI for AI ethics to:

- Advise the government on the ethical and legal use of AI and data and related ethical, legal, policy, and governance issues.
- Identify ethical problems that can arise with the use of AI in Egypt.
- Put in place guidelines for Responsible and Ethical AI to be used as a reference for AI practitioners and companies in Egypt (the "Egyptian Charter for Responsible AI").
- Communicate and coordinate with appropriate government bodies to issue legislations and regulations when and where needed. For example, building on the recently ratified Personal Data Protection Law and expanding into areas of data anonymization, Intellectual Property Rights (IPR) and patent law.
- Educate AI practitioners as much as possible on the ethics of AI. This can be promoted through ensuring that universities that grant AI degrees have a course on ethics in technology/AI as part of their curriculum.

The following points list major Key Performance Indicators (KPIs) for ensuring Responsible/Ethical AI in Egypt:

- The establishment of a dedicated track within NCAI for AI Ethics.
- Publish guidelines for Responsible and Ethical development of AI.
- A set of rules and regulations for responsible AI use.
- Ethics in AI/technology courses being offered in universities as part of computing degrees.

10.2 Data

The volume of data produced in the world is growing rapidly, from 33 zettabytes in 2018 to an expected 175 zettabytes in 2025. Furthermore, the way in which data is stored and processed will change dramatically over the coming 5 years. Today 80% of the processing and analysis of data takes place in data centers and centralized computing facilities, and 20% in smart connected objects, such as cars, home appliances or manufacturing robots, and in computing facilities close to the user ('edge computing'). By 2025 these proportions are likely to be inverted.

Data will reshape the way we produce, consume and live. Benefits will be felt in every single aspect of our lives, ranging from more conscious energy consumption and product, material and food traceability, to healthier lives and better healthcare.

Therefore, the Egyptian Parliament ratified the Personal Data Protection Law in early 2020. The Law promotes the security of personal data, which is being processed and stored online. It also sets a legal framework to regulate data transmission with other countries.

Each new wave of data represents major opportunities for any country to become a world leader in this area. In this regard, Egypt should be able to move forward in implementing its own data strategy with principles that suit its local environment, while ensuring relevance to global practices such that Egypt can have a leading role on the matter through a solid international presence.

In addition, having an effective data strategy means having the right type of data, at the right time, accessible to the right people via the right channels, while being governed and protected in the right way.

10.2.1 Elements of a Data Strategy

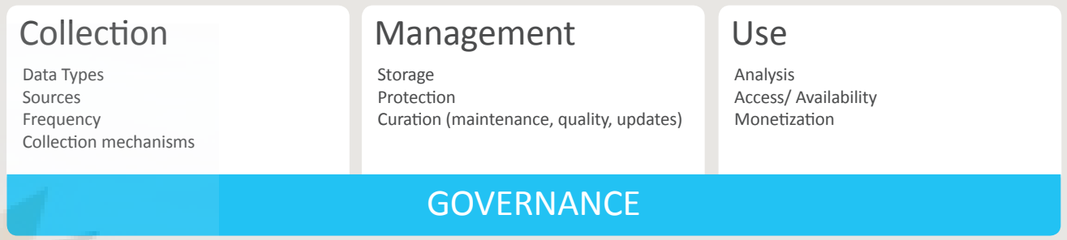


Figure 21: Elements of a Data Strategy

One of the main elements of a data strategy is "Data Classification". Data classification allows governments and private sectors to categorize information according to its sensitivity and thus deploy suitable and effective security measures, while maximizing the benefit from this data. More sensitive data, such as human resources or customer information, can be classified in a way that shows that disclosure has a higher risk. Information data, such as those used for marketing, would be classified at a lower risk.

Data classified at a higher risk can create security and access requirements that do not exist for lower risks, which might not require much protection altogether. Government classification of data is something created out of policy for maintaining national security or the privacy of citizen data. Military and intelligence organizations set their classifications on the ramifications of disclosure of the data. Civilian agencies also look to prevent unauthorized disclosure, but they also have to consider the integrity of the data.

The following table lists examples of data classification categories and descriptions used in some countries.

Classification	Description
Top Secret	Disclosure of top-secret data would cause severe damage to national security.
Secret	Disclosure of secret data would cause serious damage to national security. This data is considered less sensitive than data classified as top secret.
Confidential	Confidential data is usually data that is exempt from disclosure under laws such as the Freedom of Information Act but is not classified as national security data.
Sensitive But Unclassified (SBU)	SBU data is data that is not considered vital to national security, but its disclosure would do some harm. Many agencies classify data they collect from citizens as SBU. In Canada, the SBU classification is referred to as protected (A, B, C).
Unclassified	Unclassified is data that has no classification or is not sensitive.

Table 3: Data Classification Example

A successful data strategy defines the roles and responsibilities of each data actor (such as the data owner, curator, or user), the process to enable them to collaborate, and the underlying policies governing the interaction. The key here is building transparency through clear and comprehensive communication of what data will be shared, how, why, and what benefit it brings to the economy, and addressing any concerns.

Benefits of Data availability

- No data-driven economy can exist without availability of and access to data.
- Transparency: Individuals can access their data, and could provide useful additional information or feedback for improvement.

Data Monetization

- Data can be both a revenue stream for the government and a catalyst for an entire ecosystem.

10.3 Infrastructure

An elaboration of Egypt's infrastructure readiness and plans is out of the scope of this document. However, it is important to point out that the lack of a cloud infrastructure in Egypt, especially a presence for one of the major public cloud providers, aka 'hyperscalers' such as AWS, Google CP or Microsoft Azure poses some serious obstacles to the rapid adoption of AI due to data locality restrictions which prevent any data from leaving the country. Having a local datacenter not only provides scalable storage and compute resources, but also gives Egyptian entities access to stacks of AI and Machine Learning services which are constantly updated on these clouds, thereby eliminating the need to write many of these services from scratch or ask the provider to deploy them on-prem, an expensive and lengthy exercise which also does not guarantee they are kept up to date.

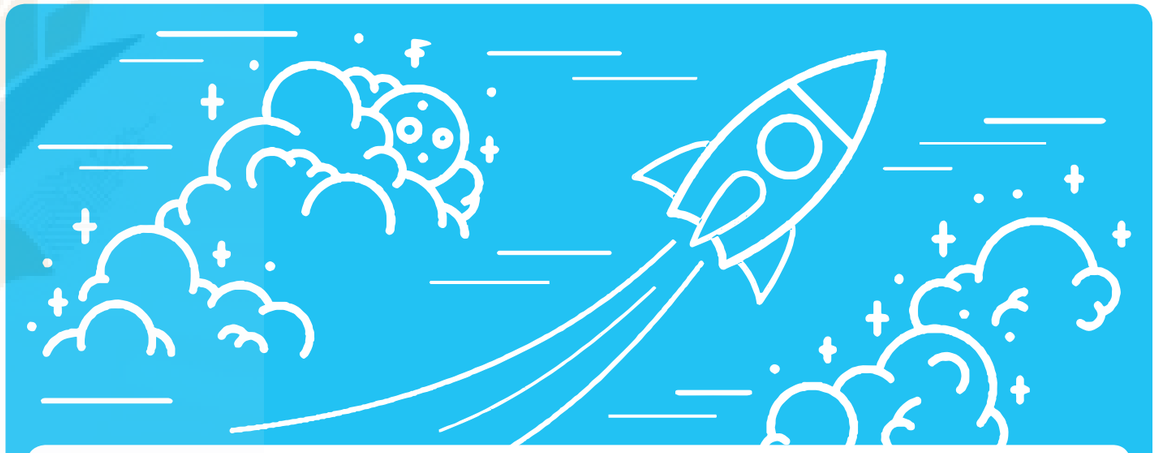
As far as software is concerned, it is important to keep abreast of recent developments in the world of AI, which are almost daily by today's measures. Reliance on open-source or 'whitebox' algorithms and tools were possible, have got to be priorities for Egypt given its support for the principles of responsible AI published by the OECD, and which include important clauses on transparency, traceability and reliability. Avoiding vendor lock-in is another imperative and it is therefore paramount to diversify partnerships as much as possible and build local capacity that is able to deal with a wide variety of vendor solutions, both on-prem and in the cloud.

10.4 Ecosystem

10.4.1 Establishment of an AI Center of Excellence

Currently, there are steps taken to establish a center that will play a considerable role in the application of AI to governmental and non-governmental problems, the so called AI Center of Excellence (CoE). The center will employ highly qualified AI researchers, possessing higher degrees, and it will be the vehicle for designing AI solutions and implementing them for a variety of problems facing the country. Specifically, it will have the following roles:

- Tackling national projects that are based on AI application and big data. For example, the CoE could apply AI to Egypt's Ministry of Irrigation, optimizing water use with the help of AI.
- Contacting government ministries and government agencies in order to search for tasks where AI can be applied for more efficient operation and better performance. Many government agencies may not have the AI insight to know that some of their operations can be improved (using AI), and the CoE can educate them on these possible enhancements.
- The CoE can be a vehicle to reverse the brain drain. This is by specifically targeting employment of Egyptian researchers with higher degrees (such as PhD) from top universities of the world. In the absence of such hiring opportunities in Egypt these students may likely not come back leading to loss of talent that is quite detrimental for the country.
- The CoE can provide internships for students and recent graduates. By training researchers and giving them real experience in tackling AI problems, it can have a large positive impact on creating a talented AI workforce that will benefit other work sectors as well.



10.4.2 Entrepreneurship and Startups

The infusion of AI, Machine Learning and data analytics into various aspects of entrepreneurship have transformed the entrepreneurial ecosystem and the global business environment around the world. AI has already penetrated firmly into many areas of business, professional, personal and even daily life. Entrepreneurs and startups are considered as major contributors to the growth of the global economy. A key pillar of Egypt in the near future is creating further job opportunities for youth in various economic sectors, especially through entrepreneurship as youth represent more than 50% of the Egyptian population. By empowering entrepreneurs, students, and startup communities in Egypt, we can fulfill the central pledge of the 2030 Agenda for Sustainable Development, which is to "leave no one behind". It is therefore important for governments and private sector to pay equal attention to AI startups which can be a strong contributor to an AI-driven economic growth. Providing support means helping start-ups with the right advice and infrastructure (legal, ethical, technical, etc.) needed to create responsible AI products.

The government started to encourage technology companies around two decades ago. Since then a large number of start-up companies have appeared. Many of them produced work that was outsourced to companies and businesses abroad. The trend kept improving and there are now tens of these companies, and many of them grew to become large companies with over 1,000 employees.

At the same time some multinational companies set up branches in Egypt and had large groups working on machine learning research and applications, such as IBM and the Cairo Microsoft Innovation Center (CMIC). Also, organizations such as ITIDA set up technology incubation programs (TIEC) and funding programs to help start-up companies that are built on innovative ideas. Recently some larger companies such as Raisa Energy established large machine learning groups to solve engineering problems in the oil and gas field. Valeo, Inc. also set up a branch in Egypt with over 1900 employees working on research in autonomous vehicles. The four major telecommunication companies also have large data analytics groups. There have been some acquisitions of Egyptian companies by multi-nationals. For example, SysDSoft was acquired by Intel in 2011, and Newport Media (with its biggest office in Cairo) was acquired by Atmel Corporation.

Today there is a healthy ecosystem of innovation and start-up companies that is one of the best in the greater Middle East. Examples of successful companies are ITWorx, which has over 800 employees and has a large group of them working on machine learning and in particular NLP. Overall there are over 30 companies with number of employees more than 30 each working mainly on AI in Egypt.

10.4.3 Boosting the AI Sector in Egypt

Government projects can provide a boost to AI companies in Egypt. As mentioned above, there are over 30 mediums-sized companies (employeeing 30 or more people) in Egypt that are specialized in AI and its applications. These will thrive if they share in some of the government projects. It would be beneficial for the country if most of these projects are allocated to an Egyptian company or an international company with an office in Egypt, provided that the quality and/or cost expected from this company is as favorable or better as any other purely international company.

The project allocation process could be run as follows:

a. Run a pilot, announced as a competition, using a subset of relevant, non-sensitive, legally-approved data. Companies are free to apply their algorithms on this data subset as a preliminary test. This is similar to kaggle.com's competitions.

b. Solicit a written proposal from the candidate companies that will present their solution methods. This is akin to ITIDA's call for proposals that seek topics from companies and researchers in the ITAC funding track.

c. Review the proposals (with the help of experts from academic institutions), and based on the solution methodology, quality and reputation of the participants, and the performance in the blind competition of Point a) decide on the best company to take on the project.

d. For large projects or certain specific projects stipulate that any foreign company that bids for a project has a joint partner company from Egypt.

In addition, the following steps are to be pursued to push this achieved momentum, until Egypt occupies an advanced position worldwide in AI technology:

a. Increase the funding offered to start-ups, also through government-related bodies.

b. Create AI-specific start-up incubators. These will provide office space, business and market advice, clerical help, etc. This will serve to reduce the cost for starting a company and will channel the focus of the engineers and scientists towards the technical problem at hand.

c. Provide incentives for public and private companies to purchase AI products locally (from Egyptian AI companies) rather than import it from abroad.

d. Initiate some national projects that make use of AI technologies. This will solve a national problem and also boost the AI industry in Egypt. Some of the projects can be posed in the form of a competition. This will give strong incentive for producing the best work.

e. Provide Tech parks, innovation hubs, R&D grants, competitions, etc. These will provide infrastructure and help for start-ups.

Innovation and Entrepreneurship are interconnected. Innovation is the specific tool of entrepreneurs; the means by which they exploit change for a different business or a different service. Egypt seeks to organize competitions at different levels to stimulate the use of AI in solving real challenges and creating new market opportunities.

The purpose of these competitions is to bring promising entrepreneurs and startups from around the world in contact with investors, mentors, donors, and government representatives with the purpose of solving innovation challenges using AI applications. It offers an opportunity to match start-ups with larger companies on the national and multinational levels.

Objectives include:

- Support innovative AI applications that create value for society and empower entrepreneurs.
- Provide startups and entrepreneurs with greater access to knowledge.
- Allow startups and entrepreneurs to invent and claim credit for their innovation.
- Provide the knowledge needed for designing and implementing large-scale, effective AI applications.
- Provide startups and entrepreneurs with process-based, project-centric workshops and training.

These challenges and competitions will also raise awareness of AI technologies in Egypt and the region, as well as provide a platform for participants to share AI ideas and applications and support the development of their entrepreneurial skills and discover how to build successful AI applications.

10.4.4 Combating the AI Brain Drain

The immigration of Egyptian scientists and engineers to more advanced economies can have the most detrimental impact on the health of the AI sector in Egypt. Brain drain is a major problem that plagues many countries, even some advanced ones like Russia and France. The AI industry is mainly based on the availability of talent. To combat the brain drain, the following steps can be taken:

- Newly established Center on AI Applications and the AI and computer departments could favor the employment of faculty members with PhD from leading international universities. These students would otherwise seek employment in the country they are studying, leading to a loss of talent for Egypt.
- The Center of AI Applications and other future centers of excellence could hire Egyptian expatriates that are prominent worldwide. For example a leading Egyptian AI researcher living in the US could be hired as a consultant or a part-time researcher at these centers. In the current age where remote employment is becoming prevalent this arrangement is quite feasible.

11 Implementation Methodology

Given the long-term nature of this strategic exercise and at the same time, the fast pace with which the industry moves, it would be prudent to divide the implementation plan into phases, each with a declared high-level goal and initiatives. Phase 1 should be outlined in detail, while Phases 2 and 3 can be defined at a high level now, to be reviewed and detailed later based on market need, changes in priorities, and lessons learned from Phase 1. We therefore adopt what we call an "Execute, Plan, Explore" (EPE) framework, which is described in detail in the next sections.

11.1 EPE Framework

The EPE framework adopts a funnel approach, whereby for each time period, ideally half a calendar year, initiatives are categorized based on their stage of maturity/implementation, as described below:

- **The Explore Theme** is about finding strategic projects/use cases to focus on implementing and testing. More on the Areas of Focus levels.
- **The Plan Theme** is about building a POV to ensure the feasibility of the use case, or project. While finding the budget, data requirements and target users. More on the Goals, and what success looks like level.
- **The Execute Theme** is about having ready to implement projects on the ground and rolling out AI applications at scale. This focuses on the Project Execution level.

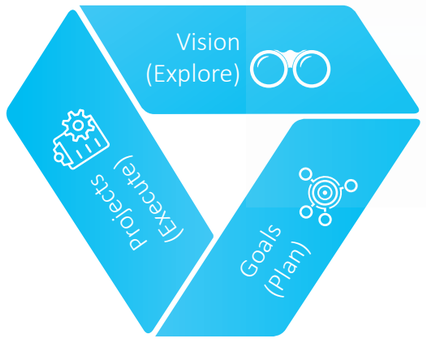


Figure 22: The Explore-Plan-Execute Framework

11.1.1 Explore

This is where we build different visions for potential AI use cases, to progress Egypt's AI leadership.

Consortiums of business experts, academics, researchers and potential beneficiaries will form committees to scope and study potential use cases to progress the strategy and enable further adoption.

Activities in the Explore phase will focus on building different roadmaps, policies and research initiatives and the ones which have the highest feasibility potential will move to "The Plan" phase.

The Explore phase will select and evaluate ideas based on the below AI Theme Canvas:

Figure 23: Elements of the EPE Explore phase

After the above canvas is filled, a score will be given to the different themes based on Feasible, Important and Urgent Matrix.

Feasibility score [1-5], how feasible is the theme, scored based on

- Data Availability: Is the data to train models available, can it be aggregated rapidly and with ease?
- Scalability & Generalization: How generalized is the potential project and can it be adopted at scale?
- Readiness of Technology and Research: Is the technology for deployment and production readily available, or is it still in research?
- Talent & Capability: Are calibers to govern, build, deploy and monitor the project available?
- Time to Market: How fast can this project be deployed?
- Funding: Is Funding available?

Importance Score [1-5], how important is the project to further progress Egyptian leadership in AI

- Overall alignment of the project to the Egyptian AI strategy
- Is the problem to be solved important to as many people, or is it common enough?
- Will Egypt gain better ranking in Indices measuring AI readiness and leadership?

Urgency Score [1-5], how urgent is the project towards Egyptian societal and economic status

- Is the problem related to a major problem currently facing Egypt?
- Is time to get in Execution of the essence?
- Are there consequences for not taking immediate action?
- The highest scored themes will move to the "Plan" phase.

11.1.2 Plan

The plan aims to develop experiments in order to confirm the "prove the value" of the theme or project previously agreed upon in the explore phase. In "Plan", Egypt is working to prove the value in terms of feasibility and impact of the model. Hence, this phase will involve a lot of experimentation, code-build, testing and validation. Once the model is proven, both technically and from an impact point of view, the project moves to execution.

The following will describe the general philosophy of operation for the "Plan" phase:

- **Classify the problem:** Frame the Problem at hand, stating a clear problem statement, and prioritizing the problem as per the mentioned above.
- **Acquire data:** Identify where the data exists to support the problem the center of expertise is trying to solve. Data used in AI can come from a variety of sources, such as ERP systems, IoT edge devices or mainframe data or public data. The data used may be structured (such as NoSQL database records) or unstructured (such as images or videos).
- **Preprocess data:** This is to prepare data for AI execution. Steps here include data transformation, normalization and cleansing, as well as the selection of training sets.
- **Model the problem:** Determine the optimum AI algorithm to be used for training or clustering. A range of algorithms can be acquired and extended to suit different purposes.
- **Validate and execute:** Validate results, determine the platform to execute models and algorithms, and then execute the AI models.
- **POV Presentation:** Presenting the work done in front of a committee of experts, with the Impact forecasted, to be moved to "Execute".

If approved, the output of every "Plan" project might have one or more of the below outputs:

- **Predictive engines** that provide instant scoring, prediction, ranking, recommendation. For the beneficiary to directly connect to it
- **Modularized Frameworks** that can be easily repeatable in "Execute" phase
- **Variable engines** that can continuously learn with every new data point and change
- **Analytical engines** that can analyze root causes of anomalies and exceptions and take next action autonomously
- **Visualizing platform** that includes patterns and seasonality and non-intuitive relationships
- Global near Real-time, **full visibility** on the whole network
- **Smart Portal**, Backend & Frontend Design and Implementation to allow business users, to access and analyze their operations
- **Restful APIs** for all Algorithms and Analytics

The 'Plan' phase has four main success criteria:

i. High impact use case

AI is only as useful as the impact it can deliver. The Egyptian National AI strategy aims at putting Egypt at a trajectory of AI leadership, by utilizing AI to power and impact its GDP.

To that matter, AI application in Industry or government should have a clear framework to quantify and measure postproduction impact. The below framework is proposed, to quantify a use case' s impact:

- **People & Labor:** a more effective labor and people performance management
- **Time Effectiveness:** making organizations be time conscious and efficient and lead the market in service and product to market
- **Assets:** Creating superior ROA by better allocating assets whether warehouse, machine, or equipment
- **Growth & Revenue:** Building better services and products that accommodate customer needs and recommending more products to them
- **Profitability:** Optimizing total supply chain costs and reducing ineffective spending to upheaving profitability

ii. Scalability of the use case

In "Plan", all activities are operating with mass adoption in mind. The Explore phase cascaded the "Plan" pipeline of potential projects, based on how common the problem is, and how feasible it is to deploy an AI at scale to solve the problem.

Although, in "Plan", entities will be working to build a Proof of Value, it has to accommodate how scalable is the use case at hand. The following should be considered in any "Plan" initiative:

- Historical Data: The availability of the Data, that has enough samples, representative of the population that the AI will target or, the data is available to the end beneficiary so that they can train their models and output the required accuracy and impact.
- Time to Onboard: The number of hours needed to onboard a new organization, such as a government entity, organization, or a business.
- Operating Costs: After deployment, how expensive will it be to update the algorithm, considering all expenses necessary, including talent needed, to deliver the proposed value and benefits.
- Variable Accuracy: How prone is the algorithm to data drifts, and how impact would be affected by it.
- Human Interaction: How the users will interact with the solution in the Human – AI interaction. Given the following scenarios:

A. AI decides, and acts autonomously

- Autonomous Vehicles
- Traffic Light automation
- Energy Optimization in facilities

B. AI decides, human implements

- Identifying Risks in pipelines (Leakage, breakage..etc.)
- Staffing & Headcount projections
- Commodity Price Prediction, and procurement

C. AI recommends, human decides

- Lead Scoring
- Credit Scoring
- Hiring and Staffing

Furthermore, the data itself, to be used in the use case must follow the below guidelines:

- Coverage: The data must be broad and consistent in terms of its coverage of the population, or at least easy to acquire.
- Accuracy & Timeliness: The data must be accurate, current, frequently updated and unbiased.
- Predictive Power: The data and the provided information from the source should be relevant to what is being predicted.
- Compliance: The data and algorithms should comply with financial regulations as well as data privacy and protection laws.

iii. Generalization of Model

In AI, there is always the question of how general this model can be. In other words, if the model is tested on a certain dataset for a use case, can the model be deployed right away, without further training, for the same use case in other locations, or for other companies.

As an example: In Alternative Credit Scoring, AI algorithms are trained on the approved and rejected applicants for company A. The data in company A, has a built-in bias, reflecting their risk appetite and internal policies, which might be only unique to them. Thus, the algorithm intelligence built on their data might not be relevant to a more global population, as it will inherit all the bias of company A in it.

That said, the teams proving the value, can build a generalized model, by which companies or governments in Egypt can leverage the intelligence right away, without relying on having high-quality or enough data.

This can be referred to, as Pre-trained Models, which makes any beneficiary able to use the algorithm right away. This is a best case scenario, which will greatly facilitate the "Execute" phase.

For Example: Arabic OCR, which can detect Arabic text from images, with high accuracy, can be leveraged in digitization processes and Robotic Process Automation scopes, or in reading algorithms that can comprehend Arabic, which can provide the basis for further applications.

iv. Funding for Mass Adoption

To really push forward the boundaries of AI impact, if the AI built in "Plan" can be adopted by as many government entities, businesses or applications. Sometimes, AI adoption in an organization, would require significant investment of resources for data ingestion, Model integration, Machine Learning operations (MLOps) etc.

If businesses adopt such a technology, they can better synchronize their supply chains, grow more sustainably, and empower Egypt's overall GDP. To encourage such adoption, subsidizing AI services and implementations might prove to be an effective strategy to incentive organizations to adopt it.

For every proof of value, a Funding document, detailing the potential costs and benefits of the mass adoption will be created. The following are the suggested areas of focus of such a document:

- **Benefits:** Representing the value delivered from the use case on the individual and collective levels, forecasted on a nation-wide level.
- **Costs:** All costs considered in subsidizing the services to enable mass adoption.
- **Network Impact:** By which, if the use case can cascade an overall benefit from having multiple beneficiaries sharing their data into a pool, for the algorithm to be more generalized.
- **Risks:** Uncertainty factor of cost to benefit over time.
- **Payback Period:** The breakeven point for the initial investment.

11.1.3 Execute

In "Execute", Projects approved and passed through "Plan" start on-ground execution. Execution can be done through third parties, with supervision of Center of Excellence, or done directly by resources within the center.

On-ground execution means onboarding Government Entities, Businesses and Organizations onto their AI solutions, planned in 'Plan'.

Execute will follow the below flow for any new entity on boarded:

i. Onboarding

In Onboarding, execution will have one of the following formats:

- **Pre-trained Model:** For which the beneficiary will connect to VIA APIs to be onboarded on the use case
- **Micro-Service, Modularized Engines:** For which the beneficiary will map their data to access the use case directly
- **Access to Dashboards:** For which the beneficiary will get direct insight form different AI processing public data
- **Ground-Up build:** For which the AI will be built from the Ground-up to fit the entity's use case

ii. Operationalization

This stage is about having the AI models and solutions working seamlessly with the beneficiary IT environment, with all data ingestions and integration already setup and moving the project in actual production.

With AI postproduction, a very critical activity is the MLOps (Machine Learning Optimization). For which the center of Expertise will be required to ensure that the algorithms accuracies are not deviating from the required accuracy. This is all about Model Monitoring and governance.

In this phase, the CoE , or third party experts will work with the entity to monitor and continuously evaluate the deployment for:

- Number of Predictions
- Data Drifts
- Model Accuracy
- Population Coverage
- Impact delivered

iii. Adoption

Adoption is all about building capacities, within the different beneficiary organization to work with the AIs. For a successful adoption, organization require significant efforts from their side. Deployed AI must be well embedded into the processes of the company and adapt the workforce on having AI a part of their daily routine.

For that matter, organizations with the help of CoE consultants will need to assure:

- Organization incentives are aligned with AI adoption
- How to create and build internal competencies to work with AI, and appoint AI change Leaders
- Align benefits to entities, to encourage full adoption
- Creating Seminars and Educational talks, on how AI benefits workers, rather than replacing them
- Reengineering organizational processes to the new AI deployed

11.2 Implementation Phases

The following sections will explain the different phases of the strategy and offer an example of the EPE model as it pertains to Phase 1.

11.2.1 Phase 1: Prove the Value

In this phase, which starts in 2020 and extends for 3 years, the main goal is to prove the value of AI in the different domains and build the foundations upon which to build AI at scale. Applied to the pillars and enablers discussed before, this means the following areas of focus:

- AI4G: identify and prototype different use cases for AI in government, with a focus on new applications pertaining to the move to the New Administrative Capital.
- AI4D: identify and execute pilot projects within each strategic sector (agriculture/water, NLP/culture, Manufacturing and Smart Infrastructure Management, economic planning, healthcare) and measure their ROI and potential to develop at scale. Successful pilots are moved directly to full-scale rollout.
- AI4H: focus on two segments: graduates/professionals to meet the short-term demands of the market, and the general public to lay the foundation for longer term AI education. This also includes training of government employees according to their job type and level, as well as enabling leaders in the government and private sector to identify and lead AI projects.
- AI4X: play a key role in unifying the African and Arab voices around issues of importance in AI, and participate actively in international fora focusing on issues such as AI ethics and impact, as well as AI in development. At the bilateral level, work to forge partnerships with key governments with similar plans regarding AI for the benefit of both countries.

11.2.2 Phase 2: Focus on Research and Expand the Market

In this phase, which lasts a further 3 years, the emphasis will be on identifying further key sectors in which to implement AI strategically. These sectors include but are not limited to Education and Banking/Financial Services. Other industries such as energy/O&G and supply chain are also to be studied and assessed. Another focus will be on rolling out AI applications at scale, especially in government, moving to the vision of a 'Paperless, Collaborative, and Smart' government. On the capacity building side, special focus will be on school and university students, absorbing AI and adjacent technologies into all levels of education. There will also be an emphasis on preparing the next generation of AI researchers who will be ready to feed the market in phase 3.

11.2.3 Phase 3: Expand Research and Grow the Ecosystem

In Phase 3, which is expected to extend until 2030, the emphasis will be on strengthening core research capabilities in the country and translating them into sustainable solutions using the repeatable model put in place during phase 2. The focus here will be on strengthening the link between academia/research and the industry, also by implementing focused startup incubation and acceleration programs in the field of AI and with a focus on deep tech. Within capacity building, the focus will be on completing the general awareness programs so as to achieve equal footing between literacy and AI literacy while at the same time, strengthening the top of the pyramid by producing high-end data scientists and machine learning researchers.

12 Phase1 Implementation Plan

12.1 Phase1 EPE

The table below shows an example of the Execute-Plan-Explore model outlined earlier in this section. It should be noted that this is a dynamic model that is subject to change depending on priorities and circumstances in other parts of the country, for example another COVID-like pandemic might lead to accelerating the emphasis on population health projects at the expense of another domain.

Classification	2nd half 2020	1st half 2021	2nd half 2021	2022	2023
Execute	First AI in government projects ToT Programs for postgraduates Professional and domain expert courses International positioning in UNESCO, OCED, Francophonie, AU, Local Startups Competition in one of AI for Government applications One project in each agriculture and healthcare in partnership with an international entity	General Awareness program 2 Healthcare projects 2 Agriculture projects Economic Planning Pilot Set up long-term Government R&D unit Start International competition for Startups in the field of AI Announce Data strategy	Focus on getting NLP and Healthcare projects off the ground Economic Planning Phase 1 Widen scope of AI4G Set up CoE for AI4G Initial programs for AI in schools Add one more sector, e.g. energy	Spin off CoEs as independent entities with their own set of partnerships and funding sources Government remains an incubator for AI adoption in more sectors Even wider scope for AI4G, start advising other countries	Focus on sustainable growth for AI Attract research centers and other think tanks to partner with or open in Egypt Government and other entities start generating ideas for AI projects Ecosystem starts showing a meaningful contribution to the AI landscape
Plan	International Competition Economic Planning Data Architecture Road map 2 Healthcare projects Media project General awareness programs	Healthcare roadmap Manufacturing and Smart Infrastructure Management roadmap More AI4G use cases	Wider involvement of startups in AI ecosystem Formal university courses in AI and data science across all specialties Foster regional partnerships	Wider Exportable solutions strategy	
Explore	NLP roadmap Data governance plan University summer camps	AI in other sectors School programs	Set up CoEs for Agriculture, Health, Government Exportable solutions pipeline	Long-term research strategy for AI in Egypt	Prepare for stage 2 of the AI strategy

Table 4: Phase 1 EPE details

12.2 Phase1 Operating Model

For Phase 1, a Center of Excellence approach is being adopted by which projects in government, development, and capacity building are identified and executed in partnership with an Egyptian beneficiary, and a local or foreign technical partner.

The CoE approach has MCIT playing a consulting role in collaboration with research and academia to explore potential projects together with a beneficiary, which can be a government entity or a private sector company. Once a project has been identified, a team is formed according to one of the models below and a tech partner is identified via the public tender process outlined below. This ensures the high quality of deliverables and at the same time, that each project contributes to a building block towards a fully integrated, unified government platform for AI which is scalable, extendable, and robust enough to also accommodate the creation of new applications with speed, ease and cost-effectiveness. It also serves to build capacity within the country, which can then be fed into the industry, as well as to encourage and grow the private sector.

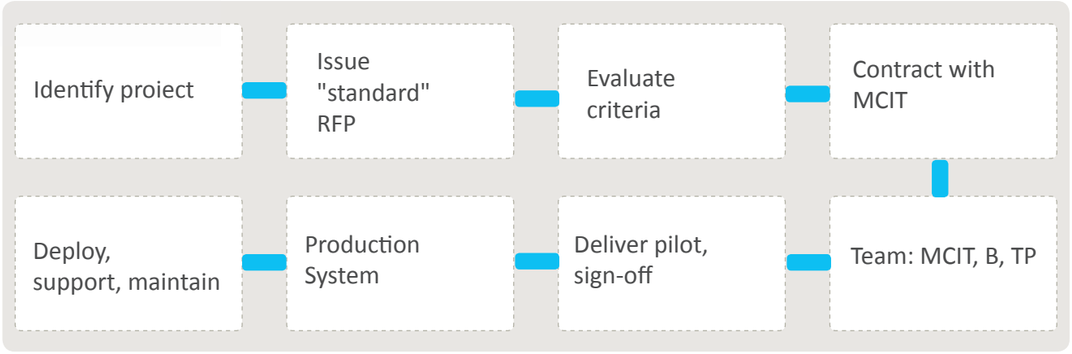


Figure 24: components of a standard project delivery process within the AI CoE

The figure below shows how all the pillars and enablers of the strategy work together to form Egypt's AI industry.

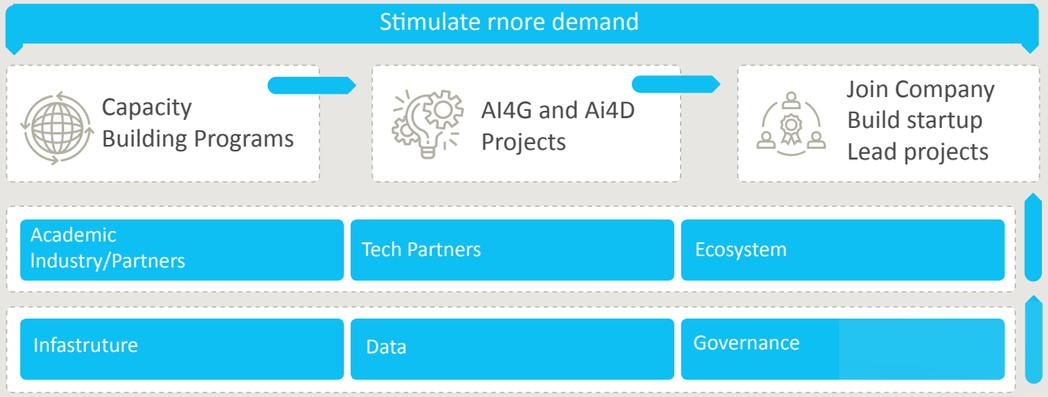


Figure 25: How the pillars and enablers of the strategy work together

The next figure shows some sample career paths which integrate the capacity building tracks with the AI4G and AI4D projects.

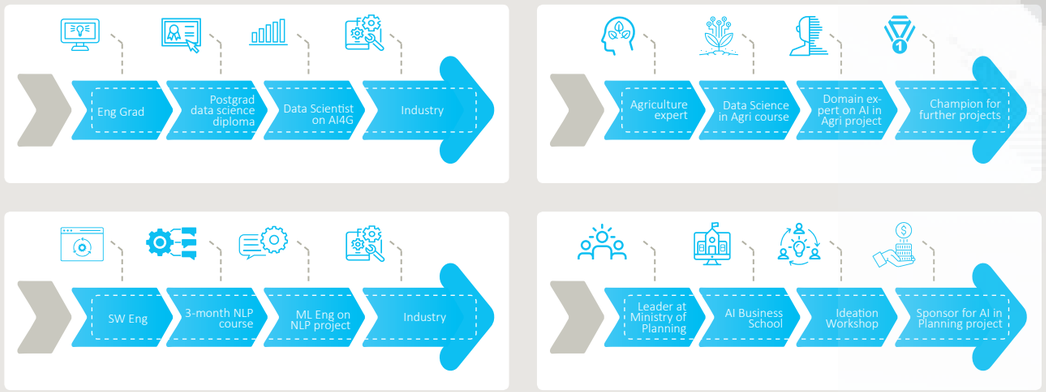


Figure 26: Sample career paths for different profiles

The operating model within the CoE can take one of 4 forms as illustrated below:

- **Co–Development:** a project of mutual interest is identified between all parties (MCIT, the beneficiary organization and the technology partner), and is implemented by a team formed out of these 3 entities. The tech partner provides training and knowledge transfer and the beneficiary organization contributes domain expertise. The resulting pilot is a shared IP and a separate commercial agreement is drawn, by which usually the Egyptian government gets the right to use the product inside Egypt while the tech partner is free to market it abroad.
- **Direct implementation:** for solutions which are mature and ready to deploy, and pending a thorough needs assessment and cost-benefit analysis, certain projects might be awarded to a tech partner through a public tender and the co-development part will be replaced by shadowing of Egyptian resources.
- **AI competitions:** as a way of stimulating the private sector, especially startups and the academic research domain, a series of competitions will be held around key topics to build an MVP where the prize money will be the seed fund to build the full solution with a full package of mentoring and support is offered by MCIT and partners.
- **Rapid Prototyping:** for use cases that are difficult to find and where the feasibility has yet to be proven, a small development unit will produce some rapid prototypes which, if successful, can be turned into a full project to be implemented using one of the 3 methods above.

12.3 Phase1 Main Initiatives

This section lists some key initiatives planned for phase 1 of the strategy, with their main KPIs. A more detailed approach to managing the strategy will be detailed in the next section, which also includes a lower-level classification of projects and how their KPIs will be set.

Pillar	Initiative	Goals/KPIs
AI4G	Implement a government-wide NLP platform to enable Arabic language applications	
	Spread awareness of AI across government entities	
	Publish "Egyptian Charter for Responsible AI" to guide development in government	
	Implement Center of Excellence approach to ensure quality and standardization of deliverables	
	Implement at least ten pilot projects/year in different government sectors	Pilots completed and next steps decided, including evaluation reports and recommendations
	Identify most suitable use cases for AI development across government	Hold at least fifty sessions per year with government entities to explore AI opportunities
	Produce "AI catalog"	Full catalog of potential AI use cases in government to be implemented until 2030
AI4D	Pilot projects in AI for agriculture	Complete at least five pilots, with at least one rolled out to full scale
	Pilot projects for AI in healthcare	Complete at least five pilots, with at least one rolled out to full scale
	Pilot projects for AI in infrastructure and Manufacturing and Smart Infrastructure Management	Complete at least two pilots with next steps determined
	Pilot projects for AI in economic planning and development	Complete at least two pilots with next steps determined
	Pilot projects for AI in Culture and NLP	Complete at least five pilots with at least one rolled out to full scale

Ecosystem	Launch AI applications center with research and implementation arms	
	Build bridges between industry, government, research and academia	Hold at least five hackathons per year for university students and researchers with AI in development themes
	Support AI startups	Incubate at least ten new AI startups per year
	Support AI startups	Launch specialized course and mentorship program for AI startups
	Support AI startups	Direct Science & Tech funding to AI use cases
AI4H	Spread general awareness of AI benefits, risks and limitations across the population	Implement a general awareness programs aimed at a general audience, including a short, introductory level and a more in-depth level for those interested
	Launch ai.gov.eg to serve as an AI hub for the country	Portal to have sections for all actors in the AI ecosystem as well as prospective international partners
	Introduce AI into schools	Pilot targeting high schools and TVET to boost AI knowledge through practical projects
	Introduce AI courses into undergraduate programs	All CE and CS departments across the country have at least 2 undergrad AI courses
	Launch AI-specific majors	Launch at least ten new AI departments or Colleges across the country
	New Technology University at the New Administrative Capital	University functional at the undergraduate level
	Introduce sector-specific AI courses into non-CS/CE majors	Launch sector-specific AI courses for at least three specialties including: finance, marketing, and healthcare
	Launch postgraduate programs in different AI-related domains	At least 3 postgrad programs launched, producing a total of at least 5000 graduates per year
	Professional upskilling programs	At least five levels of upskilling programs launched for different skill levels and specialties
	Educate government leaders in AI	Launch “AI business school” for five sectors Conduct “AI for leaders” sessions in all government entities
	Educate private sector leaders in AI	Launch a series of sector-specific awareness campaigns, including training and workshops for strategic sectors
AI4X	Lead efforts to coordinate AI strategies across African countries	Propose AU working group and produce unified African AI strategy
	Lead efforts to coordinate AI strategies across Arab countries	Propose ALS working group and produce unified Arab AI strategy
	Engage with Responsible AI and AI Ethics initiatives in international organizations	Expert representation in at least three international organizations active in responsible AI
	Lead the region in catalyzing AI for development through competitions for startups and researchers	Organize at least one regional and two international competition on an AI theme related to development
	Build diversified and balanced bilateral relations with like-minded countries for the benefit of both sides	Sign cooperation agreements with at least ten countries from different geographic and socio-economic groups
	Implement OECD country program for AI	Program implemented as per the agreed proposal
	Boost cooperation with donor organizations to exchange expertise and increase resource pool	Sign at least one major deal with donor organization to fund AI projects in Egypt

Table 5: Main initiatives of phase 1

13 Monitoring and Evaluation

To accurately monitor and continuously evaluate the Egyptian National Strategy and correct course, the following are the performance indicators for analyzing the strategy progression. The following is a group of Quantitative and Qualitative metrics, to benchmark the vision progress through tangible examination.

The evaluation criteria will be based upon 3 main axes:

- Total Strategy Impact
- Strategy Thought Leadership
- Strategy Execution Effectiveness

13.1 Total Strategy Impact

The Total Strategy Impact is to be considered on 3 Horizons of focus, as per the figure below:

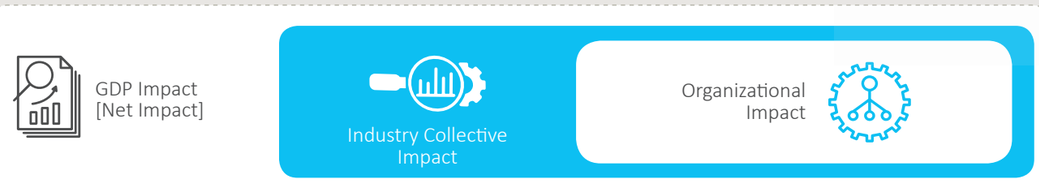


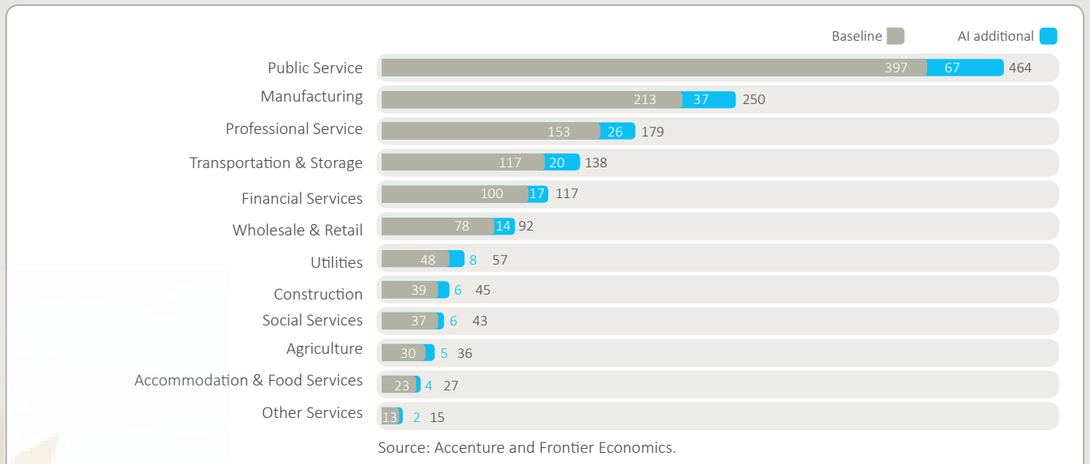
Figure 27: Levels of total strategy impact

Overall GDP impact

- This is the overall AI contribution to boost GDP growth. The direct net gains from AI adoption.
- For example, Egypt is forecasted to witness direct impact of $42.7Bn USD in 2030 (7.7% of GDP).

Industry Collective Impact

- This is the incremental value/boost driven by AI adoption. The figure below shows a forecasted Macro model for AI adoption in Saudi Arabia for example:



Source: Accenture and Frontier Economics.

Figure 28: A forecasted macro model for AI adoption in Saudi Arabia

Organizational Impact

- This is a micro analysis of the AI adoption impact per Entity.
- The impact will be surveyed based on the impact model mentioned above, with the help of the CoE consultants.

13.2 Strategy Thought Leadership

Egypt aspires to become a hub for research and development for AI in the region as a pioneering adopter of the technology. To that matter, it is critical to continuously showcase Egypt's superiority in the field, supported by its different industry players and centers of expertise through the different global media channels and public relations engagements.

The following are strategy performance indicators to stand the course of the strategy progression

- Egypt's representation in global AI events
- Mentions in research reports and AI impact studies
- Number of papers published in esteemed scientific journals or relevant publications
- Egyptians leaders in AI in the global market
- Egypt's contribution to AI research through building useable AI technology
- Number of advanced research centers in Egypt
- Profile of engaged contributors (individuals and organizations) to the AI strategy
- Global research/data partnerships to progress AI strategy
- Number of AI events in Egypt
- Foreign students coming to Egypt to learn/ research AI
- Diversity of usecases and AI applications in Egypt
- Progression of Egypt in the AI Readiness Index
- Diversity of Egyptian Governorates adopting AI
- Egyptian data quality per industry sector or research purposes

13.3 Strategy Execution Effectiveness

This is where we monitor the Strategy execution effectiveness in creating the change and enabling AI adoption. As mentioned, a dedicated Center of Excellence (CoE) will be assigned to introduce, build, consult and manage AI adoption throughout the Nation, based on the EPE model, The Explore, Plan, and Execute.

The main Key Performance Indicators for Explore, Plan and Execute are as follows:

13.3.1 Explore

- Total themes scored (quarterly, yearly)
- Total themes passed to “Plan” (quarterly, yearly)
- Total themes adopted (yearly)
- Total number of committees formed (quarterly, yearly)
- Profile of contributors (individuals and entities) in the committees
- Use cases and projects discussed
- Alignment of scoped projects with strategy

13.3.2 Plan

- Total number of Proof of Value delivered (POV)
- Total number of POV passed to “Execute”
- Total number of POV adopted
- Number of projects in pipeline
- Total number of generalized models (example: Arabic NLP, or pipeline defect recognition)
- Total number of scalable models passed to “Execute” (example: mappable predictive algorithms, or data synthesizers)
- Total potential impact documents crafted
- Total funding approved
- Data size acquired to enable different usecases
- Usecase alignment with overall strategy
- Advantageous to Egypt use cases (for example: use cases that are only relevant to Egypt due to locality of datasets)
- Data quality acquired
- Plan contributor profiles
- Academic/ white papers published from “Plan” operations
- Contribution to AI readiness index
- Engagement of the global AI communities and Egyptian representation in global AI events

13.3.3 Execute

- Total projects onboarded
- Total projects deployed and operationalized
- Total projects adopted
- Total number of generalized/ scalable AI model currently in use
- Total impact (additional income, cost savings due to increased efficiency, preventative fraud, theft, time effectiveness..etc)
  - per project
  - per industry
  - per GDP
- Average time-to-adoption
- Total governmental entities AI enabled
- Total spend to payback
- Number of third parties engaged in execution
- Establishment of data driven governments and entities
- Network contributors (those who contribute with their data, to improve prediction accuracy per industry)
- Academic/ white papers published
- Total cost efficiency in implementation
- News and media mentions of “Execute” use cases

13.3.4 Talent & Caliber Enablement

The strategy also focuses on enabling engineering calibers through different educational initiatives. The following is critical to ensure the strategy has right direction and execution:

- Number of courses sponsored
- Diversity of courses, technical and soft skills
- Number of applicants to graduates (yearly)
- Total number of graduates hired after the program (yearly)
- Average graduate turnover post hire (quarterly, yearly)
- Total number of graduates hired in target industries
- Graduates career progression (1,3 and 5 years) post-graduation
- Use cases graduates are working on post hiring
- Position/ title graduates hold after graduation
- Average salary for graduates post-graduation
- Total graduates hired for non-Egyptian companies
- Total number of international AI content partnerships

14 Conclusion & Next Steps

The document in its current form, serves as a high-level overview of Egypt's National AI Strategy. In it is not meant to replace an operational plan, and will be treated as a living document until the conclusion of the strategy in 2030. Constant monitoring and evaluation through the NCAI and other bodies will be essential, as will be continuous reviews and improvement. Notably, this document only details the priorities and implementation steps of phase 1 of the strategy. Subsequent versions of this document will be published in due course, outlining details for the following phases, while also taking advantage of the lessons learned during the implementation of phase 1.

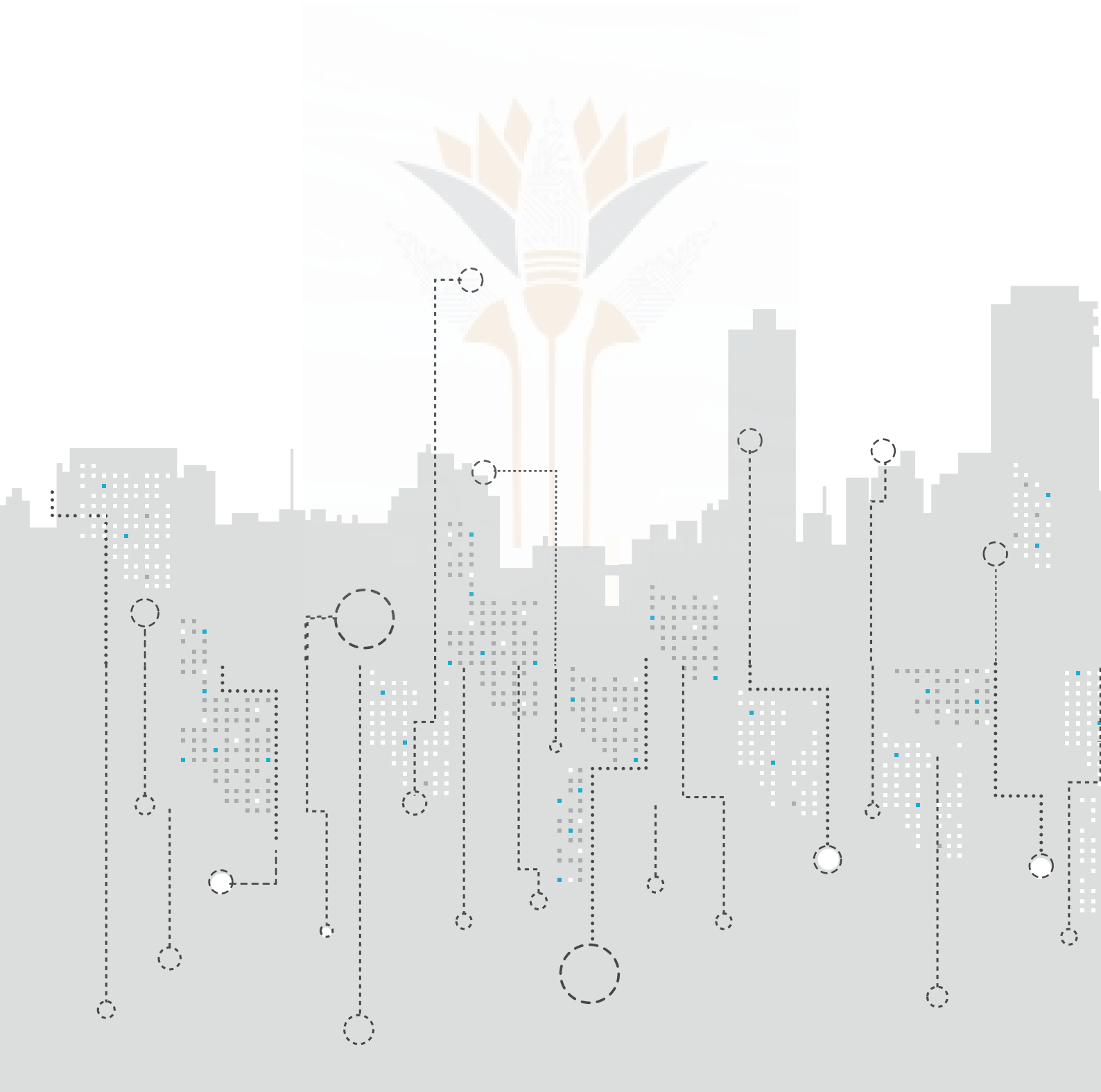
Related documents, such as the "Egyptian Charter on Responsible AI", the draft "Data Strategy", and sector-specific implementation plans, will also be published to complement the information in this document.

Appendix A: List of Main Contributors

- H.E. Dr Amr S. Talaat, Minister of Communications and Information Technology, Chair of the National AI Council
- Eng. Khaled El Attar, Deputy Minister for Administrative Development, Digital Transformation and Automation
- Eng. Golestan Radwan, Advisor to the Minister for AI
- Prof. Gamal Darwish, Former Information Section Chief, Higher Council of Universities. Former Professor, Faculty of Computers and AI, Cairo University
- Prof. Amir Attiya, Professor of Computer Engineering, Cairo University
- Prof. Ibrahim Moawad, Faculty of Computing and Information, Ain Shams University, AI Program Director, Al Galala University
- Ambassador Essam Ashour, Deputy Assistant Minister of Foreign Affairs for Innovation, Technology and Youth Forums
- Dr. Islam Zekry, Chief Data Scientist, Commercial International Bank
- Dr. Samhaa El Beltagy, New Giza University
- Prof. Mohamed Zahran, New York University
- Dr. Nagla Rizk, The American University in Cairo
- Eng. Ahmed Abaza, Synapse Analytics

Editorial Support

- Dalia Ibrahim Halawa, Publications Department Manager, IR Division, MCIT
- Samar Sobeih, External Relations Manager, AI Unit, MCIT
- Mahmoud Ibrahim, Translation Manager- Publications Department, IR Division, MCIT
- Suzy Naguib, Content Manager- Publications Department, IR Division, MCIT
- Sara Mahmoud, Graphic Design Manager- Publications Department, IR Division, MCIT
- Sameh El Amir, Graphic Design Manager- Publications Department, IR Division, MCIT
- Mohab Abdallah, AI Researcher, AI Unit, MCIT
- Noha Elwani, Translator and Administrator, AI Unit, MCIT

Appendix B: References

1. First version of Egypt's National AI Strategy, produced in 2019 as a joint effort between the ministries of communications and information technology, and higher education and scientific research.
2. 2020. Estonia's national AI strategy 2019-2021. [online]
3. 2020. Report of Estonia's AI taskforce. [online]
4. Niti. gov. in. 2020. Indian national strategy for AI #AIFORALL.[online]
5. Startupbridge. eu. 2020. Digital poland: map of the Polish AI. [online]
6. Ai-hungary. com. 2020. Hungary's AI strategy. [online]
7. Ki-strategie-deutschland. de. 2020. AI made in Germany. [online]
8. industry. gov. au. 2020. AI in Australia. [online]
9. The White House. 2020. AI for the American people | The White House. [online]
10. Oecd. ai. 2020. AI strategies and policies in Brazil - OECD. AI. [online]
11. Umali, T. , 2020. the philippines to draft an AI roadmap. [online] OpenGov Asia.
12. Oecd. ai. 2020. AI strategies and policies in Latvia - OECD. AI. [online]
13. Smartnation. gov. sg. 2020. singapore's national AI strategy. [online]
14. GOV. UK. 2020. AI sector deal. [online]
15. Satw. ch. 2020. recommendations for a Swiss AI strategy. [online]
16. Future of life institute. 2020. AI policy - Russia - future of life institute. [online]
17. A. Jobin, M. Ienca and E. Vayena, "The global landscape of AI ethics guidelines", nature machine intelligence 1, 389-399 (2019), p. 396.
18. M. Luengo-Oroz, "Solidarity should be a core ethical principle of AI", nature machine intelligence 1, 494 (2019).
19. B. Mittelstadt, "Principles alone cannot guarantee ethical AI", nature machine intelligence 1, 501-507 (2019), p. 504.
20. Regulatory impact analysis, OECD, [online]
21. V. Dignum, responsible AI: how to develop and use AI in a responsible way, springer, 2019, p. 51.
22. A. theodorou and V. Dignum, "Towards ethical and socio-legal governance in AI" nature machine intelligence 2, 10-12 (2020), p. 11.
23. Unesdoc. unesco. org. 2020. Preliminary study on the ethics of AI. [online]
24. Nedo. go. jp. 2020. Japan's AI technology strategy. [online]
25. Kurklt. lt. 2020. Lithuania's national AI strategy. [online]
26. Gouvernement. lu. 2020. Luxembourg's AI strategy. [online]
27. Mbie. govt. nz. 2020. New Zealand AI strategy. [online]
28. Ciencia. gob. es. 2020. Spain's RDI strategy for AI. [online]
29. Unesdoc. unesco. org. 2020. AI for sustainable development: synthesis report. [online]
30. Oecd. ai. 2020. The OECD AI policy observatory - OECD. AI. [online]
31. Oecd. org. 2020. AI in society. [online]
32. Regeringen. se. 2020. Sweden: national approach to AI. [online]
33. Whitehouse. gov. 2020. USA: national AI R&D strategic plan. [online]
34. Assets. publishing. service. gov. uk. 2020. UK: A guide to using AI in the public sector. [online]
35. En. wikipedia. org. 2020. Technology readiness level. [online]
36. Thefutureworldofwork. org. 2020. Top 10 principles for AI. [online]
37. Legalinstruments. oecd. org. 2020. OECD: recommendation of the council on AIe. [online]
38. Itic. org. 2020. ITI: AI policy principles. [online]
39. Itu. int. 2017. ITU: AI for good global summit report. [online]
40. Itu. int. 2019. UNESCO activities on AI. [online]