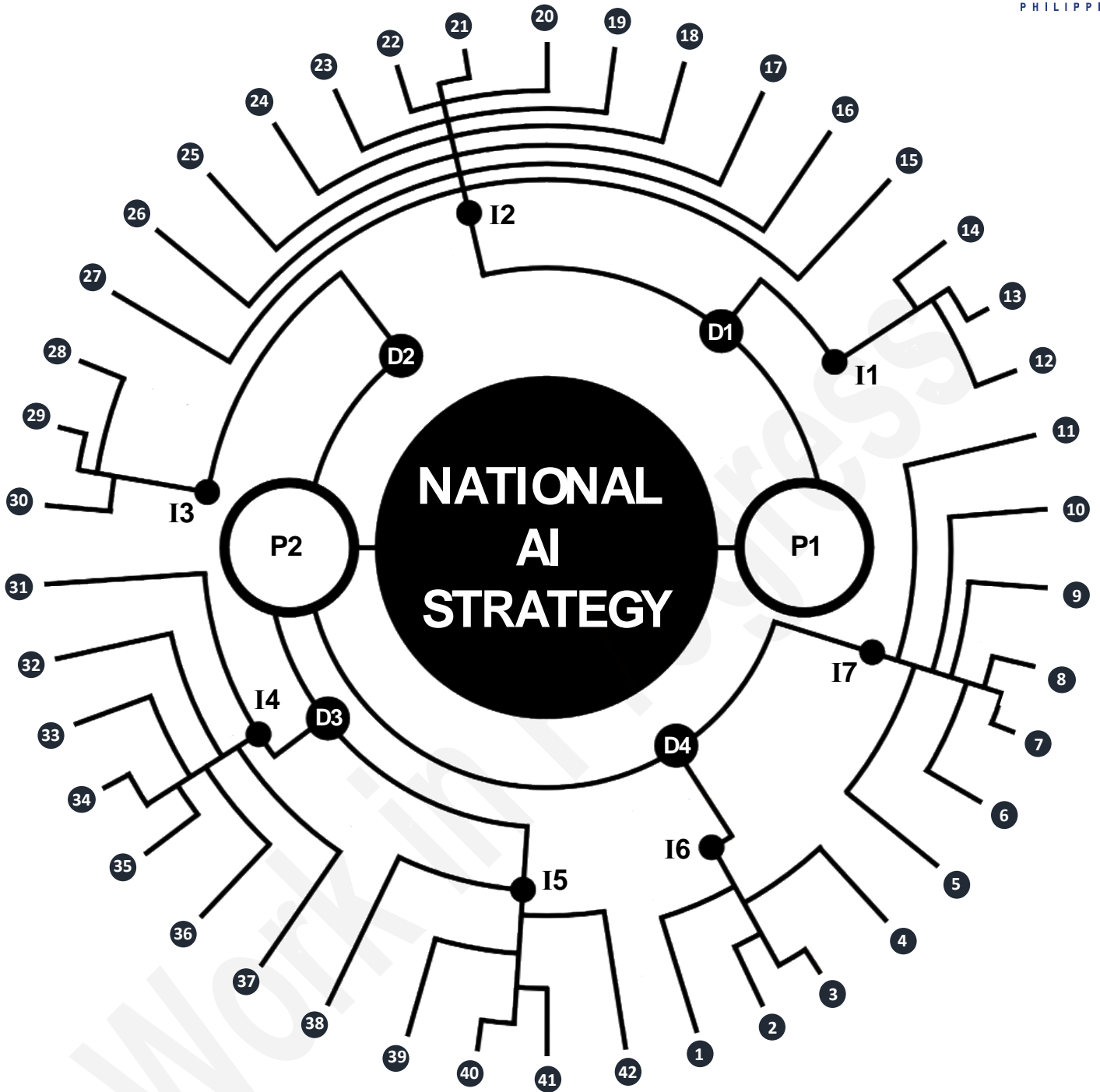


NATIONAL ARTIFICIAL INTELLIGENCE STRATEGY FOR THE PHILIPPINES

A large, stylized graphic of the Philippines flag is centered on the page. The flag's colors are rendered in a soft, glowing manner. Overlaid on the flag is a glowing yellow circuit board pattern that extends from the left edge. In the center of the flag, the letters "AI" are displayed in a bold, white, sans-serif font. The background of the entire page is a dark blue space filled with numerous small, colorful specks, resembling a starry night sky or a digital data field. The overall aesthetic is futuristic and technological.

AI



- 2 Pillars
- 4 Dimensions
- 7 Strategic Imperatives
- 42 Strategic Tasks

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Work in Progress

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Work in Progress

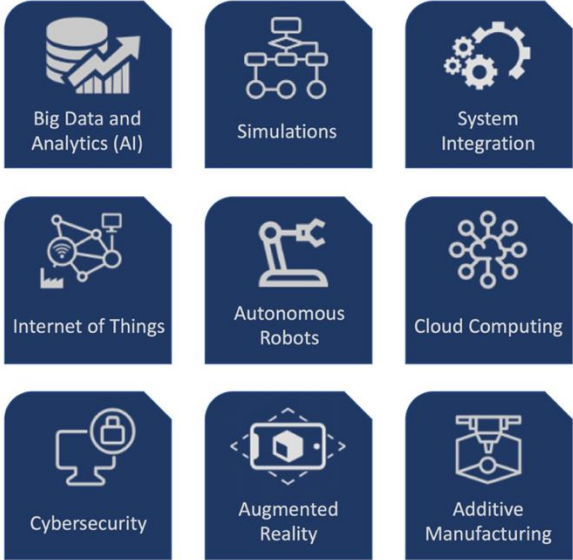
PART ONE:

INTRODUCTION

1.1 The Fourth Industrial Revolution

The Fourth Industrial Revolution (FIRe) is set to transform industries at an unprecedented rate. It will change everything from products and processes to design philosophies and business models—a multifaceted phenomenon involving technology, people, and the environment. FIRe is supported by nine main technological pillars: Big Data and Analytics, Simulations, System Integration, Internet of Things (IoT), Autonomous Robots, Cloud Computing, Cybersecurity, Augmented Reality (AR), and Additive Manufacturing.

Fig 1. The Nine Pillars¹ of FIRe.



Even from this technological perspective, it is clear that the response to FIRe should also be multi-pronged and fully integrated, especially since it is seen to impact not just industries but also, more importantly, people’s livelihoods and lifestyles. Although FIRe is sure to drive innovation and bring positive transformation to our society and the economy—such as the “potential to raise global income levels and improvement of the quality of life for populations around the world,¹” among others—it could, unfortunately, also result in greater inequality if not properly prepared for, stemming from how an untamed FIRe could influence the labor market, among others.²

¹ “The Fourth Industrial Revolution: what it means, how to respond” by Klaus Schwab, World Economic Forum, January 2016.
² Amy Bernstein and Anand Raman, “The Great Decoupling: An Interview with Erik Brynjolfsson and Andrew McAfee”, Harvard Business Review, June 2015.

Because of these equally likely outcomes, governments need to prepare, strategize, and maximize the benefits that can be obtained from FIRE's technological innovations; at the same time, policymakers should also aim to minimize its likely negative impacts on society and the economy.

Meanwhile, FIRE's influence on both personal and global perspectives, as well as on people's social and economic standing, has yet to be seen. Thus, governments with the help of both the industry and society need to be truly involved and should have a strong resolve to review and study how FIRE's nine pillars could particularly impact people—i.e., the current workforce as well as future talents.

Due to the expansive nature of FIRE, it is a pragmatic and strategic decision to focus on its key aspects, especially since resources are limited. Of all of its new and forthcoming technologies, Artificial Intelligence (AI) has been projected to drive 70% of the disruption, with blockchain and cloud computing accounting for the other 20%.³ AI is seen to greatly impact not only businesses and industries, but also societies and economies. In addition, according to PwC's recent report, AI could contribute a whopping \$15.7 trillion to the global economy by 2030.⁴ In this light, a strong focus on AI has significant potential to uplift the lives of Filipinos, local industries, and the national economy.

1.2 Artificial Intelligence

Broadly speaking, Artificial Intelligence (AI) refers to the capability of machines to simulate how humans think and perform tasks, which involve learning from data. AI is a big umbrella that can be divided into two general types: Artificial General Intelligence (AGI) and Artificial Narrow Intelligence (ANI).

AGI refers to the "hypothetical intelligence" of machines: their human-like capability to digest and interpret ideas, be creative, and learn any intellectual task that a person can also learn and implement. AGI allows machines to do practically everything that humans can do and are even expected to compete against humans. However, AGIs, as of this writing, are not yet in existence.

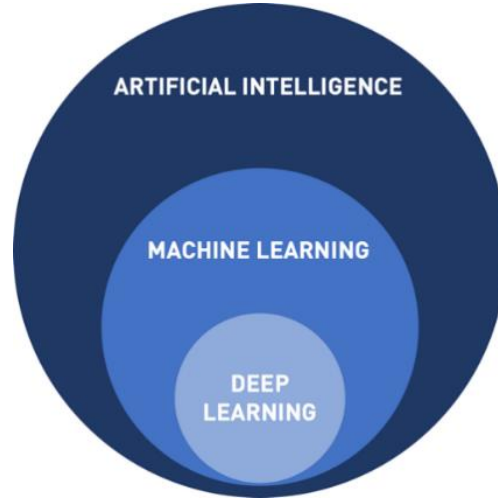
On the other hand, ANI, as its name implies, refers to machines that perform a very limited set of tasks—oftentimes, a specialization in one specific task. There may be platforms that combine multiple ANI models (e.g., platforms for predictive maintenance can perform both image detection and then classification). Most business- and industry-use cases only need ANI algorithms, which are good at—and can actually outperform humans at—tasks that are routine or repetitive. Examples of ANI models include those that could be used to conduct medical diagnoses; to predict whether a machine in a factory will breakdown or not; to classify and separate spam emails; to play chess; etc.

While ANI may seem underwhelming in comparison to AGI, it is this kind of AI that is mainly referred to when discussing FIRE and when talking about driving innovation. In this document, when AI is mentioned, it refers to ANI, unless stated otherwise.

³ "Big Data Executive Survey 2018", NewVantage Partners LLC, 2018.

⁴ <https://www.pwc.com/gx/en/issues/data-and-analytics/publications/artificial-intelligence-study.html>

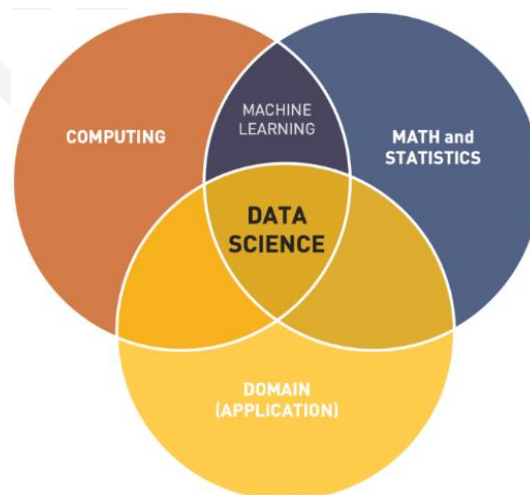
Fig 2. Artificial Intelligence, Machine Learning, and Deep Learning.



The terms strongly associated with AI include machine learning (ML) and deep learning (DL). Plainly speaking, these terms refer to the methods and models implemented in machines to look for patterns in data and learn from them to perform singular tasks. Deep learning, on the other hand, is a set of machine learning models that involve the use of neural networks, inspired by the structure of the brain, in looking for patterns in data and making predictions; DL is a subset of ML. (see Figure 2)

Another concept strongly associated with AI is Data Science (DS)—a much bigger umbrella term, in that it encompasses the use of descriptive, predictive, and prescriptive analytics. This specifically includes AI models that can reveal patterns in data and drive insights within organizations (see Figure 3). In DS, there is an equally strong emphasis on domain applications aside from AI or ML algorithms.

Fig 3. The Data Science Venn Diagram conceptualized by Drew Conway. AI and Machine Learning are subsets of the Data Science field that also emphasizes domain application.



From a purely academic perspective, AI has a relatively longer history than what many might assume: the first AI program that can mimic humans' problem-solving aptitude was built by Herbert Simon, Allen Newell, and John Shaw in 1956.⁵ How come, then, that it is only now that we are seeing a global rise in artificial intelligence, in both theory and practice? This progression can be attributed to at least four phenomena:

1. The deluge of data
2. The increase in the computing power of machines
3. The increase of storage capacity of devices and the depreciation of their cost
4. The innovations in machine learning and other computing algorithms

The development of AI is expected to continue at an accelerating rate driven by exponential increases in both data and computing power, coupled with cheaper data storage. In particular, the world has been producing 10 times more data every two to three years. On the other hand, computer processing power doubles every 2 years, even while the cost of data storage cost has predictably dropped over 2 million times in the last three decades alone. Moreover, the pending breakthrough in quantum computing will further revolutionize computation on a factorial scale and will make AI more powerful than we have ever imagined.

Within the next decade, AI can be expected to revolutionize many mundane aspects of our daily lives. For one, the automotive industry will most likely be able to practically perfect autonomous vehicle technology. The synchronization of vehicle movements will be straightforward, and it can be expected that traffic congestion will be addressed and alleviated even in developing countries like the Philippines. AI-driven precision farming can also drastically decrease losses due to pests, natural disasters, and can increase significantly outputs of high value products per hectare of land. Having the right people and technology to carry the above concerns will not only allow wealth generation but also assure inclusivity, as these will address the need for shared basic infrastructure that citizens need to be productive and contented: housing, transportation, and food security, among others.

In a report by McKinsey, AI could be seen to open up opportunities in Southeast Asia in that it could “automate about 50% of the work activities performed in ASEAN’s four biggest economies,” which include the Philippines. And, in an October 2020 report by EDBI and Kearney, AI is expected to boost Southeast Asia’s GDP by up to US \$1 Trillion by 2030.⁶ In addition, Kearney analysis estimates a 12% uplift in the Philippine GDP by 2030; this is equivalent to 92 billion USD.⁷

Without a doubt, AI will fundamentally transform many aspects of society and the economy—but it is a precision scalpel which, if misused or misguided, can harm rather than heal. It is thus important to ensure that only positive transformations are maximized.

⁵ Leo Gurty, “Newell and Simon’s Logic Theorist: Historical Background and Impact on Cognitive Modeling,” Human Factors and Ergonomics Society Annual Meeting Proceedings 50(9):880-884, October 2006.

⁶ EDBI, “Artificial intelligence could deliver a US\$1 trillion uplift to Southeast Asia’s GDP by 2030”. Accessed from:

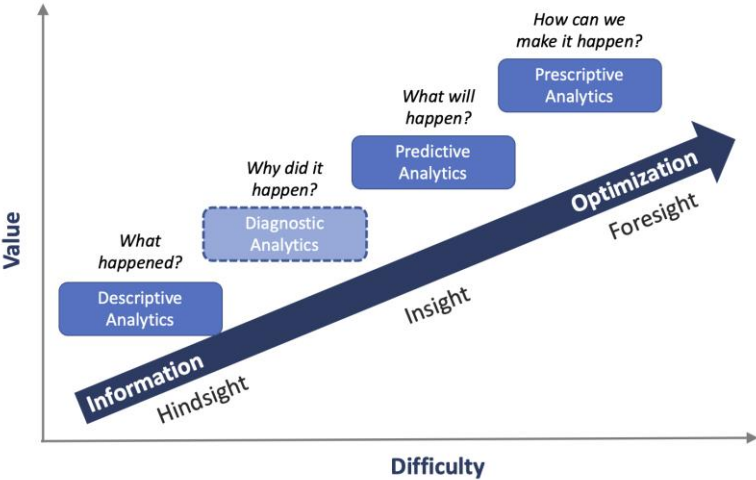
<https://www.edbi.com/news-room/latest-news/artificial-intelligence-could-deliver-a-us1-trillion-uplift-to-southeast-asia-s-gdp-by-2030>

⁷ EDBI and Kearney, “Racing towards the future: artificial intelligence in Southeast Asia”, 2020.

1.3 Potential Transformations brought about by AI

Industrial Structure

Fig 4. The Gartner Analytics Maturity Levels. (re-illustrated)



In 2012, Gartner released an analytics maturity graph, identifying four types of analytics: descriptive, diagnostic, predictive, and prescriptive analytics; the analytics maturity level is with respect to the potential value a type of analytics can contribute to organizations. As illustrated in Figure 4, descriptive analytics is about extracting value from information from both the present and the past; it asks the question “what happened?”, while diagnostic analytics asks the question “why did it happen?” Predictive analytics, on the other hand, answers the questions “what will happen?” Finally, prescriptive analytics asks the question “what can we do?” or “how can we make it happen?” And, for both predictive and prescriptive analytics, Artificial Intelligence, as a tool and technology, plays a significant role.

In this era of digitization and digitalization, it is expected that industries will start competing in the field of (predictive and prescriptive) analytics; descriptive (and diagnostic) analytics will be a commonplace. Indeed, the more mature organizations will have begun to embrace AI technologies.⁸ In fact, this is already being observed in the Philippines: some of our biggest enterprises have already jumpstarted their digital transformation and AI journeys. Innovative organizations acknowledge that data science is no longer an optional “nice-to-have” capability but an absolute must-have necessity; it thus follows that AI should also be a strategic capability. It needs to be emphasized, however, that the value that AI can bring into an organization cannot exist without business intelligence or data analytics—which normatively refers to descriptive analytics—capability.

⁸ Thomas Davenport, “Competing on Analytics,” Harvard Business Review, January 2006.

More formally, enterprises that compete on analytics have at least three distinct features⁹:

1. They use data and analytics enterprise-wide. That is, the applications of AI are not only siloed nor limited to certain verticals within the organization; instead, the whole is transformed.
2. Their leaders are knowledgeable about analytics. In these organizations, the knowledge of industry leaders goes beyond definitions; they have a deep understanding of the technology and how it can impact their products and processes.
3. Industries competing on analytics employ advanced analytics, going beyond just descriptive analytics. Aside from machine learning and deep learning, they also use simulations, another pillar of the Fourth Industrial Revolution, in their decision-making processes.

Organizations that take the lead in their own digital transformation invariably leapfrog their competitors. With AI, this first-mover advantage is much more emphasized. We must expect that the gap between the have-mores, the haves, and the have-nots in the industry will further widen.

It must be stressed that 99% of Philippine enterprises are MSMEs, which employ over 73% of the workforce. Thus, the government cannot simply leave industries on their own to equip themselves with the right analytics capabilities, especially since many do not have the needed resources. The government should assist and enable MSMEs, which have scarcer resources, in taking advantage of AI technologies and Business Intelligence (BI) tools that could help them improve their efficiency and productivity.

Labor & Employment Structure

Job Loss and Job Creation

Many jobs, especially low-level and routine-driven ones, will be taken over by machines. This wave of automation has already commenced in “high-wage countries,” and is expected to hit the Philippines and the rest of the developing world soon.¹⁰ According to the McKinsey Global Institute: “48 percent of employees’ activity, equivalent to 18.2 million jobs, could be automated. The largest share of automatable work in the Philippines, amounting to 6 million jobs, is in agriculture-related sectors, where occupations involve a large proportion of physical activities in predictable environments. Other sectors with large numbers of automatable work include retail (3.4 million jobs) and manufacturing (2.4 million jobs). Manufacturing has the highest proportion of automatable work of any sector, at 61 percent.”¹¹ This is, of course, contingent on the presence and prevalence of the elemental processes and technology systems (e.g., mechanized systems, IoT) that allow for the proper implementation of AI solutions.

The high concentration of automatable work in the Philippine agricultural and related sectors—which are, on the average, among the lowest-earning jobs locally—is compounded by a demographic profile tilted towards younger ages and a higher automation risk faced by younger workers (ages 15-24): 76%, according to a recent study; this threatens the country’s “demographic sweet spot” and may lead to

⁹ Ibid.

¹⁰ Jayant Menon, “Why the Fourth Industrial Revolution could spell more jobs – not fewer”, World Economic Forum, September 2019.

¹¹ Suraj Moraje, “Seizing the automation opportunity in the Philippines”, February 2017.

increased youth unemployment, with all the societal consequences that that entails.¹² It is instructive to note that, historically speaking, during the Second Industrial Revolution, local societal and labor disruptions took place as a consequence of long-delayed efforts at agricultural mechanization.^{13,14}

On the other hand, new jobs are also expected to be created, especially centered around the FIRE pillars. In the short term (2018-2023), 10 million jobs are expected to be created in the fields of data science and big data analytics. With the Asian Institute of Management inaugurating a graduate program in Data Science, and other higher educational institutions on the brink of instituting similar programs, this bodes well for the Philippines' transition from a BPO services hub to a big data processing and analytics hub.¹⁵

Creative and Emotion-Strong Skills

Creative and emotion-strong skills will be necessary prerequisites on top of technical skills for the future workforce. While highly technical skills will be in short-term demand, creative and emotion-strong skills will be necessary in the long term for workers to avoid being impacted by digitalization.¹⁶ In the field of machine learning, for example, even the implementation of algorithms is already being automated (e.g., auto ML). Workers who lack the creative and emotional skills needed to go beyond machines' capabilities will likely find themselves redundant.

Platform-dependent workers

Lastly, there will be a greater demand for platform-dependent workers. With digitization, the demand for freelance workers is only going to grow, with attendant shifts in our traditional concept of job security—and not necessarily for the better. Filipino freelancers have previously been reported as over-represented (relative to the total Philippine population) in at least one online platform for contract work as early as seven years ago¹⁷, and this proportion has only increased in succeeding years. The dominance of self-employment, short-term or seasonal work, and part-time employment is recognized to have an undermining effect on job security¹⁸, and the FIRE will only strengthen trends towards a “gig economy”. While digital labor does offer a means to escape limited local opportunities and bring important and tangible economic benefits, it also carries risks and costs such as alienation, discrimination, and lowered bargaining power for workers.¹⁹ It can also be expected that occupational health and safety issues brought about by the global scope of digital work and business networks, such as disrupted biorhythms, overwork and social disconnection, to rise in prominence.²⁰

¹² Jamil Paolo Francisco *et al.*, “Mapping Philippine Workers Risk of Automation in the Fourth Industrial Revolution”, AIM-RSN-PCC Working Paper 2019-01, April 2019.

¹³ Jesrael Medrano *et al.*, “Rice Combine Harvester: Its Effects to the Livelihood of Rice-Field Tenants in a Second-Class Municipality”, *Asia-Pacific Journal of Multidisciplinary Research*, November 2016.

¹⁴ Boyd Luis Antonio Tolentino, “Factors Affecting the Adoption of Combine Harvesters among Rice Farmers in Baliwag, Bulacan, 2016”, Baccalaureate Thesis, BS Agricultural Economics, UP Los Baños, August 2017.

¹⁵ Elmer Dadios *et al.*, “Preparing the Philippines for the Fourth Industrial Revolution: A Scoping Study”, PIDS Discussion Paper Series 2018-11, August 2018.

¹⁶ Carl Benedikt Frey and Michael Osborne, “The Future of Employment: How Susceptible are Jobs to Computerisation?”, September 2013.

¹⁷ Ajay Agarwal *et al.*, “Digitization and the Contract Labor Market: A Research Agenda”, October 2013.

¹⁸ Anders Borg, “How will the Fourth Industrial Revolution Affect Economic Policy?”, World Economic Forum, January 2016.

¹⁹ Mark Graham *et al.*, “Digital Labour and Development: Impacts of Global Digital Labour Platforms and the Gig Economy on Worker Livelihoods”, *Transfer* 23(2): 135-162, 2017.

²⁰ Jeehee Min, *et al.*, “The Fourth Industrial Revolution and Its Impact on Occupational Health and Safety, Worker's Compensation and Labor Conditions”, *Safety and Health at Work* 10: 400-408, 2019.

Lifestyle and Living Environments

Consumers will start demanding more from businesses in terms of providing them with their specific needs and wants. Customers will be looking for much more personalized and customized products in addition to faster and more efficient services.

Digital payments will become more prevalent. While the total value of digital transactions in the Philippines was previously projected to reach \$10.5 billion in 2020, up 26.6% from 2019,²¹ societal and economic changes brought about by the ongoing COVID-19 pandemic will drive up the digital shift even further. But some challenges remain: the Philippines continues to lag behind its ASEAN neighbors in 4G and broadband penetration, digital adoption, internet speeds, and digital payments and logistics, among others.²²

While the “smart home” concept—involving real-time sensing and monitoring of, e.g., indoor energy usage and temperature, air quality, and the control of “smart appliances” via Apple Siri and Google Home—has been commercially available since before recent advances in AI, the latter can be harnessed in conjunction with the Internet of Things (IoT) to integrate previously-disparate data streams and obtain insights from the former to enhance the home owner’s decision-making process.²³ Furthermore, such data streams—collected, anonymized, and aggregated with full respect for the digital rights of home owners and prevailing data privacy and security regulations—may be useful to architects, engineers, and urban planners and policymakers.²⁴

Economy

As stated earlier, the Philippines is facing profound changes in the nature of jobs due to automation (in turn driven by AI), with agriculture and related sectors facing the most number of automatable jobs (6 million) and manufacturing facing the greatest automatable proportion (61% of jobs in the sector).²⁵ At the same time, long-term projections estimate a 12% (92 billion USD) increase in Philippine GDP by 2030, provided that favorable actions are taken.²⁶ The potential impact of AI and automation is mixed and may vary across sectors; capturing the economic benefits from these will depend on a willingness on the part of business leaders to reorient entire processes, increase technological investments and institute organizational changes—something which may vary from industry to industry.²⁷

The Philippines benefits from favorable changes in the local innovation and startup ecosystem, which would otherwise inhibit AI adoption. The local startup ecosystem ranked 54th out of 100 countries in 2019, an increase of 16 places from 2017.²⁸ Simultaneously, the Philippine government has instituted legal frameworks aimed at fostering an innovation ecosystem, with Republic Act 11337 (the Innovative Startup

²¹ Statista, “FinTech Report 2020 – Digital Payments”, <https://www.statista.com/outlook/296/123/digital-payments/philippines>.

²² The World Bank, “A Better Normal under COVID-19: Digitalizing the Philippine Economy Now”, <http://documents1.worldbank.org/curated/en/796871601650398190/pdf/Philippines-Digital-Economy-Report-2020-A-Better-Normal-Under-COVID-19-Digitalizing-the-Philippine-Economy-Now.pdf>

²³ Omid Saberi *et al.*, “Artificial Intelligence and the Future for Smart Homes”, International Finance Corporation, February 2020. <https://www.ifc.org/wps/wcm/connect/6fc5b622-05cb-4ee9-b720-ab07591ac90e/EMCompass-Note-78-AI-Smart-Homes.pdf>

²⁴ Ibid.

²⁵ Suraj Moraje, op. cit.

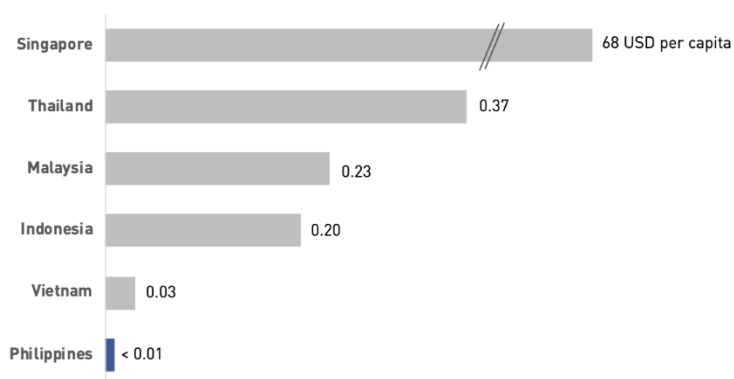
²⁶ EDBI and Kearney, op. cit.

²⁷ Suraj Moraje, op. cit.

²⁸ PricewaterhouseCoopers Philippines, “Charging Ahead: Philippine Startups Break Boundaries”, 2020. https://www.pwc.com/ph/en/ceo-survey/2020/pwcp-h-start_up_survey_2020.pdf

Act) signed into law in April 2019²⁹ and its implementing rules and regulations issued later that same year. The act created a Philippine Startup Development Program, led by the Department of Science and Technology (DOST), the Department of Trade and Industry (DTI) and the Department of Information and Communications Technology (DICT). Under the program, the law provides for a series of incentives and benefits for selected startups and startup enablers (accelerators and incubators, co-working spaces, investors, funders, startup-oriented event or meet-up organizers and other support organizations), such as subsidies for business registration, use of office space and equipment, travel and visa assistance, grants for R&D activities, and venture funding. Furthermore, the education-oriented agencies—the Department of Education (DepEd), the Commission on Higher Education (CHED), and the Technical Education and Skills Development Authority (TESDA)—are to integrate entrepreneurship into curricula and provide grants and incentives to academic institutions.³⁰ The Philippine Corporation Code was also revised in 2019 to improve ease of doing business³¹ by allowing for the incorporation of one-person corporations.³²

Fig 4. 2019 Investments on Artificial Intelligence across Southeast Asia.



Data Source: Pitchbook; Kearney analysis (2020)
 * Philippines's figure reflects investments in 2018 due to data availability

However, at present, the Philippines is hamstrung by insufficient research and development expenditures and other factors.³³ Within ASEAN member countries—which, except for Singapore, tend to lag behind more advanced countries by two to three years in terms of AI investments—the Philippines, at less than 0.01 USD per capita trails its neighbors Thailand (0.37 USD p.c.), Malaysia (0.23), Indonesia (0.20) and Vietnam (0.02) (see Fig. 4). To date, annual government R&D spending remains below the recommended 2% of GDP, equivalent to 5.0 B USD (see Fig. 5).^{34,35} A relative dearth of R&D personnel³⁶ and weak data infrastructure and governance³⁷ are also major inhibiting factors.

²⁹ Congress of the Philippines, “Innovation Startup Act”, RA 11337.

<https://www.officialgazette.gov.ph/downloads/2019/04apr/20190717-RA-11337-RRD.pdf>

³⁰ Teresa Umali, “The Philippines Signs Innovative Startup Act into Law”, July 2019. <https://opengovasia.com/the-philippines-signs-innovative-startup-act-into-law/>

³¹ Congress of the Philippines, “Revised Corporation Code of the Philippines”, February 2019.

<https://www.officialgazette.gov.ph/downloads/2019/02feb/20190220-RA-11232-RRD.pdf>

³² Pricewaterhouse Coopers Philippines, op. cit.

³³ Department of Trade and Industry, “The Philippine Inclusive Filipinnovation and Entrepreneurship Roadmap”, October 2018. <http://industry.gov.ph/wp-content/uploads/2018/12/Inclusive-Filipinnovation-and-Entrepreneurship-Roadmap.pdf>

³⁴ Business Mirror, “PHL Needs to Beef Up R&D Spending”, April 2020. <https://businessmirror.com.ph/2020/04/22/phl-needs-to-beef-up-rd-spending/>

³⁵ Business Mirror, “More investment in R&D needed,” February 2017. Quote: “More investments in R&D needed, 2% to propel Philippines to 1st world status” from Acd. Balisacan, former NEDA secretary and current Philippines Competition Commission chairman

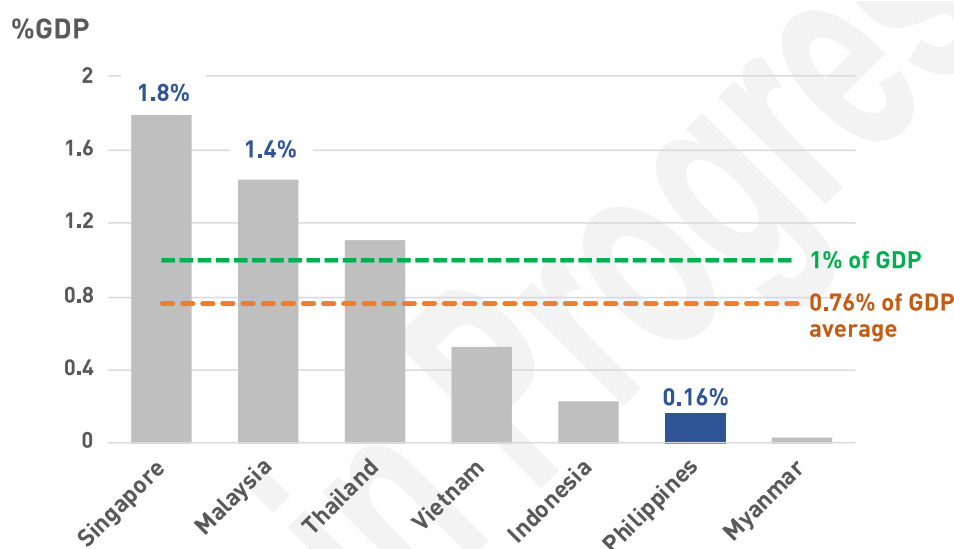
³⁶ Department of Trade and Industry, op. cit.

³⁷ EDBI and Kearney, op. cit.

Governance

AI holds out the promise of helping governments deliver services faster and more efficiently, as well as better citizen engagement, accountability, and transparency. Key governance areas where AI and automation of repetitive tasks can result in more efficient transactions and more accurate assessment of policy outcomes include healthcare, finance, transportation, infrastructure, telecommunications, policymaking, and the legal and justice sector.³⁸ AI is also expected to improve the ease of doing business (EODB) in the country, specifically with regard to cutting red tape. This will further the mandate of the Anti-Red Tape Authority under the Office of the President.

Fig 5. R&D Investment of ASEAN-member countries. The 0.76% of GDP is the average among the focused countries. On the other hand, the recommended expenditure is at 2%.



Data Source: World Bank Data Base, 2020. Available online: <https://data.worldbank.org/>
For Singapore and Thailand, data are taken from OECD and NXPO, respectively, as they have more recent information.

A robust ICT infrastructure is a key driver for the AI transformation of governance, so it is worth examining the current state of ICT in Philippines and how it ranks relative to its neighbors and the rest of the globe. As envisioned by the Philippine Digital Strategy 2011-2016,³⁹ the Philippine DICT was created in 2016 to serve as the focal agency for coordinating all government ICT efforts, leading e-Government initiatives, and increasing accessibility to public services. In turn, DICT in 2019 released its e-Government Masterplan 2022 (EGMP 2022)⁴⁰, which both surveyed the state of progress from the previous EGMP (2016) and set forth new objectives and a refined blueprint for a common government information system and a National Government Portal as a primary gateway for government online services. Increased cohesion of government ICT programs, the rationalization of ICT initiatives into a standards-based framework, and the

³⁸ Gagan Deep Sharma *et al.*, "Artificial Intelligence and Effective Governance: A Review, Critique and Research Agenda", *Sustainable Futures* 2, 100004, 2020.

³⁹ The Philippine Digital Strategy 2011 – 2015, <https://dict.gov.ph/wp-content/uploads/2014/06/philippine-digital-strategy-2011-2015.pdf>

⁴⁰ Department of Information and Communications Technology, e-Government Masterplan 2022, <https://dict.gov.ph/ictstatistics/wp-content/uploads/2020/03/EGMP-2022.pdf>.

promotion of opportunities for acculturation and formation of a mindset of collaboration and information-sharing among government employees are among the expected outcomes of EGMP 2022, yet challenges related to e.g. clear benchmarking of project impacts (vis-à-vis outcomes), already noted upon with respect to the previous EGMP, remain.⁴¹

At present, the Philippine government is rated to have a high capacity to maximize information and communications technologies (ICTs) in the delivery of public services and a very high degree of engagement with constituents via ICTs, by a pair of United Nations indicators: the e-Government Development Index (EGDI) and the e-Participation Index (EPI). However, among the 193 jurisdictions so rated, the Philippines ranks 77th in EGDI (a fall of two places from 2018)⁴² and joint 57th in EPI (a fall of 38 places from 2018).⁴³ Among ASEAN member states the Philippines lags behind Malaysia and Thailand in both indices, behind Brunei in EGDI, and ranks the same as Indonesia in EPI; for further comparison, the ASEAN frontrunner, Singapore, ranks 11th according to EGDI and 6th in EPI, and China ranks 45th in EGDI and 9th in EPI.

It is imperative to track the ways in which governance is being transformed by AI and digitalization. However, our current knowledge of governance transformation due to AI is lacking. Current research efforts are unevenly spread across sectors,⁴⁴ and the understanding the challenges of AI adoption and the risks involved are lacking. Substantial knowledge gaps exist in education, healthcare, and socio-cultural services, sectors which are of utmost importance for the Philippine context, and where we cannot afford hit-and-miss, trial-and-error approaches.

Finally, while AI is poised to transform governance, it is supremely important to go about it in an ethically responsible way, to avoid the institutionalization of existing biases and the creation of new ones. This matter is too important to be left to anyone or any single group and must involve vigorous and constructive conversation among all stakeholders: government, academia, industry, and civil society. Such a conversation will need to be grounded in the Philippine context, taking into account the particularities of the Filipino experience, while remaining open to conversations taking place in the rest of the world and willing to adopt best practices from them. Other countries and trans-national organizations, such as the European Union, the United Kingdom, Japan, and China have taken the lead in these conversations;^{45,46} insights from the latter could be used to jump-start local discourse.

1.4 Barriers to AI Adoption

Most enterprises and C-level executives worldwide are largely cognizant of AI's enormous impact on their business processes and products, but the Philippines is slow in this realization and its embrace of AI. To address this deficiency, it is critical to identify the major barriers to AI adoption for most, if not all, local organizations and enterprises.

⁴¹ Ibid.

⁴² UN e-Government Knowledgebase, <https://publicadministration.un.org/egovkb/en-us/Data-Center>

⁴³ Ibid.

⁴⁴ Ibid.

⁴⁵ "AI Governance in 2019: A Year in Review", Shanghai Institute for Science of Science, April 2020, <https://www.aigovernancereview.com/static/AI-Governance-in-2019-7795369fd451da49ae4471ce9d648a45.pdf>.

⁴⁶ Wenjun Wu, *et al.*, "Ethical Principles and Governance Technology Development of AI in China", *Engineering* 6: 302-309, 2020.

Lack of Understanding of Data Science and AI

Many organizations in the Philippines still have insufficient knowledge of what Artificial Intelligence (AI) and Data Science are. Hence, they cannot conceptualize how this new technology and set of tools can help their business processes and products. Critically, they cannot invest or are not willing to invest money and other resources into something whose value and impact are not explicit nor tangible to them.

Among those with a degree of familiarity to AI, concern about employee backlash due to the pace of change and job displacement tends to be an inhibitory factor.

Lack of Knowledge on Potential Use Cases

Perhaps another reason local industries and other organizations lack an understanding of the field of analytics is the scarcity of information on potential use cases of AI. While many concrete examples exist outside of the Philippines that are readily accessible via the news and from online resources, many of our local enterprises cannot connect or relate to these examples. Many still seem far-fetched to local enterprises and the workforce. We need more potential use cases that are locally generated, so as to paint a more compelling picture for local stakeholders.

Lack of Resources

Here, the lack of resources is categorized into two forms: equipment (computational resources) and manpower (human resources).

Many enterprises, mostly MSMEs in the Philippines, are resource challenged in terms of the capability to set up their own computational resource, including cloud computing resource, and/or even acquire BI software to aid them in their data and system analysis. Thus, even though many are familiar with the different AI use cases in their particular industry, they still cannot bring in the facility as it could cost them an arm and a leg. And with no clear business value, this is definitely not worth risking additional resources to.

In addition to the computing resource, most, if not all, industries in the country, especially those that have started to invest in AI and Data Science have been restricted by the scarcity of data experts, which include data analysts, data scientists, machine learning engineers, data engineers, data architects, and data stewards, among others. More importantly, many of the data-skilled talents lack the required business skills to make AI R&D projects practical and profitable for the enterprises.

Lack of Data Strategy

Data Strategy or AI strategy is essentially a vision for how organizations should invest their resources towards building capabilities in data science and AI, anchored particularly on each company's strategic imperatives and business objectives. A common misunderstanding is that a data strategy is all just about the data and the technology—e.g., how/what to collect, where to store, what BI platforms to use, etc. Rather, it is about how acquiring technologies and technical capabilities can help enterprises achieve their strategic goals.

It is potentially disastrous when organizations pour significant investments into digitization without charting their data/AI strategy in alignment their own corporate vision. This could result in enormous monetary losses and opportunity losses.

This particular barrier is more prevalent in large enterprises that have the financial capacity to invest in digitization, which include the capability to solve use cases with ML, but do not have the right people who are both technically and business savvy to bridge the gap between technology and business.

Uncertainties about Legal & Regulatory Framework for AI

By setting out ethical boundaries to prevent indiscriminate and non-rights-respecting AI applications and protections for both customers and businesses, a clear legal and regulatory framework for artificial intelligence will both protect the rights of Filipinos and spur responsible adoption of and innovations in AI. However, at the present the Philippines lacks a complete framework for such. Indeed, as far as AI has been in the public statements of lawmakers, more emphasis has been placed on its potential disruptive effects such as job losses, especially in the financially-important BPO sector.

Fortunately, one component of the framework is currently present: the 2012 Data Privacy Act, modelled after the European Union's General Data Protection Regulation, offers robust protections for data privacy. Filling in the missing pieces of the puzzle is now the next step.

PART TWO:

OBJECTIVES of the ROADMAP

In 2019, the Philippine Congress championed the approval of the Philippine Innovation Act (RA 11293), aiming to fund and support R&D efforts in the country towards national development. The Act's main objective is “to generate and scale up actions in all levels and areas of education, training, research, and development towards promoting innovation and internationalization activities of micro, small and medium enterprises as drivers of sustainable and inclusive growth.”

On the other hand, innovation cannot be divorced from technology within enterprises. In fact, most innovations happening today in businesses, industries, governments, and society are chiefly driven by new technologies. Three ways⁴⁷ have been highlighted by which new technologies accelerate innovation:

1. Technology as founder of new markets
2. Technology as vehicle for innovation
3. Technology as enhancer of human capabilities

Thus, it is paramount to carefully look into new technologies and the role they play in driving inclusive development and promoting growth and national competitiveness of our people and our enterprises—all of which are at the core of the Philippine Innovation Act.

By the same token, among all new technologies, artificial intelligence (AI) has been projected to drive majority of the disruptions in industry.⁴⁸ AI is seen to greatly impact not only businesses and enterprises, but also the very fabric of societies and economies.

In this light, the objective of the Roadmap is to focus on how AI can be used to uplift our people, our industries, and our economy. In particular, the AI Roadmap has been crafted as a guide for codifying and devising a strategy of national preparedness to maximize the benefits from employing AI technologies and developing AI economies, and also being mindful of the potential consequences and impacts of algorithms to processes and business models.

AI is expected to not only improve the competitiveness of our enterprises, but also to improve society, including our people's well-being, since data and analytics are seen to also facilitate more affordable, more accessible, and more bespoke public services that include disaster preparedness and management, education, and healthcare.

⁴⁷ Mikael Eriksson Björling, “3 Ways That New Technologies are Accelerating Innovation”, Ericsson Blog, June 07 2018. Accessed at: <https://www.ericsson.com/en/blog/2018/6/3-ways-that-new-technologies-are-accelerating-innovation>

⁴⁸ “Big Data Executive Survey 2018”, NewVantage Partners LLC, 2018.

Although not exhaustive, the main objectives are as follows:

1. To maintain the regional and global competitiveness of local industries, noting that AI is one of the biggest drivers of innovation for enterprises.
2. To identify key areas (in both R&D and technology application) for investing both time and resources of government, industry, and society. In line with the Philippine Innovation Act, this includes harnessing existing global knowledge and new technologies that will aid in the development of new processes, products, and services for increasing productivity and for promoting overall public welfare.
3. To recommend ways for effectively fostering a triple-helix (R&D) collaboration among government, industry, and the academe, which is essential to national development.
4. To suggest approaches for preparing the future workforce for the jobs of the future.
5. To attract the biggest industries to set shop in the country, and thus generating more jobs for the Filipino people.

The Roadmap is organized according to pillars (2), strategic dimensions (4), strategic imperatives (7), and strategic tasks (42). The pillars and dimensions have been defined so as to ensure that we have clear metrics in terms of tracking the progress of our efforts towards a National AI Strategy and ultimately toward a competitive AI Economy with respect to the global arena.

2.1 Critical Components of Success

Below, seven ways are listed to track the effectiveness of the country's investments in digitization and in preparation for the AI economy:

1. *Track internet speed, pervasiveness, and reliability.* A reliable internet connectivity is critical in our transformation to become a more knowledge-based and information-driven society. Network and data infrastructures should be at the forefront of our nation's digital transformation journey. They go hand-in-hand with a country's development to an AI economy.
2. *Track GII ranking.* In the Global Innovation Index (GII 2020), the Philippines has climbed up the rankings to be at the 50th among 131 countries. With the successful application of AI to enterprises and government services, we can expect to be in the top 30 globally, and top 3 in ASEAN in the next 5 years. This would, of course, entail identifying and supporting new industries with AI and Data Science.
3. *Track the number of new companies and local offices where data and AI are critical components* of their products bringing in at least 10 million USD of annual revenue.
4. *Track top-tiered enterprises that set-up shop in the Philippines.* A clear indicator of achieving a critical mass of AI maturity is attracting by 2023, as a result of the Roadmap, at least five (5) recognized brands/companies in technology, agriculture and/or manufacturing sectors. For technology, this should be one of the top 100 biggest market capitalization company (e.g. Apple Inc., Samsung, Foxconn, Alphabet Inc., Microsoft, Huawei, Dell Technologies, Hitachi, IBM, and Sony), while for manufacturing it should be a tier 1 company, i.e. companies that supply parts or systems directly to Original Equipment Manufacturers (OEMs) or "largest or the most technically-capable companies in the supply chain". For agriculture, we can start by looking at the list of major

leading industry players under the Global Smart Agriculture segment provided by Research Report World listings.⁴⁹ Attracting the big names will not only translate to more jobs in the Philippines, but will also level-up the Philippine brand, which can positively impact our local enterprises—big and small. Finally, through Corporate Recovery and Tax Incentives for Enterprises (CREATE) Act, the government can have more strategic discussion with top-tier enterprises with the goal of encouraging these firms to set-up shop in the country and attract capital flows towards AI-driven and R&D-intensive industries.

5. *Track Labor Market efficiency.* In 2016, the country has been ranked 84th out of 137 countries in this category. To improve our standing, noting the era of digitization and automation and the rise of platform-dependent workers, we need to have a more flexible labor market, specifically allowing for elasticity of working hours and arrangements and promoting both task-oriented and output-oriented organizations.
6. *Track quality of education rankings like those provided by TIMMS, PISA, Times Higher Education, QS rankings, etc.* We need to design our curricula and training modules to put emphasis on creativity, critical thinking, and technological capacity (increase the tech “vocabulary” of our citizens and improve their intuition on new technologies). We must also value accreditations like those from the Association to Advance Collegiate Schools of Business (AACSB) or International Organization for Standardization (ISO) to ascertain that the competence of Filipinos in the workplace will improve not only locally, but also globally.
7. *Track ROI and Equitable-Impact index.* A clear articulation of both Return on Investment (ROI) and Total Cost of Ownership (TCO) to be used in tandem to realistically depict the cost and the benefits of AI investments. Aside from wealth, job and business value creation, an index that maps the impact of AI investment in saving lives, education, critical thinking and innovation must be developed and monitored specifically for the Philippines. Targets should be made as high as possible in national level and equitable in regional level to assure inclusivity in this area.

2.2 Key Players and their Roles

For this strategy to work and be successful, four important players and their corresponding roles. The need for a whole-of-society approach and participatory governance in promoting AI must be emphasized. There must be public consultations and citizen engagement, which are key in identifying the bottlenecks in the different tasks and sectors. This will allow citizens to own initiatives as primary stakeholders, promoting accountability. This will also take advantage of Filipinos who are tech enthusiasts and social media-active. We should also promote convergence of the national government, local government units, AI companies, and citizen organizations, among others. This is key in removing barriers that hinder wider participation by defining governance and accountability relations.

⁴⁹ Global Smart Agriculture Market Size, Status and Forecast (2020-2026). Research ReportsWorld. Publishing Date: 15 April 2020

Government

The government, as a major partner of the industry, society, and other sectors, is the champion and main enabler of this initiative. The government is expected to provide the right infrastructure, tools, and services needed to help organizations take advantage of AI technologies and other technologies, in general, associated with the FIRE. In addition, the government is expected to chart the strategic direction of where R&D efforts and their funding should go.

Academia

The role of academia in a nation's AI investment and journey cannot be overemphasized. Primarily, academic research institutions are the main sources of research and development talent and HR development. Our local scientists and engineers based in our local universities and expected to not only work on basic research that can push the boundaries of knowledge, but to also work on applied research in collaboration with the industry and government as recipients of the technologies.

Aside from engaging in R&D projects, academics are also expected to provide our enterprises with the right talents (i.e., research scientists, research engineers, data scientists, analysts, etc.) that can help the industries in their own digital transformation journeys.

We also expect the academe to serve as advisors to the government or, at the very least, to be part of the government's AI and/or digital transformation task force.

Business / Industry

Businesses and industries will be the main users and/or developers of AI technologies. In addition, we consider businesses as the "scale-up" factor expected to take on AI R&D projects, turning them into integrated business processes that serve customers. Consequently, they are expected to define the impact and value of AI technologies and R&D projects with the goal of growing, innovating, thriving, and competing regionally and globally. They are, thus, also expected to invest in digital and data transformation initiatives; for MSME's and start-ups—with the help of government.

Enterprises are also expected to assist government by providing enabling environments for their employees within their own organizations. That is, businesses and industries are expected to work closely with government and craft learning and development strategies to upskill and reskill the workforce. Furthermore, medium-sized and large corporations that have the means to invest in R&D are encouraged to also facilitate, promote, and invest R&D within their companies.

Society

Finally, Filipino citizens are expected to proactively find ways, through government programs, to upskill themselves and take advantage of online, free, and/or subsidized learning materials. They are to become active participants in holding other sectors accountable, i.e., for holding them to ethical standards, ensuring that provided AI technologies are adopted by businesses and academia, and using these tools and technologies to improve the community.

Work in Progress

PART THREE:

STRATEGIC IMPERATIVES and INITIATIVES

Key dimensions of a national strategy

Each strategic imperative listed will be tagged with at least one of four key strategic dimensions of our national strategy. The *first* dimension is **Digitization and Infrastructure** as it is critical in achieving all the strategic goals defined in this roadmap. The *second* dimension is **Research and Development** that includes as subset “Investing in Strategic Sectors” and “International Collaboration”.

The *third* dimension is the **Workforce** as we need to focus on anticipating and preparing for the potential impact of AI technologies. We need to ensure enough talents and skilled practitioners that can deliver AI solutions (more on application and implementation) and perform AI research (academic and industry-driven). This dimension will also cover both reskilling and upskilling of the workforce. Finally, the *fourth* dimension is **Regulation**, which protects human rights and put into place equitable AI activating opportunities.

Pillars of the Global AI Index

In addition to the key strategic dimensions, we also use the structure of the Global AI Index (GAI)⁵⁰ with its three main pillars (Investment, Innovation, and Implementation) and their subsequent sub-pillars as guides in plotting this roadmap. Since the crafting of the Roadmap or a National AI Strategy falls under the **Investment** pillar and many of the investment and commercialization ventures in this Roadmap are closely intertwined with tasks under both Innovation and Implementation, here the focus is particularly on the two other pillars, namely **Innovation** and **Implementation**.

Again, in terms of investments, the emphasis is on the *commercialization* component under the Innovation pillar as this is closely linked to Research and Development. For the investments from industry and government, including the commitment needed from government—these are highlighted in many of the strategic tasks that fall under the two pillars:

⁵⁰ Global AI Index, <https://www.tortoisemedia.com/intelligence/global-ai/>.

Innovation

- Research
- Development

Implementation

- Talent
- Infrastructure
- Operating Environment

More formally, in the 2020 report of GAI, these are defined as:

- Implementation - these metrics reflect the operationalizing of artificial intelligence by practitioners in business, government and communities.
- Innovation - these metrics reflect technology breakthroughs and advancements in methodology that are indicative of greater capacity for artificial intelligence in the future.

Each strategic imperative is pigeon-holed under a particular key strategic dimension and a GAI pillar using the empty circle symbols colored blue and brown for Innovation and Implementation, respectively.

3.1 Digitization and Infrastructure

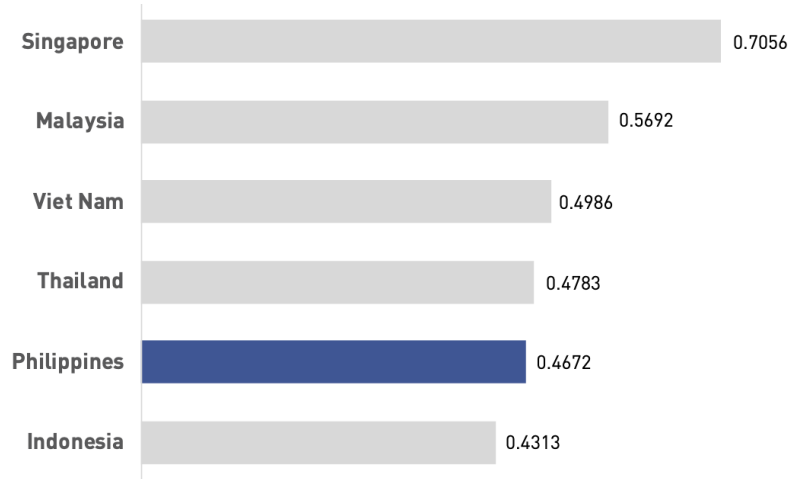
Under the Digitization and Infrastructure dimension, the goal is to ensure that we have the minimum requirements to successfully promote an AI-driven economy. This dimension is focused on the reliability, robustness, and scalability of access of infrastructure, which cover internet access, access to supercomputing resource, and data access, to name a few.

3.1.1 Build a robust connected and networked environment

The need for reliable and robust network and internet connection is paramount to the transformation of the Philippines into a knowledge-based economy. This is crucial to support, sustain, and scale AI and Data Science and Analytics (DSA) programs in the country. It is imperative that cities, especially the more urbanized ones, should have fixed, reliable, and fast broadband speeds. It goes without saying that ultimately the hope is for all Filipinos in all parts of the archipelago should have access to the internet.

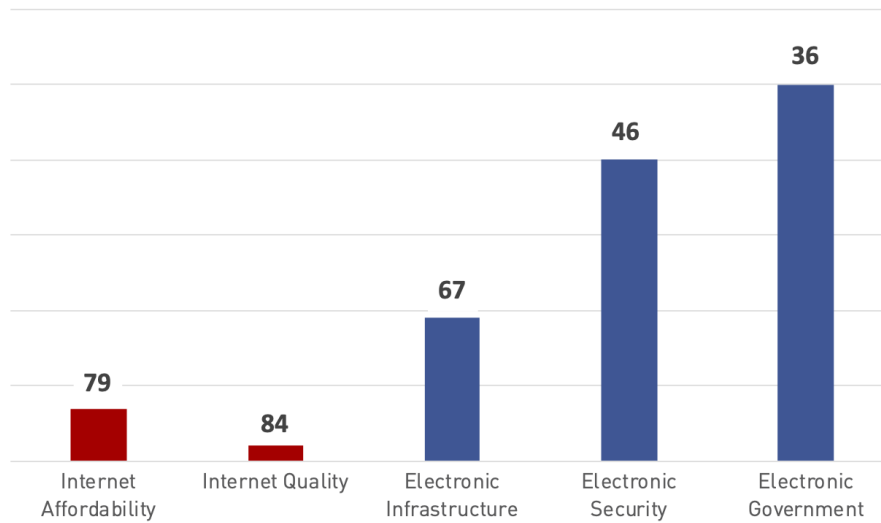
In the Digital Quality of Life (DQL) Index 2020 report, the Philippines ranks only 66th out of the 85 researched countries; we are 5th of the 6 countries indexed from Southeast Asia (see Fig. 6). The DQL incorporates five fundamental pillars: internet affordability, internet quality, electronic infrastructure, electronic security, and electronic government.

Fig 6. Philippines ranks 5th of 6 countries in Southeast Asia indexed on the Digital Quality of Life Index (2020).



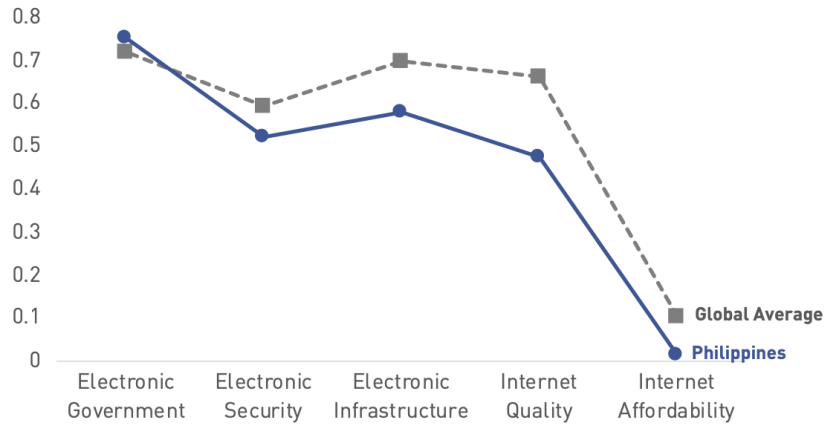
Data Source: Surfshark's Digital Quality of Life Index (2020)

Fig 7. Philippines' Performance (ranking) in Digital Quality of Life Index (2020) out of 85 countries researched.



Data Source: Surfshark's Digital Quality of Life Index (2020) Philippines' Country Profile

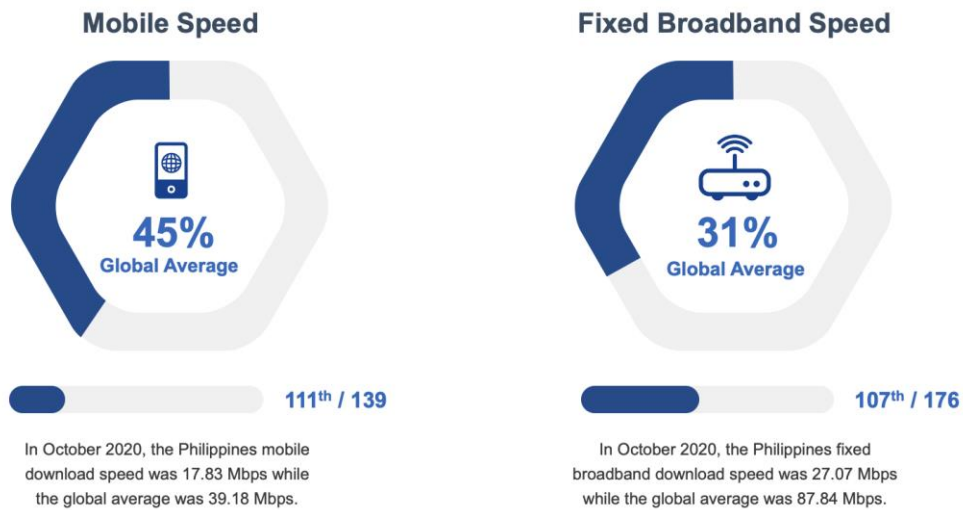
Fig 8. The Philippines performs below the average in all but one pillar of the Digital Quality of Life Index (2020).



Data Source: Surfshark's Digital Quality of Life Index (2020)

The Philippines performs below the global average in four out of the five fundamental pillars of DQL (see Fig. 8). Our goal should therefore be to at least narrow these gaps from the global average. Increasing our DQL index is crucial in the country's vision to become one of the AI hubs in the ASEAN, especially since the AI economy and society are very much dependent on digital network and infrastructure.

Fig 9. Mobile and Fixed Broadband Speeds of the Philippines vs. other researched countries.



Data Source: Ookla Speedtest Global Index. October 2020. <https://www.speedtest.net/global-index>

Strategic Tasks	Responsible Agencies
1. Make the internet equitable; i.e., more affordable for everyone. Ultimately, access to the internet must be ensured for everyone.	DICT
2. Improve internet quality. <i>In October 2020, Ookla Speedtest registered a 17.83 Mbps download speed for mobile and 27.07 Mbps for fixed broadband, which put the Philippines in rank 111 out of 139 and 107 out of 176 of the total countries researched, respectively. The global average speeds for mobile and fixed broadband in the same month are 39.18 Mbps and 87.84 Mbps, respectively.</i>	DICT
3. Ensure that industries, especially those in economic zones, have access to reliable and secure networks that are at least within the global averages; that is, about 40 and 90 Mbps for mobile and fixed broadband currently. This will reflect and symbolize government's commitment to global competitiveness.	DICT, DTI
4. Ensure that government agencies and other public institutions have access to reliable and secure networks. Government agencies, like economic zones must be considered as reliable areas for information access and transfer.	DICT, DILG for LGUs
5. Ensure that HEIs and RDIs have access to reliable and secure networks.	DICT, CHED, DOST

It is also recommended that internet service be treated as a public utility, as essential as electricity and water.

The goal is for every household to have at least 1 Mbps download and upload capabilities and for critical zones—economic, government offices, HEIs, and RDIs—to have internet speeds that are at least within the global averages for mobile and fixed broadband (currently about 40 and 90 Mbps, respectively). Internet speed is now a symbol of advancement and potential for innovation and must be placed as high priority.

The Department of Information and Communications Technology (DICT) has two ongoing initiatives towards this goal of having internet service as an essential public utility:

1. The **National Broadband Plan**⁵¹ envisions “a resilient, comfortable and vibrant life for all, enabled by open, pervasive, inclusive, affordable, and trusted broadband internet access.” NBP is consistent with the twenty-five-year long term vision “Ambisyon Natin 2040”, which is to “raise the

⁵¹ National Broadband Plan: Building Infrastructures for a Digital Nation. Department of Information and Communications Technology (2017).

Filipinos' living standards and subsequently, eradicate poverty through the provision of strategic, reliable, cost-efficient, and citizen-centric infostructure.”

2. The **Free Wi-Fi for All Program** was launched in 2016 with the aim to "accelerate economic, social, and educational opportunities", prioritizing schools and government offices across the country.

3.1.2 Improve data access and data value extraction

Data, especially in the FIRE, is the fuel that powers artificial intelligence algorithms and platforms. Without data, AI systems will not be able to properly learn systems and their functions. Thus, it is imperative that data accessibility be improved, and that cross-sector data utilization be supported. The government can take the lead in making data more accessible and open, which can optimistically nurture a Philippine society that has a more data-driven culture.

In the Global Open Data Index (GODI), for example, the Philippines scored 30% of the maximum possible mark a government can get in terms of how they have opened its national government data. The GODI is a good place to start as an actionable indicator for governments. The index focuses on specific categories as shown in Figure 10 and where each category is scored based on six criteria: (1) openly licensed, (2) open and machine-readable, (3) downloadable, (4) up-to-date, (5) publicly available, and (6) available and free of charge.

As shown in Fig. 10, it is apparent that government needs to improve on several aspects with respect to opening up its datasets to other stakeholders. Meanwhile, it must also be stressed that the government and other sectors have to do more than just boost access to (open) data; they also need educate society on how to retrieve and make sense of these datasets. In other words, public and private sectors should all take part in extracting value from these open datasets. After all, data is unserviceable without analytics.

Fig 10. Performance of the Philippines in certain categories of the Global Open Data Index.

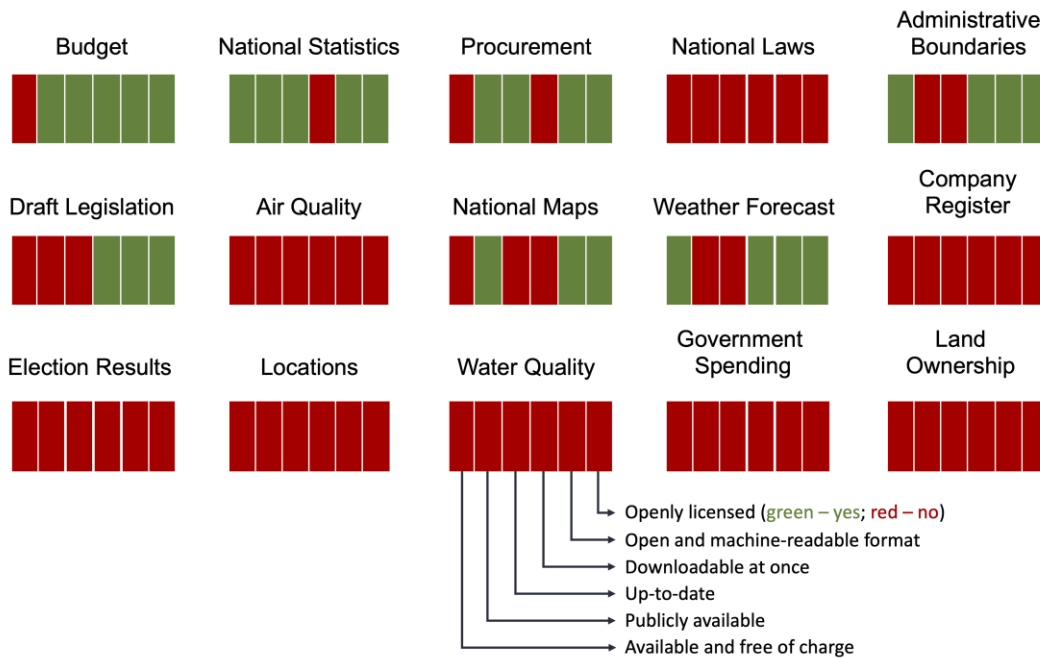
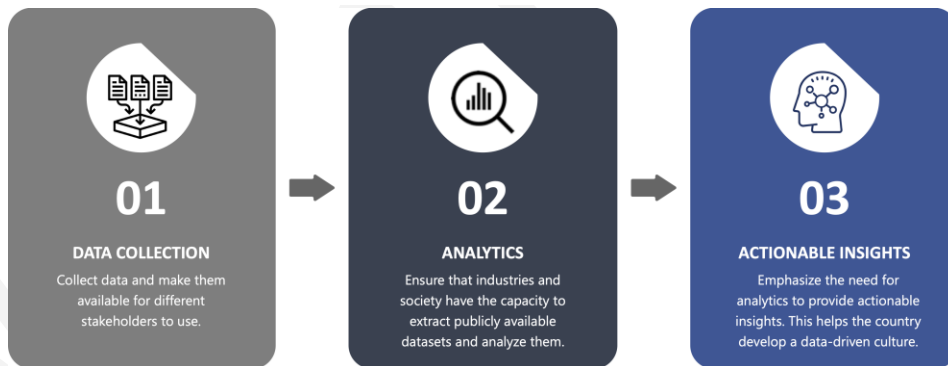


Fig 11. To be valuable, data must be analyzed and drive actionable insights.



This strategic imperative is consistent with Executive Order No. 2, s. 2016 “operationalizing in the executive branch the people’s constitutional right to information and the state policies to full public disclosure and transparency in the public service and providing guidelines therefore”. The Freedom of Information EO envisions that “every Filipino shall have access to information, official records, public records and to documents and papers pertaining to official acts, transactions or decisions, as well as to government research data used as basis for policy development.”

In addition to opening up public datasets, it also needs to be explored how private datasets can be tapped and, at the very least, insights be democratized whenever possible. MSMEs lament about the imbalance of power aggravated by data ownership and exclusivity. That is, bigger companies have more data and R&D resources and thus have a better understanding of the pulse of the market, among others; the more data you have, the larger your potential is to be more powerful. On the other hand, MSMEs are already disadvantaged at the onset due to this lack of data access and R&D capability. Experts agree that “exclusive control over customers’ data could aid entrenchment of large digital companies.”⁵²

To help MSMEs and even academic institutions and the general public in this particular aspect, it is proposed to have both a National Data Center and National Research Cloud. The National Data Center (NDC) will house publicly available datasets, other government datasets, and even private datasets. It will be a one-stop-“data”-shop for governments, universities, and enterprises. The NDC will ensure that all data are properly managed and secured—it goes without saying that all data will be made available in machine-readable formats. On the other hand, the National Research Cloud (NRC) will provide our academic researchers and MSMEs—especially those that do not have enough resources to buy their own machines and supercomputers—with affordable computing power, noting that physical servers can be hefty for most, if not all, academic institutions and MSME’s, not to mention these machines can easily become obsolete.

Strategic Tasks	Responsible Agencies
6. Make public data open, freely available, and downloadable in digestible format, making them ready for analysis. Pending bill/s strengthening the open data of government can satisfy this strategic task and create the impetus for Strategic Task 7 (ST7) and ST8. ⁵³	DICT, FOI, all government agencies
7. Build a national data center (NDC) that will eventually be housed under the proposed National Center for AI Research (NCAIR), which is discussed in Sec. 3.2.2.3. The NDC will be a “one-stop-shop” where datasets are stored, secured, and exchanged. This requires a reliable and robust data infrastructure and data management system.	DOST, DICT
8. Invest in a National Research Cloud (NRC) that will be part of NCAIR. As in the proposal of Stanford HAI to the US Government ⁵⁴ , the NRC will afford scientists and researchers with low-cost access to compute power and public datasets secured in a cloud environment, among others.	DOST, DICT
9. Encourage government agencies, research institutions, top universities, and big state universities to maintain their own data centers linked to the NDC. Work with private institutions to link public	DTI, DICT, DOST

⁵² V Govindarajan, B Lev, A Srivastava, and L Enache (2019). “The Gap between Large and Small Companies is Growing. Why?” Harvard Business Review.

⁵³ House Bill 7786, an act strengthening the open data of the government is filed recently, September 2020, by Representative Pablo Garcia. If approved, this will satisfy Strategic Task 6 (ST6) and create the impetus for ST7 and ST8.

⁵⁴ J Etchemendy and FF Li, National Research Cloud: Ensuring the Continuation of American Innovation, Stanford University Human-Centered Artificial Intelligence. 28 March 2020.

and private datasets. Example of private datasets include healthcare data (hospitals), airline data, supply chain data, etc. Allow for integrated data search.

- | | |
|--|-----------------|
| 10. Encourage and promote data analysis (at least descriptive analytics) across all functions of businesses, industries, and government. agencies. This is important for everyone to contribute to the extraction of valuable insights from open datasets. | DOST, DTI |
| 11. For more sensitive data sets, promote projects that would enable access to them as long as the business value and/or the value to society is clear. | DOST, DTI |
| 12. Extensive and up-to-date training of analysts and data scientists to extract actionable insights from data accessible from ST6 and communicate these insights. | CHED, DTI, DOST |

The above goals are linked and will immediately get momentum if government agencies, especially DICT, DOST, DTI, FOI and CHED with support from DILG, follow the guidelines stated in House Bill 7786 where the heads of agencies are tasked to publish “*all open data maintained by the government, its agencies and instrumentalities as far as practicable with the use of most appropriate standard...*”

3.2 Research and Development

Under the **Research and Development** strategic dimension, our shared aspiration is to build a nurturing AI research environment so that we can be competitive both locally and globally. Data Science and AI are fields that are useful in both academic and industry R&D; thus, it is imperative that we maximize the value they can bring to bear on different sectors of society.

Since AI is one of the few fields strong in both academic and applied/industry fronts, we need to properly categorize R&D programs and projects as either applied or “applied” or “basic”: the difference between the two is in terms of the timeline of their applicability to real-world use cases.

Basic Research	Applied Research
Employ AI research to improve computing, enhance feature engineering, and promote algorithmic innovations. In contrast with applied research where application is potentially achievable within 3 years, the usefulness of basic research is realized at longer times. However basic research strongly builds the fundamentals for a more innovative and impactful applied research.	Improve research in high-performance computing as applied to various domains; catch-up with other countries already using AI technologies in their processes and business models; perform industry-driven research in collaboration with the industry; develop state-of-the-art data-driven tools. Application and

resulting innovation are almost immediate as the development of tools.

Key Performance Indicator (KPI):

- Publications in indexed journals
- Presentations in computing conferences

Key Performance Indicator (KPI):

- new jobs generated
- industry dollar generated/saved for enterprises
- investments in R&D from the industry
- patents, creative works, and technology disclosures

R&D Key Performance Indicators

For the research projects, it is vital that different technology readiness levels (TRL) are correctly classified and focused on, since AI has strong academic and industry applications. The TRL is an important indicator to track the ratio of investments between basic and applied research, as the Philippines is still at its infancy relative to other countries in terms of its scientific journey.

Thus, for R&D, there should be three main key performance indicators (KPIs):

1. Number of publications to indexed journals
2. Number patents, creative works, and technology disclosures
3. Amount of industry dollar generated from R&D projects
4. Number of jobs created

The first and second items are especially central to the goal for the country to become an AI Center of Excellence. The Philippines can establish its dominance in the field by showcasing our researchers' and scientists' capability in R&D to push the boundary of the field, not only for the Philippines, but for the whole scientific community.

The third and fourth items are essential for the industry to truly engage in R&D, especially in collaboration with academic/research institutions. These KPIs are good indicators that AI and DSA are truly working for the industries and other private organizations and are helping the latter innovate and remain competitive both locally and globally.

Finally, one of the problems in the STI sector is the lack of public awareness on the results of public-funded research undertakings as well as the slow commercialization of STI outputs. Hence, it is imperative that research organizations should have an action plan on how they can effectively publicize and promote government research on AI and its applications; ideally, the government should help in the proper enforcement and implementation of this communication strategy.

3.2.1 Master and push the boundaries of Artificial Intelligence

To be recognized as one of the AI hubs in the ASEAN region, it is imperative that the Philippines fortify its understanding of AI technology and contribute to the global body of AI knowledge. Furthermore, to accelerate international visibility, we need to improve the immediate recruitment of international talent and enhancement of international collaboration. Hosting international AI conferences here in the Philippines will also be important, so more Filipino students can attend these scientific events.

Pushing the boundaries of knowledge in AI translates quantitatively to publications in peer-reviewed indexed journals and presentations in international conferences related to AI and computing. In addition, we also track patents and technology disclosures as part of the metric.

Strategic Tasks	Responsible or Lead Agencies
13. Develop competency in AI research as measured by publications, patents, and technology disclosures. Provide funding to support researchers in AI conferences, and host international AI conferences.	DOST, CHED
14. Invite and recruit international experts ⁵⁵ that can bring in new capabilities augmenting our pool of AI mentors. In the long term, this can also help promote international collaborations.	DOST, CHED, DA
15. Appropriate funding for AI algorithmic innovations. The funding shall go to research universities (to support graduate students and faculty researchers, among others) and RDIs.	DOST, CHED

Some of the AI topics Philippine HEIs and RDIs can contribute to include:

- Machine Learning and Deep Learning
- Natural Language Processing
- Computer Vision
- Reinforcement Learning
- Expert Systems
- Robotics
- Speech Recognition
- Quantum AI

⁵⁵ The DOST *Balik Scientist* program, Transnational Higher Education Act, and the 11th Regular Foreign Investment Negative List (RFINL) will play crucial roles in bringing-in international experts on AI. As such, there is a need to ensure that these policies and programs aligned with the roadmap.

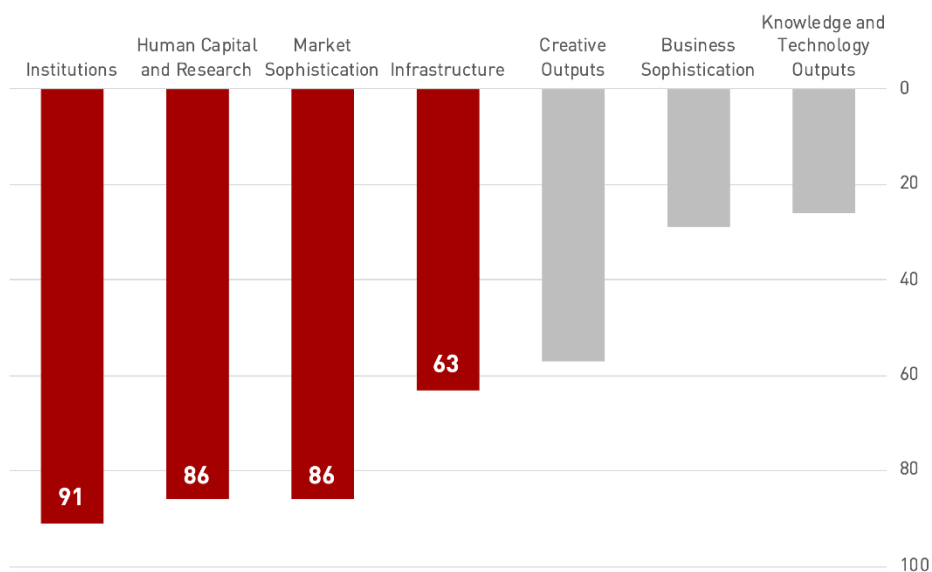
It is also recommended that research topics be aligned with the Harmonized National Research and Development Agenda (HNRDA) and the National Higher Education Research Agenda (NHERRA) to ensure that AI will be prioritized in R&D initiatives of RDIs and HEIs, as well as, in the provision of research grants.

3.2.2 Accelerate innovation with AI

The Global Innovation Index 2020 (GII) report emphasized the role of R&D and science—including basic science, as a way to produce “unexpected knowledge”—in fueling innovations and counteracting business cycles. In addition, in the Global AI Index, Research and Development are the only two sub-pillars identified under the Innovation pillar (one of the only three in the structure of the GAI). This further reinforces the role of R&D in fostering innovation through AI.

Why AI? Artificial intelligence has shown great promise among all other new technologies in the FIRE in terms of its potential to accelerate innovation. Deep learning, the key component of AI alongside robotics and symbolic systems, has been identified as both a **general-purpose technology (GPT)** with applicability across a wide and diverse array of fields, and an **invention of a method of inventing (IMI)**, which more than just increasing the efficiency and reducing the costs of innovation, drastically alters the techniques, conceptual approaches and framing (the “playbook”) to innovation itself, and expanding the set of problems that can feasibly be addressed. Inventions and concepts which are both (a GPT as well as an IMI), like the university, the telescope, and the personal computer, have in the past led to profound economic, technological, and societal transformations.⁵⁶ This is why it is imperative for the Philippines to invest in AI technologies to further fast-track its already remarkable performance in innovation as reflected in the GII in recent years.

Fig 12. Rankings in the Seven Global Innovation Index Pillars. (out of 131 countries)



Data Source: Global Innovation Index. 2020.

⁵⁶ Iain M. Cockburn *et al.*, “The Impact of Artificial Intelligence on Innovation: An Exploratory Analysis”, in Ajay Agrawal, *et al.* eds, “The Economics of Artificial Intelligence: An Agenda”. National Bureau of Economic Research, May 2019. URL: <https://www.nber.org/system/files/chapters/c14006/c14006.pdf>

In 2020, the Philippines rose to the 50th rank out of 131 economies in the GII, which has put the country in the top 10 best-ranked lower middle-income economies (#4 out of 29). The Philippine economy is among those that have a high innovation input-output performance, placing it among the **global brand outperformers** quadrant of the GII brand value matrix—i.e., the Philippine economy has the ability to “translate more effectively innovation inputs into innovation outputs.” This is an assuring development, giving us more confidence in investing more in R&D and science to further accelerate innovation.

Moreover, we can take a hint from our performance in the seven GII pillars as actionable indicators in terms of optimizing our efforts toward this end by focusing on certain strategic areas. There is definitely room for growth, especially in the following four pillars of the GII: institutions, human capital and research, market sophistication, and infrastructure. More specifically, we have shown weakness in Education and R&D engagement from companies. More specifically, we have not been spending enough on education, R&D, and innovation linkages.

This strategic imperative is consistent with Republic Act No. 11293 or the **Philippine Innovation Act**, which considers “innovation as a strategic tool to transform and upgrade the industries, generate more jobs and attract more investments in the Philippines.” In addition, RA 11293 acknowledges the role of R&D in advancing national development and sustainable economic growth. Furthermore, Section 10, Article XIV of the Constitution recognizes that science and technology are “essential for national development and progress”, giving priority to “research and development, invention, innovation and their utilization.”

3.2.2.1 Help industries innovate through AI R&D

We need to invest in AI research and development and focus on strategic areas where the Philippines can perform well and compete regionally, if not globally. These strategic areas should also have the end goal of attracting big multinational companies to the country, where they can rely on our AI and ML engineers, data scientists, data engineers, and data analysts.

For MSMEs, in particular, the provided assistance coming from government can be expanded, in addition to financial assistance to enable the return to their operation (especially due to the challenges brought about by the COVID-19 pandemic), to cover other forms of support, such as:⁵⁷

- Response to increasing customer expectations and competition in the market
- Digitalization of business processes (See Sec. 3.1)
- Formulation and implementation of business continuity plans
- Upskilling and retooling the workforce (See Sec. 3.3.2)
- Introduce AI technologies to MSMEs that are part of labor-intensive sectors such agriculture, trade, and manufacturing—which is discussed in more detail in this section.

Furthermore, with the DOST’s Science for Change Program (S4CP), the Philippines is already in a good position to make this happen. S4CP was created to accelerate Science, Technology, and Innovation, acknowledging that technology and innovation are game changers for the economy. Under the S4CP, there are four programs that can serve as channels through which we can bolster our competitiveness in AI

⁵⁷ Chapter 16 (Promoting Competition) of the Updated Philippine Development Plan (PDP) 2017-2022

research. These programs are: (1) Niche Centers in the Regions for R&D (NICER) Program, (2) R&D Leadership (RDLead) Program, (3) Collaborative R&D to Leverage PH Economy (CRADLE) for RDIs and Industry Program, (4) Business Innovation through S&T (BIST) for Industry Program. For all these programs, AI can be more deliberately identified as an area to be pursued.

Strategic Tasks	Responsible Agencies
<p>16. Strengthen academic-industry partnerships in AI R&D through government programs such as DOST's CRADLE, whose innovation is that it requires HEIs and RDIs to partner with local private enterprises to solve use cases under pre-identified thematic areas (e.g., sustainable supply and logistics, products for the new normal, reinventing the workplace, etc.). The practice of imposing the partner industry to incorporate the decision-support tools created in the company operation is commendable and must be monitored closely.</p>	DOST, DTI
<p>17. Incentivize HEIs to promote R&D internships with local private institutions. As an example, the Asian Institute of Management's MSc. in Data Science program students are required to serve as junior data science consultants for local and international organizations and take on R&D projects centered on Data Science and AI. In the last two years, the program has worked on 25 high-impact use cases that foster academe-industry partnership. The potential business impact has been valued by its stakeholders at 40 million USD (2020) and 10 million USD (2019). This is a promising undertaking that government could support and promote.</p>	CHED, DOST, DTI
<p>18. Create quantifiable measures to track, coordinate, and improve government services and policies for industries.</p>	DOST, DTI
<p>19. Strengthen technology transfer framework between HEIs/RDIs and the industry. It is recommended that the government develop something that is conceptually similar to A*STAR Singapore's Exploit Technologies Pte Ltd (ETPL) that is responsible for marketing and commercialization of R&D projects and products coming from A*STAR.</p>	DOST, DTI
<p>20. Identify and prioritize sector-specific R&D projects that can maximize impact of AI research. Categorize key areas where AI R&D can make the most impact in local industries.</p>	DOST, DTI, and other government agencies
<p>21. Track and analyze the quality and quantity of job displaced, job created, and/or job transformed as a result of the academic-industry partnerships.</p>	DOST, DOLE, DTI

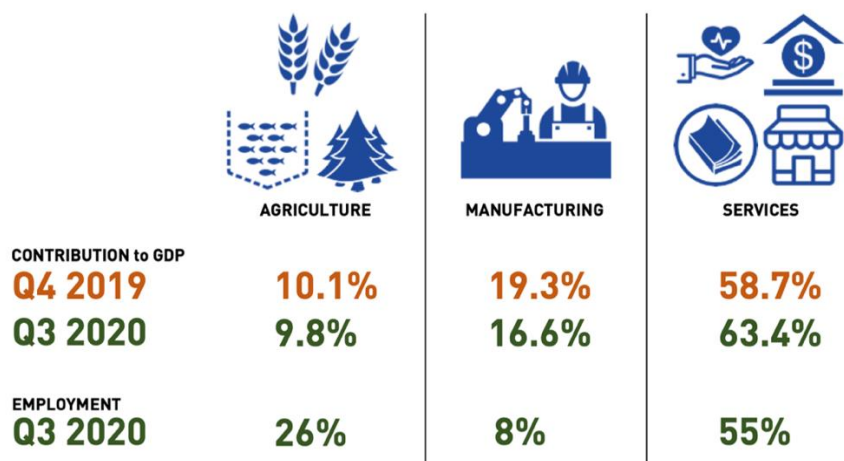
Sector-Specific Research Projects

To further ensure that R&D in AI in driving innovation is maximized, there is a need to identify specific projects that clearly address existing pain points among local enterprises. Focus on strategic areas, such as manufacturing and marketing and sales where AI has been shown to have the most impact, is also important.

Below are the recommended research projects and/or programs to embark on initially to guide investments in DSA and AI with the industry. Government-funded projects under the National AI initiative will require stakeholders/collaborators from both academia and the industry. Projects under this initiative may be co-funded under the S4CP or under a separate AI government fund.

The projects listed below are borne from the different focus group discussions conducted with over 30 industry executives and founders from Luzon, Visayas, and Mindanao. The contribution (current and future) of each sector and subsector to the GDP and to employment are also considered. The themes can be further teased out with R&D review panels, preferably composed of both local and international scientists.

Fig 13. Contributions to the GDP of the three Industry Sectors.



AI in Manufacturing

From 2020 to 2030, it is expected that FIRE technologies will further multiply the manufacturing value added (MVA) by 35-40%⁵⁸, and the role of AI cannot be modulated in this setup of maximizing the MVA. According to a recent study by Kearney, AI is expected to have a huge impact to supply chain, manufacturing, and procurement with a percentage of total impact (AI incremental value) estimated at 20-25%. Specific high-impact use cases show, for example, that machine learning algorithms can lead to 21 to 30% reduction in stock-outs in inventory optimizations. As another example, in an AI-driven industry project done at the Asian Institute of Management, a machine learning algorithm that provides demand and sales forecast to a manufacturing company has been estimated to help reduce cost due to wastage by up to 100 million pesos annually. It is thus vital to explore initiatives that can further help our manufacturing industry maximize the impact of AI technologies.

In the Philippines, the manufacturing industry has been estimated to contribute 16.6% to the GDP as of Q3 2020 (this was 19.3% in Q4 2019, pre-COVID-19). In addition, 8% of total employment (or approximately 3.4 million jobs) are generated by the manufacturing sector. Many of the challenges in the sector is on increasing productivity and efficiency of processes in factories and in supply chain and logistics. In the FGDs, the scarcity of resources to acquire new technologies (particularly IoT sensors for machine health monitoring) has also been brought up.

Below are some recommendations.

- I. For Advanced Manufacturing, to setup a “museum” of AI-enabled technologies that can monitor health, efficiency, and cost-effectiveness manufacturing products and processes, to name a few.
 - A. The DTI, in collaboration with the DOST, can set-up a one-stop shop for SMEs to “borrow” or “loan” equipment including IoT sensors and additive manufacturing technologies.
 - B. The DTI, in collaboration with the DOST, can also set-up a one-stop shop for SMEs to familiarize themselves with most recent AI technologies and high-impact use cases together with inventories of available providers. This could also be done through free or subsidized workshops/trainings that can be conducted every quarter across the country. In terms of execution, the different RDIs can serve as training hosts.
 - C. The well-curated “museum” linking various manufacturing sectors can also serve as education hubs for engineering and science graduates for tours, trainings, and enrichment activities. Similar to the above item, these could be hosted in RDIs as identified by the DOST.
- II. A critical aspect of implanting AI technologies is the availability of data, especially since algorithms learn from data. Thus, it is critical that MSMEs are provided with the means to collect information about their factories, machines, and/or supply chain network. This can be address through the deployment of AI-enabled/enhanced IoT:
 - A. To drive real-time monitoring of linked processes, and
 - B. To drive sustainability of operations with respect to community concerns such as noise, safety, and pollution.

⁵⁸ Kearney analysis (2020). Racing Toward the future: AI in Southeast Asia

- III. Optimization of human-machine interaction
 - A. Improve efficiency of factories by taking into account human’s natural tendencies when operating machinery for long-hours (including mental health issue)
 - B. Improve efficiency of factories by forecasting the “health” of critical machines mitigating disruption on operations
 - C. Proper understanding of infrastructure and environment necessary for a work-life balanced creating happy and productive citizens
 - D. Research in decreasing occupational health and safety risks, especially of factory workers.

Priority topics can further be beefed up by exploring how the proposed National Smart Manufacturing Implementation Framework of the DOST can be utilized to provide a more systematic approach to increase manufacturing value added, thereby truly maximizing the role of AI in increasing production capacities of the manufacturing sector.

AI in Agriculture

The agriculture sector—including livestock, fisheries, and forestry—has been estimated to contribute 9.8% to the GDP as of Q3 2020 (this was 10.1% in Q4 2019, pre-COVID-19). Twenty-six percent (26%) of total employment (approximately 11 million jobs) is generated by the agriculture sector. Given the size of the workforce and the contribution of the sector to the GDP, there is a lot of room for productivity improvement. And the role of AI has never been more instrumental. Below, themes and use cases that can be taken on as R&D projects as part of the nation’s AI journey are identified; some of the R&D topics listed are aimed to address some of the food and nutrition insecurity in the country.

- I. Supply and Demand forecasting to maximize yield at opportunistic time. This entails creation of:
 - A. Database of all available products (supply);
 - B. Database/projection of all demands (local/regional/global).
- II. Productivity/yield optimization for crops, livestock, and aquaculture including:
 - A. Detection and monitoring of diseases and other potential agri- and aquaculture issues;
 - B. Deployment of sensors and analysis of collected data for optimal growth and health;
 - C. Prescriptive decision-support tool for strategies and plans for crop irrigation, fertilizer, and pesticide inputs;
 - D. Planning and decision-support tool to maximize livestock nutrition.
- III. Weather forecasting and the creation of decision-support tools that (a) prescribe when to plant and harvest crops, (b) identify which areas to develop and which crop variety to plant, and (c) advise when to apply fertilizers and other inputs.
- IV. Farm machinery advancement and optimization to increase efficiency of processes, which entail
 - A. Deployment of AI-enabled robots to perform monitoring of equipment and collection of data;
 - B. Use of drones and remote sensing technologies for the monitoring of land parcels;
 - C. Use of more efficient machines instead of using “carabao power”.⁵⁹

⁵⁹ Philippine Star, “Farmers return to carabao power” by Eva Visperas, 08 July 2008. <https://www.philstar.com/other-sections/news-feature/2008/07/08/71635/farmers-return-carabao-power>

- V. Optimization of resource expenditures and yields for marine fisheries operations through the
 - A. Identification of spatiotemporal trends in fuel consumption;
 - B. Use of predictive models for fish distribution;
 - C. Deployment of IoT sensors for predictive maintenance of equipment.
- VI. Sustainable management and biodiversity preservation that will involve
 - A. Development of a decision-support tool for when, where, and how much fish to catch during marine fishing operations;
 - B. Rapid assessment of forest coverage from remote sensing data;
 - C. Detection and mapping of damages brought by natural hazards on agricultural lands and forest areas.

AI in Services

The services sector has been estimated to contribute 63.4% to the GDP as of Q3 2020 (this was 58.7% in Q4 2019, pre-COVID-19). Clearly, we are a services-driven economy. In addition, fifty-five percent (55%) of total employment (approximately 23 million jobs) is generated by the services sector. Most of the employment under this sector is with Wholesale and Retail Trade (40%) followed by Transportation and Storage (13%) and Public Administration and Defense (11%). In terms of contribution to the GDP, Financial and Insurance Activities is next to Wholesale and Retail Trade (which also includes the repair of motor vehicles and motorcycles). Below, some use cases for potential R&D projects in the service sector are identified, with those related to Public Administration and Defense covered under **AI in Government**.

- I. Optimizing business-to-business and business-to-consumer matching for the wholesale and retail trade sectors. For example, personalization of B2B and B2C services based on historical business and/or customer activity.
- II. FinTech: payments, microfinancing, social-financing (cooperatives), etc. A potentially useful information for both entrepreneurs and consumers is a digitized and integrated network data of sari-sari stores nationwide.
- III. Deployment of sensors on facilities and transport systems within supply chains with a view towards machine learning-assisted predictive maintenance.
- IV. AI to help the gig economy workers and OFWs:
 - A. Digitization to lookup staffing firms with criminal charges, who take passports away from people
 - B. AI to help identify for embassies OFWs who may need more help with visa extensions, labor issues (predictive maintenance type model)
 - C. AI/data driven educational resources that can provide targeted continuing learning about to seamen, nurses, laborers, etc
 - D. Data-driven jobs platform to help people understand prevailing wages and fair contract terms

AI in Healthcare

AI R&D is also expected to revolutionize our healthcare systems. Below are some of the recommended projects that our organizations and researchers can pursue. Needless to say, it is crucial that a fully integrated and interoperable health information system and database is instituted to solve the fragmentation and inefficiency of health information system in the country.

- I. Smart distribution and allocation of resources, including human resource, and hospital equipment; Create decision-support tools in improving the management and deployment of human resources for health (HRH);
- II. Smart distribution and production of quality and affordable health and nutrition products (e.g., drugs, medical supplies and equipment) to minimize risk of shortage;
- III. Maximizing access to healthcare facilities and services; build a platform that can prescribe construction of health facilities to strategically identify areas that would be optimal for access and service delivery;
- IV. AI-assisted disease identification with Computer Vision;
- V. Modeling of disease trends and properly anticipating needed medical supplies; AI-assisted surveillance, monitoring, and treatment of diseases such as COVID-19;
- VI. Personalized healthcare plans to improve patient journey;
- VII. Telemedicine solutions, especially for hard-to-reach areas.
- VIII. Especially with the advent of the COVID-19 pandemic and the need for strengthened risk management and emergency response during crises, research projects related to the pharmaceutical industry may also be ventured on noting that AI is expected to become the “primary-drug discovery tool” by 2027.⁶⁰

AI in Education

Aside from the sectors covered above, AI can also help accelerate innovation in education. At present education spending is modest, totaling PhP 154.5 million (3.7%) of the GDP as of Q3 2020. Some use cases include:

- I. Model spatial distribution of schools nationwide to optimize reach of learning institutions to the Filipino youth.
- II. Personalized learning pattern detection to identify best ways (choice of materials, methods etc.) to maximize learning and identify students that need special attention
- III. Predict and suggest career paths based on students' interests, performance, and other background information.
- IV. Curricula optimization based on an ever-changing demand in state-of-the-art and rapidly evolving fields.
- V. Bridging of knowledge gaps to accommodate students shifting from one course, or even school, to another through AI.

⁶⁰ Chapter 2 (Global and Regional Trends and Prospects) of the Updated PDP 2017-2022.

AI in Government

Government spending amounted to 15.2% of the GDP as of Q3 2020. Of this, about a third (5.2%) fell under the Public Administration and Defense sub-sector, which covers activities relating to governance falling under the three branches of government (executive, legislative and judicial) such as enactment and interpretation of legal and regulatory frameworks, and the administration of government programs (including subsidies, social security pensions, and other social services). This sub-sector also accounted for 11% of the employment for the same quarter.

Governments the world over have been at the forefront of driving AI transformation initiatives via investing in AI R&D programs or leading them; China with its concept of “Indigenous Innovation” (自主创新, *zìzhǔ chuàngxīn*) and the European Commission with its Horizon 2020 program are noteworthy examples in this regard. At the same time, AI has the potential to profoundly transform the government’s day-to-day operations, with potential applications ranging from streamlining procurement and customs processes to improving the management of urban traffic and public transport, to providing the public with improved and personalized access to government services. Government-owned and controlled corporations (GOCCs) share the same potential for AI-driven transformation as their private sector counterparts, along with agencies with regulatory oversight such as the Banko Sentral ng Pilipinas (BSP) and the Securities and Exchange Commission (SEC).

The following are potential use cases and/or technologies for the government’s AI journey:

- I. Management and optimization of public transport systems and traffic flow that enable:
 - A. Passenger forecast and predictive maintenance for smart MRT and LRT systems;
 - B. Intelligent metropolis-wide traffic signaling and control system.
- II. Resilient Technologies to help in disaster preparedness, mitigation, response, and rehabilitation.
- III. Risk assessment and decision-support tools for DTI’s Board of Investments for monitoring and interventions.
- IV. Streamlining GOCC operations, which include, for example, anomaly detection and streamlining workflows for various government agencies like the BSP and SEC.
- V. Streamlining procurement & supply chains operations for GOCCs and government agencies in general.
- VI. Applications for Peace, Order, and National Security.
- VII. Legal Analysis using natural language processing (NLP) to analyze laws and court decisions.

AI can also assist in helping governments and international organizations in making more informed policies towards achieving Sustainable Development Goals (SDG’s). For example, data science consulting firm Thinking Machines Data Science has worked with the United Nations Development Programme (UNDP) to develop an “interpretable machine learning model that estimates wealth” to understand poverty trends in the Philippines.⁶¹

⁶¹ Ledesma, C., Garonita O.L., Flors, L.J., Tingzon, I., and Dalisay, D., “Interpretable Poverty Mapping using Social Media Data, Satellite Images, and Geospatial Information”, arXiv:2011.13563.

For the government to be at the forefront of the country's AI journey, it also needs to be at the forefront in making creating an enabling environment for the use of AI and the growth of a healthy ecosystem around it. Below are a few recommendations:

- I. Enhance the government's data warehousing capabilities. For example, by utilizing NLP, consistent digitization of official documents and other datasets can be achieved.
- II. Streamline processes to enhance availability of data. As a matter of policy and eventually internalized practice, all government agencies should become proactive in making available select high-quality public datasets instead of waiting for 3rd parties to initiate FOI requests.

3.2.2.2 Support and Nurture AI Startups

The role of startups in economic growth cannot be overemphasized. Especially in the FIRE, startups have been instrumental in accelerating economic growth of countries. As engines of growth, they create more jobs, create wealth, open new markets, effect innovations, and use technologies to improve our well-being. In line with R.A. No. 11337 or the "Innovative Startup Act", incentives and support must be provided to startups, in this case AI startups, to uplift both economy and society. The government must also support the coming together of R&D and AI startups that shall be fostered through NCAIR (Sec. 3.2.2.3).

Strategic Tasks	Responsible Agencies
22. Identify and support local startups that can significantly contribute to the development of the AI ecosystem. Turn AI R&D into new ventures by providing incubators that allocate office space, basic business support (e.g., incorporation support, access to information regarding government programs, etc.), marketing and support network (connect to potential clients and investors) for these organizations.	DTI, DOST
23. Improve government regulation in the areas of: visa issuances to foreign technologists and startup founders, tax-breaks for new startups (under certain conditions), and issuing stock equity to employees, to name a few.	DTI, SEC
24. Encourage and incentivize investors and venture capitalists to support promising AI startups. These include, but are not limited to, tax-breaks, state recognition, and avenue to easily attract global costumers. Government may also come in as a Limited Partner to existing qualified venture capitalist firms, giving the latter mandate of investing more in the Philippines.	DTI, DOST
25. Government to co-host AI-themed hackathons and other competitions between enterprises that use AI technologies. This way, the government will encourage more innovative groups to invest their time and creativity in helping the nation develop an AI ecosystem.	DTI, DOST

26. Government to also co-host events inviting global and regional experts in AI and also invite successful AI and/or data-driven startups to foster collaboration and sharing of ideas and expertise. DTI, DOST

3.2.2.3 Transform institutions to maximize the impact of AI R&D

It is essential that Higher Education Institutions (HEIs) and Research and Development Institutions (RDIs) are capable of engaging in both basic and applied AI research. To accelerate the impact of AI and DSA, it is imperative that industry should also be engaged.

Strategic Task	Responsible Agencies
27. Build a National Center for AI Research (NCAIR)	DTI, DOST, NEDA, DICT, CHED

National Center for AI Research (NCAIR)

The National Center for AI Research (NCAIR) will serve as the country's hub for AI research that will be instrumental in making the Philippines an AI powerhouse. It will be responsible for advancing scientific discoveries in AI, including algorithmic innovations. It will also engage in research and development (R&D) projects that address various socio-economic needs of society—together with the rolling out of the National ID, NCAIR is envisioned to be a reliable partner in providing efficient service to 110 million Filipinos—and industry research to help enterprises accelerate innovation. NCAIR will also play a pivotal role in nurturing and developing AI talent and Data Science leaders not only for the benefit of the Center, but also for government agencies, industries, and other research centers in the country. NCAIR will be home to full-time research scientists and research engineers.

The two pre-requisites to advance AI research are data and computing power. As the premier AI center of the Philippines, NCAIR will also serve as a data center and will have the necessary computing facilities to collect and manage data and drive research, including advancing algorithmic innovations. The Center is also expected to build and administer both the National Data Center (NDC) and the National Research Cloud (NRC) described in Sec. 3.1.2; it will also have on-premise supercomputers for projects better executed using on-premise machines.

The creation of this is central to the implementation of the AI roadmap as it will serve as the nexus for the AI competitiveness of the country. It is expected to be central to world-class R&D activities and coordinators and drivers of AI integrators to be deployed in regional hubs previously identified by the DOST.

One of the goals of NCAIR would be to assist MSMEs interested in using different DSA and AI tools to help them improve their efficiency and productivity. In particular, the Center will support enterprises through the utilization of their data to help develop solutions through AI and data-driven science. In addition, NCAIR will

serve as an incubator for collaboration between universities, industries, and startups. Finally, the NCAIR will also serve as a hub where multinational companies can explore various R&D projects with the Philippine government, its researchers, and/or its linkages with HEIs and RDIs.

Technical capabilities at NCAIR would initially include algorithmic improvements in machine learning applications, natural language processing, deep learning, recommendation systems, sentiment analysis, public opinion monitoring, and computer vision.

The research center can initially partner with HEIs and RDIs to build the needed critical mass of scientists and researchers for sustainability. It is also expected that NCAIR will have strong ties with various national research institutions such as the International Rice Research Institute (IRRI), the Marine Science Institute (MSI), the Philippine Genome Center (PGC), the Philippine Space Agency, the Advanced Science and Technology Institute (DOST-ASTI), National Mapping and Resource Information Authority (NAMRIA), Philippine Statistics Authority (PSA), the Food and Nutrition Research Institute (DOST-FNRI), and the DOST Philippine Council for Health Research and Development (PCHR), among others. Aside from our local talent pool, NCAIR should also hire international and well-renowned experts in the field of analytics and AI. This way, our local talents will get to learn more and even imbibe some of the best practices that other international research institutions have.

Examples of National Research Centers

- (1) Agency for Science, Technology, and Research in Singapore
- (2) AI Research Center of the National Advanced Industrial Science and Technology (AIST) in Japan
- (3) Center for Artificial Intelligence at the Moscow Institute of Physics and Technologies in Russia
- (4) The Fraunhofer Big Data Alliance in Germany

As indicatively shown in Figure 14, to prepare for NCAIR, it is recommended to initially start with a government funded AI Program—starting with **Ideas Generation** through hackathons, FGDs, and short-term R&D projects. As mentioned in Section 3.2.2.1, where some sector-specific use cases were outlined, projects and themes still need to be further teased out. It is highly recommended that the **Ideas Generation Initiative** be rolled out in partnership with AI experts in the country and abroad and incubators and accelerators in the Philippines, like the QBO Innovation Hub, the AIM-Dado Banatao Incubator, and IdeaSpace Foundation, to name some, and including the Technology Business Incubators (TBIs) of DOST-PCIEERD.

The AI Program will help researchers and other stakeholders establish the relevance of their work, topics, and expected outputs with respect to the formation of the Center. As we move further along the timeline and financing R&D projects with different Technology Readiness Levels (TRL), it is recommended that the Program hires international referees, aside from local experts, to guide the funding. This is crucial in making certain that projects do indeed drive innovation as envisioned. The success of the projects is pivotal to efforts to attract more multinational companies to involve the country in their value chain, particularly in R&D.

Our ability to demonstrate research capability in AI and harnessing it to innovate companies in the country must be done in the soonest time with compelling and scalable success stories. We need to identify low-hanging fruits that would result to job creation and wealth generation because of innovation through AI.

Fig 14. Towards a National Center for AI Research (NCAIR).

1. Build a National Center for AI research by 2024
2. Foster collaboration between academia and the industry
3. Engage and collaborate with international teams



3.3 Workforce Development

There is a pressing worldwide shortage of AI talent. At the 2017 APEC meeting, the scarcity of data science and analytics in the region was highlighted as having “resulted to billions of dollars in revenue annually.”⁶² This paucity will be further aggravated if not urgently addressed. Investment in the education sector is needed for this and cannot be overemphasized. Further, the education sector needs to be transformed to meet the demands of the FIRE.

3.3.1 Transform education and nurture future AI talents

As a first step, initiatives and programs that promote data literacy and digital literacy for all must be designed and launched. It is crucial that the Philippines as a nation develop a deep appreciation for Science, Technology, Engineering, and Mathematics (STEM) and DSA courses. Thus, there is a need to review existing curricula to include the foundations of DSA (mathematics, statistics, and computing) in secondary education. Programming and Data Analysis should be mandatory even at the secondary school level. In terms of developing DSA curricula, DepEd can take inspiration from some of the research done on drafting data science curricula for secondary schools⁶³ and have some of the following modules included.

⁶² Data Science and Analytics Skills Shortage: Equipping the APEC Workforce with the Competencies Demanded by Employers, APEC Human Resource Development Working Group, July 2017.

⁶³ Birte Heinemann, Simone Opel, et al. “Drafting a Data Science Curriculum for Secondary Schools,” in 18th Koli Calling International Conference on Computing Education Research (Koli Calling '18), November 22–25, 2018, Koli, Finland.

- a. Exploratory Data Analysis with Business Intelligence Tools
- b. Artificial Intelligence
- c. Data Science Use Cases and Projects
- d. Data Science and Society (including Data and AI Ethics)

On the other hand, HEIs should also offer data analytics, business analytics, and artificial intelligence (introductory level) as general education courses in the universities and colleges. Expand AI learning beyond the more traditional fields/degree programs such as mathematics, statistics, and computer science.

Having these modules and courses in secondary schools and undergraduate levels across the country requires competent teachers who are themselves data literate. Thus, it is also imperative that teachers be trained so that they are competent and confident enough to teach suggested modules.

Currently, there are less than a handful of academic institutions that offer teachers' training in DSA. At this stage, and given the urgency of the matter, it is recommended to launch a government-funded program that supports a blended kind of learning where teacher participants take pre-identified and learning-pathway-specific online courses (MOOCs) and then attend live (online or face-to-face) discussions to digest and contextualize learnings. For the assurance of (quality) learning, STEM education professors from top universities must be consulted and tasked to review the online learning modules and/or learning pathways. In addition, HEIs, other academic institutions, and/or accredited professional organizations must be tapped to train teachers in the different aspects and levels of DSA. Government can also tap international experts in DSA education. Under the 11th Regular Foreign Investment Negative List (RFINL), allowing the entry of foreign educational institutions and experts specializing in teaching advanced high technology skills is expected to:

- Stimulate knowledge transfer from specialized institutions to local industries;
- Equip the country's current and future workforce with skills needed to align local industry processes with emerging frontier technologies; and
- Attract foreign-owned training centers that specialize in short-term high-level skills development can aid in upskilling workforce to improve productivity.

Furthermore, to realize the AI strategic goals, particularly with respect to R&D, graduate programs in data science and AI must be supported. This could be through DOST's Accelerated Science and Technology Human Resource Development-National Science Consortium (ASTHRDP-NSC), which provides "scholarships for the pursuance of Master's and Doctorate degrees in priority S&T areas;" this could also be realized through DOST's Foreign Graduate Scholarship Program that provides "opportunities to talented and deserving students to study and obtain MS and PhD degrees in science and engineering in reputable institutions abroad." The latter more especially since the Philippines has yet to develop a critical mass of programs and research laboratories in the field of Artificial Intelligence and Data Science.

Indeed, we must invest in increasing the number of graduate students (masters and PhD) in business analytics, data science, and artificial intelligence, noting that these graduate degrees should be geared towards research degrees. Having said that, it is also equally important that the government properly and sufficiently evaluate the quality of new AI and DS degree programs; ensure that the needed resources,

manpower and equipment, are adequate. Note that a graduate degree in AI and DS (especially a PhD) are among the very few ones useful in both academia and the industry.

Finally, local academic institutions must be incentivized and/or supported to have practitioners engage with graduate students; this way, academic institutions will produce graduates who are experts not only in the technical aspects of data science and artificial intelligence, but also in making the technology useful and impactful to other fields.

Strategic Tasks	Responsible Agencies
28. Promote data literacy for all. This includes the mainstreaming of Data Science and Analytics (DSA) throughout the secondary curriculum, beyond its traditional domain in science, technology, engineering, and mathematics (STEM).	DepEd, CHED, DOST
29. Ensure proper training of teachers in DSA.	DepEd, CHED, TESDA, DOST
30. Support and/or initiate the development of graduate programs centered on data science and AI. Students under the DSA programs should also be included in the tracer studies – this will be one of the basis for improving the curriculum and delivery of education services.	CHED
31. Increase the number of graduate students in business analytics, data science, and AI.	CHED, DOST
32. Promote lifelong learning. Design learning pathways for out-of-school individuals who want to learn the latest trends and technologies in AI.	DOST, DTI, TESDA
33. Include data science and analytics, including data visualization and storytelling, as general education courses in universities and colleges.	CHED
34. Work with technology companies to provide sufficient computing resource and equipment to students and teachers.	DepEd, CHED, DOST, DICT

3.3.2 Upskill and reskill the workforce

This imperative is consistent with Republic Act No. 11230, also known as the “Tulong-Trabaho Act”, which has four objectives. Below, three of these objectives relevant to the nations AI journey are highlighted.

- (a) To strengthen the qualifications of the Filipino workforce to meet the challenges of the rapidly evolving workplaces and work structures;

- (b) To provide for more innovative approaches to Technical Vocational Education and Training (TVET) linked to the requirement of industry to primarily address unemployment and job-skill mismatch;
- (c) To encourage the participation of industry and communicates in competencies formation and upgrading towards a more competitive Filipino workforce.

To this end, the DTI and TESDA have partnered with SkillsFuture Singapore (SSG) in a collaborative effort to develop Filipinos' individual skills and the country's workforce as a whole in preparation for the FIRE:

The DTI with TESDA partnered with SkillsFuture Singapore (SSG) to cooperate and enhance Philippine human capital and the reskilling and skills upgrading of the country's workforce by preparing them for the needs of industry and the demands of the global market, especially in the Fourth Industrial Revolution. The Philippine Trade Training Center (PTTC) and the Technical Education and Skills Development Authority (TESDA) are cooperating with other government agencies to draft Skills Frameworks for various sectors.

In addition to the Skills Framework being developed by DTI and TESDA, incentivizing or mandating industries to offer Learning & Development (L&D) programs related to data extraction, data cleaning, data analysis, and machine learning, among others, is also recommended. In an ADB-funded study on TVET Financing Options, it recommends introducing a voluntary levy and training fund to provide a stable source of funding for training provision within a specific industry/sector; this can be one option to incentivize industries. Further on L&D programs, TESDA is also currently pursuing the creation of the sector skills councils / recognized industry boards or associations, which shall provide L&D programs for workers, employers, and trainers in their respective sectors.

Strategic Tasks	Responsible Agencies
35. Incentivize industries to offer Learning and Development (L&D) programs, which should also include programs that improve digital/data literacy. Where appropriate, the L&D programs should be linked to the existing policies and guidelines of TESDA particularly on apprenticeship, dual training systems, and other enterprise-based training (EBT) modalities.	DTI, TESDA, DOST, DOLE
36. Develop sector-specific curricula and/or stackable programs with varying degrees of specialization (low, medium, high). Curricula should include use of BI and off-the-shelf AI tools.	DTI, TESDA, DOST
37. Identify the tools needed to help upskill the workforce; this should be industry-specific.	DTI, TESDA, DOST
38. Incentivize industries to send employees for graduate studies; choose programs that focus on R&D to develop a scientific culture within organizations.	DTI, DOST, CHED, DOLE

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39. Identify jobs that are vulnerable to automation and other FIRE DTI, TESDA⁶⁴, NEDA technologies. Map the skills that need upgrading or retooling. Embark on an inventory of skills and competencies needed in the future to respond to the changing demands of organizations and society.
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The upskilling and reskilling need to be fast-tracked; one approach to realize this is by identifying tools and other resources (online and offline) for the workforce to learn (could be guided or self-taught). Identify an academic institution or a consortium of academic institutions to partner with to collect and/or develop and design the needed resources.

For example, TESDA ⁶⁵, together with CHED and DOST, could develop stackable/modular programs/curricula customized to specific industries. At the very least, these programs should cater to the following needs of the workforce:

- Awareness and appreciation of AI and/or Data Science
 - What are the different analytics maturity levels? (e.g., Gartner's)
 - What is exploratory data analysis? How is it done?
 - What is data science?
 - What is artificial intelligence?
 - Training on the use of at least one of the following business intelligence software: MS Excel, Tableau, Power BI, QlikSense.
 - Training on Exploratory Data Analysis
- Applying AI models to augment existing processes that require domain expertise
 - Training on Exploratory Data Analysis
 - Training on Regression Models
 - SQL training for beginners
- Specialization in AI, machine learning, and data science
 - Check graduate programs related to data science and AI (e.g., UP's MSc and PhD in Computer Science programs, AIM's MSc and PhD in Data Science programs, etc.)
 - Explore offering modular/micromasters degrees.

The DTI could also partner with learning institutions and offer workshops and/or executive education programs to leaders of enterprises, particularly the C-suite, to acquaint them with DSA and AI. It is crucial that these programs not only cover the technical aspects of becoming an Analytics Competitor, but more importantly, programs should be able to present to business leaders clear and high-impact AI use cases that connect AI-driven projects to the strategic objectives of organizations. The Asian Institute of Management, for example, under its School of Executive Education and Lifelong Learning, offers a 2-day

⁶⁴ TESDA is pursuing to be a demand-driven organization through the area-based framework, which starts with skills mapping and identifying skills priorities at the local level.

⁶⁵ In our discussion with TESDA, it was mentioned that TESDA is currently developing more bite-sized or stackable competencies to ensure TVET graduates are equipped with relevant and in-demand skillsets.

executive education program titled “Leading with Data Science,” custom-designed for the top 25 leaders of enterprises. This initiative should also be part of the L&D programs of organizations.

3.4 Regulation

Under the Regulation strategic dimension, the Roadmap aims to ensure that individual data are well protected, especially since many AI algorithms are contingent on personal data. In addition to data privacy, other potential ethical issues that may arise when building AI-driven platforms need to also be audited and properly and sufficiently addressed. For one, we need to ensure that societal biases are not amplified; that is, they should not be learned and propagated by AI algorithms. In addition, for certain AI applications, interpretability may be critical, especially when AI-driven platforms use personal data and decide in situations that involve humans; for these, we need to have the capability to properly appraise algorithms.

3.4.1 Build an AI Ecosystem “Conscience”

To this end, IP Laws and data-protection laws and to address potential ethical concerns on the use of both data and AI technologies need to be standardized. In this aspect, particular champions from government that need to work closely together include the National Privacy Commission (NPC), the Intellectual Property Office of the Philippines (IPOP HL), the Philippine Competition Commission (PCC), and the Department of Trade and Industry (DTI). The role of IPOP HL will be relevant in establishing the intellectual property rights of scientists and research engineers and, of course, the stakeholders (private) in any government-funded or government co-funded engagement. On the other hand, the NPC will ascertain that data protection is upheld at all cost for all stakeholders, and that the country’s laws are timely and relevant. Together with the DTI, they will ensure that the rights of consumers are protected, including access to remedy, in the AI economy. Particular to the e-commerce growth expected in the new normal, there is a need to promote the use of digital platforms in handling dispute resolution.⁶⁶ Finally, the PCC will look at data as a commodity (a competitive asset) and therefore will ensure proper regulation of the accumulation and exchange (or productization) of data.

It is recommended that the government establish a commission or an advisory board that will focus on the responsible use of data and AI technologies. The advisory board will be composed of lawyers, ethicists, academics, and data science practitioners. This body should have international experts who can ensure that policies will be convergent with other ethical guidelines for AI⁶⁷ issued by other countries. We recommend exploring, in particular, the following requirements established by the European Union (EU)⁶⁸ to promote regulatory considerations in the Philippines: (a) human agency and oversight; (b) technical robustness and safety; (d) privacy and data governance; (d) transparency; (e) diversity, non-discrimination, and fairness; (f) societal and environmental well-being; and (g) accountability.

⁶⁶ Chapter 9A (Expanding Economic Opportunities in Industry) and Chapter 6 (Pursuing Justice) of the Updated PDP 2017-2022.

⁶⁷ Jobin, A., Ienca, M., and Vayena, E., “The Global Landscape of AI Ethics Guidelines,” *Nature Machine Intelligence* **1**, 389-399 (2019).

⁶⁸ White Paper on Artificial Intelligence A European approach to excellence and trust. European Commission. Brussels, February 19, 2020.

Finally, exploring the creation of a “regulatory sandbox,” under NCAIR (Section 3.2.2.3) is recommended, where government can provide a better environment and testing ground to balance both regulation and consumer protection that can help assist the growth of emerging business models brought by the disruptive technologies from AI.

Strategic Tasks	Responsible Agencies
40. Ensure industries and businesses, especially MSMEs, can freely compete in an AI-driven and data-driven environment to support their growth.	DTI, DOST, NEDA
41. Review and transform business regulations for ease of business, especially in launching new platforms, products, and services.	DTI, DOST, NEDA
42. Establish a committee of experts in data and AI ethics who will serve as guardians; to be composed of academics, human rights lawyers, ethicists, and industry experts to minimize abuse or misuse of data and AI algorithms. Same committee will ensure that the negative effects of AI algorithms, especially the amplification of inequality / unfairness, are minimized.	DICT, DOST, NEDA, DTI (IPOPIL) with NAST, CHR, NPC

PART FOUR:

WAY FORWARD

4.1 AI Council

An AI Council needs to be established, composed of representatives from the DTI, DOST, NEDA, DICT, CHED, TESDA and other champions from government, together with industry and academic representatives, which would steer and oversee the implementation of the Roadmap.

For the academe, it is imperative that representatives should have a strong portfolio on Artificial Intelligence R&D and significant exposure to industry innovation, especially since the Council will chart the strategic direction on AI R&D investments and other AI-related technologies/programs. An R&D portfolio means a list of publications in reputable indexed journals while “industry experience” implies successful completion of applied R&D projects with industry stakeholders. For the industry, members should have demonstrated successful collaboration with academic institutions on novel problems showing openness and agility in adapting new ideas and technology in pursuit of solutions. For government, we aim to have leaders with advanced degrees required to have the appreciation, intellectual rigor, and competence to understand and articulate regulations as well as the risks and limitations of AI technologies.⁶⁹

The Council should also enlist the assistance of the National Academy of Science and Technology (NAST), which is the “highest recognition and scientific advisory body of the Philippines under the Department of Science and Technology.”

4.2 Funding

Investment in AI, as with any technology, is not without some risk. However, the initiative investments of various countries are promising as they give a clear return of investment (ROI) ranging from **20-40%** of measurable financial value, which is positively correlated with the amount of investment.

Table 1 lists some high-impact use cases as reported in the Kearney-EDBI report “Racing toward the future: artificial intelligence in Southeast Asia”. With AI technologies, when properly adapted, survey results also point to the mitigation of job losses and more importantly improvement in job satisfaction.

⁶⁹ Thus, it is highly recommended to have PhD holders from government in this AI Task Force.

Table 1. High-impact use cases across the value chain as reported in the Kearney-EDBI Artificial Intelligence report “Racing toward the future: artificial intelligence in Southeast Asia”.

Sector	High-impact use cases		
Supply chain, manufacturing, and procurement	Predictive maintenance >30% reduction in maintenance cost	Yield, throughput, and line optimization >30% increase in productivity	Inventory and parts optimization 21% to 30% decrease in stock-outs
Finance	Credit risk modelling >30% improvement in risk model performance	Audit and compliance 21% to 30% reduction in noncompliance-associated costs	Fraud and anomaly detection 11% to 20% decrease in cases of fraudulent transactions
Customer service operations	Call center customer/agent profiling and routing >30% increase in first call resolution	Predictive service intervention 21% to 30% decrease in customer service ticket	Self-serve incident management 21% to 30% reduction in customer service cost
Human resources	Candidate sourcing and matching 11% to 20% increase in hiring productivity	Adaptive learning 11% to 20% increase in employee engagement	Employee retention 11% to 20% decrease in employee attrition
Marketing and sales	Predictive purchase intent identification >30% increase in lead conversion	Next product to buy/individualized offerings 21% to 30% increase in revenue	Churn reduction 21% to 30% decrease in customer churn

The benchmark spending on R&D per capita is pegged at 1% of GDP (~USD 3.75B for the Philippines).^{70,71} For the Philippines, however, experts suggest that expenditure should be at 2%, which is ~USD 7.4 B of ~USD 370B of the Philippine GDP to become globally competitive. This is in fact lower than the 3% R&D investment target—the so-called Barcelona target—adapted as Europe’s innovation and progress performance target indicator.⁷²

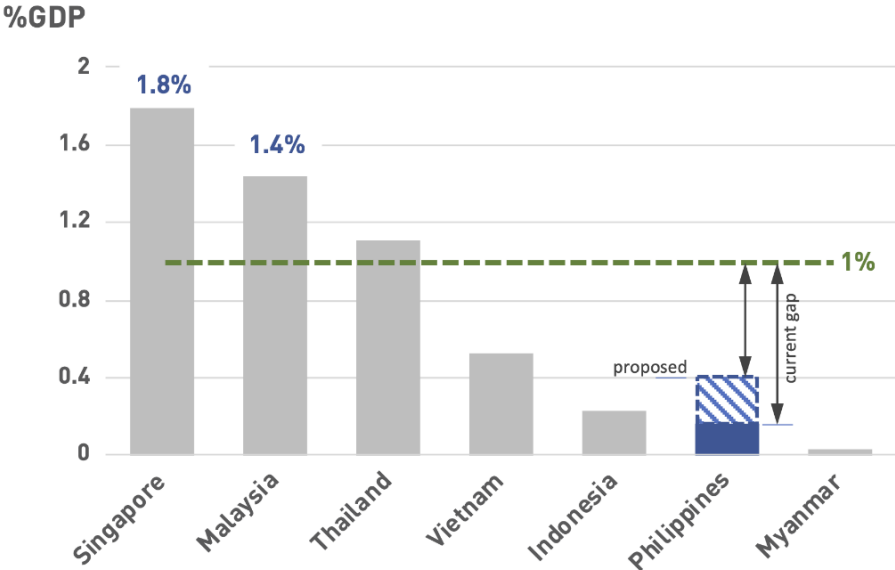
⁷⁰ Study on the State of S&T Development in ASEAN (2012), Volume 1, ASEAN. https://asean.org/wp-content/uploads/2017/10/01-Study-on-the-State-of-S_T-Development-in-ASEAN-Vol-1-ASEAN-State.pdf

⁷¹ Statistical Yearbook for Asia and the Pacific (2013). United Nations ESCAP. <https://www.unescap.org/sites/default/files/C.4-Research-and-development.pdf>

⁷² A Time Series Analysis of the Development in National R&D Intensities and National Public Expenditures on R&D. IDEA Consult Belgium and Fraunhofer Institute for Systems and Innovation Research ISI. 2008.

Currently, the Philippines is only spending less than 0.2% (USD 0.8 B) of GDP on R&D, and we are second to the last compared to the researched countries in Southeast Asia as shown in Figure 15. On the other hand, AI can be a good anchor to start justifying R&D spending, as it immediately has a multiplier effect and is aligned to future jobs and skill sets.

Fig 6. Proposed increase to the RDE as % of GDP.



Data Source: World Bank Data Base. 2020. Available online: <https://data.worldbank.org/>
 For Singapore and Thailand, data are taken from OECD and NXPO, respectively, as they have more recent information.

In this context, an added USD 0.8 B (~PhP 38.5B) annually (that will only increase by 0.2% the R&D spending in the country) can be considered, resulting to a total of 0.4%, which is still 0.6% to 1.6% short of the recommended RDE depending on which target being looked at. Nonetheless, such spending will immediately bear fruit as it will result to enhanced competitiveness of local industries and workforce (in the manufacturing, services, and agriculture sector) and will develop a more efficient and agile government service. It will most likely increase the branding of the country’s workforce as well.

