



Technical Education and Skills Development Authority



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THE POTENTIAL OF AI:

Divergent Possibilities of Innovation

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The Potential of AI: Divergent Possibilities of Innovation

EXECUTIVE SUMMARY

The fourth wave of technology, the birth of Artificial Intelligence (AI), promises us a more innovative and productive future. Artificial Intelligence, as defined by Oxford Languages, is the theory and development of computer systems able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.

TESDA as the government agency mandated to manage and supervise the technical education and skills development in the Philippines aims to prepare TVET in adapting to the skills needed for the uprise of AI. The ability and speed of adaptation must be robust enough to cope with the increasing pace of innovation. Meanwhile, AI can be useful and applied in the different sectors in the country such as: Healthcare, Finance, Data Security, Travel & Transport, Automotive Industry, Robotics, Agriculture, E-commerce, and Education. The priority of AI is more on the Business Sector due to the massive investments in AI. We can expect that AI's potential in retail is a savings of over \$340 billion a year by 2020 as a direct result of AI cross functions, with an expected 80% of the savings coming from AI increasing efficiency and processes. On the other hand, there are Relevant Policies signed and executed in order to support the activities of AI including RA 11293, PDP 2017-2022, and the AI Roadmap.

AI in other countries is also advancing. China published the "Made in China 2025" plan which is a \$1.68 trillion investment in artificial intelligence. The United States of America had administered different organizations and policies to help aid the advancement of AI. There is some sort of lag in the European Union because of data privacy regulations, ethical concerns and reluctance to adopt cutting-edge tech.

In connection with this, TVET will need to improve their way of imparting skills to students. The status of the Philippines in terms of AI is very hopeful. Just recently, the Department of Trade and Industry (DTI) launched the National AI Strategy Roadmap, which includes the establishment of the National Center for AI Research (NCAIR) by 2024. The Technical Education and Skills Development Authority (TESDA), have taken initial steps on education and training relative to AI. However, more actions will be needed in response to AI that will impact how TESDA does its TVET policies; training regulations, standards and curricula; TVET delivery, quality of TVET human resource; partnership and networking; and governance.

BACKGROUND

A. ARTIFICIAL INTELLIGENCE: AN OVERVIEW

The conception of Artificial Intelligence (AI) is much older than generally perceived. It was initially incompletely envisioned by Lady Ada Lovelace in the 1840s as an Analytical Engine which today would be “equivalent to a general-purpose digital computer” (Boden 2018, 25-26). In 1936, the next progress only came with Alan Turing’s universal Turing machine (Boden 2018, 27). However, due to technological limitations, it was only in the 1950s when the theoretical foundations of AI was largely developed (Shiohira 2021, 11).

AI’s impact on society is undeniable. Mankind has witnessed four industrial revolutions. From Great Britain’s shift to manufacturing to the “extreme automation, connectivity, and the wider implementation of artificial intelligence” being witnessed in the Fourth Industrial Revolution (Khatiwada 2020, 263; Speilvogel 2014, 444, 472), “what has changed dramatically over the past decade is access, speed and availability” (Shiohira 2021, 11).

So, what is AI? Unfortunately, there is still no consensus on its definition (Calo 2017, 404; Shiohira 2021, 11). Simply said, AI attempts to simulate the workings of the human mind (Boden 2018, 1; Shiohira 2021, 11). In the Fourth Industrial Revolution, which is a digital revolution, technologies are easily connected with the online world. Such a connection, unlike before, has easily diminished the division between the physical and the digital world. Numerous technological innovations have emerged from advanced digital production (ADP) technologies, biotechnology, nanotechnology, and of course, AI (Lavopa and Delera 2021; Schwab 2016). As of now, AI is composed of augmented intelligence, automation, big-data analytics, deep learning, machine learning, and robotics. Although just starting, AI is already making strides in performing recurrent simple tasks for businesses thus making them more efficient. AI is also helping human decision when AI is utilized in analyzing large amounts of data thus helping lessen human error. What is even more amazing is that such services are more readily available although offered for a prize. Moreover, AI is utilized to enhance productivity when it is used to streamline production in agriculture, logistics, and digital banking. AI is also employed analyzing investments (even in the arts), unemployment, recruitment and much more. Thus, helping businesses make better decisions. Surprisingly, AI is already also made use in medicine in assisting in diagnosis and offering more options to patients suffering

from breast cancer, stroke, and even the recently-appeared COVID-19 virus (ABAC 2020, 8-16).

According to Dr. Erika Legara in her presentation during the AI Roadmap Launch, AI is seen as the biggest driver of innovation and disruption for enterprises followed by cloud computing and blockchain technology.

AI can now do many things that only humans are capable of including reasoning, adapting, recognizing patterns, and solving complex problems (ISTE 2019). Provided this, urgency and international attention is being given to AI, especially as it moves beyond just technology but as a strategic capability towards innovation and its disruption on the world of work.

B. APPLICATION OF AI TECHNOLOGIES

During the AI roadmap launch, Dr. Erika Legara stated that “it is difficult to imagine a sector that AI will not impact”. But to name a few, the following are some of the AI applications (JavaPoint, n.d.):

Healthcare. AI is applied to make better and faster diagnosis than humans. AI can help doctors with diagnoses and can inform when patients are worsening so that medical help can reach the patient before hospitalization.

Finance. The finance industry is implementing automation, chatbot, adaptive intelligence, algorithm trading, and machine learning into financial processes.

Data Security. AI can be used to make data safer and secure. Some examples such as AEG bot and AI2 Platform are used to determine software bugs and cyber-attacks in a better way.

Travel & Transport. AI is capable of doing various travel related works spanning from making travel arrangements to suggesting the hotels, flights, and best routes to the customers. Travel industries are using AI-powered chatbots which can make human-like interaction with customers for better and faster response.

Automotive Industry. AI is used to provide virtual assistants to their users for better performance. Various industries are also currently working on developing self-driven cars.

Robotics. With the help of AI, intelligent robots can be created which can perform tasks with their own experiences without being pre-programmed. Humanoid Robots are best examples for AI in robotics (i.e. the intelligent Humanoid robot named Erica and Sophia).

Agriculture. Agriculture is becoming digital and applies AI in fields such as agriculture robotics, solid and crop monitoring, and predictive analysis.

E-commerce. AI is providing a competitive edge to the e-commerce industry, and it is becoming more demanding in the e-commerce business. AI is helping shoppers to discover associated products with recommended size, color, or even brand.

Education. AI can automate grading so that the tutor can have more time to teach. AI in the future can work as a personal virtual tutor for students, which will be accessible easily at any time and any place.

C. EXPECTATION AND PRIORITY AREAS

Countries around the globe, including the Philippines, are starting to adapt AI in order to boost the country's economy. It is expected that many industries will work side by side with smart machines and technologies to drive efficiency and productivity (ISTE, 2019). AI is also projected to create high-income jobs and protect unnecessary job losses.

For instance, Amazon, a pioneer in AI as an early user of the technology, saw a 35% increase in sales, experienced faster stock transportation to twice as fast, and reduced task risk and accuracy all resulting from the use of AI software.

Another is the use of chatbots projected to help reduce the costs by at least 30%. Instead of replacing jobs, chatbots are helping humans do their jobs better and allow them to focus on the more complex workload and processes.

Additionally, the launch of the Philippine AI Roadmap reveals AI's role in providing socially relevant solutions to the problems that the society is currently facing. The Department of Trade and Industry Secretary Ramon Lopez pushes for the country as the "AI center of excellence" with AI being the "next high-value service-winner after BPO" (DTI, 2021).

Some of the priority areas based on the Philippine AI Roadmap include precision farming in Agriculture, autonomous vehicles and smart manufacturing in Manufacturing, and healthcare services and BPO in the Services industry.

AI IN OTHER COUNTRIES

Artificial Intelligence has been the fourth wave of technological advancement, according to Comin and Mestieri (2017). The four waves being talked about is the sequence of "General Purpose Technologies" (GPTs). The four most important GPTs of the last two centuries were the Steam Engine, Electric Power, Information Technology (IT), and **Artificial Intelligence (AI)**.

The Global status of technological changes is very quick. In one glimpse or another, new technological proposals are popping. But, there is a trend which states that the pace of

invention is not accelerating. In addition, the time between invention and implementation has been shrinking. However, it is of positive note that this time lag had been cut off by half from the last over each GPT.

The results of this year's McKinsey Global Survey (2021) on artificial intelligence (AI) suggest that organizations are using AI as a tool for generating value. Increasingly, that value is coming in the form of revenues. A small contingent of respondents coming from a variety of industries attribute 20% or more of their organization's earnings before income and taxes (EBIT) to AI. These companies plan to invest even more in AI in response to the COVID-19 pandemic and its acceleration of all things digital. This could create a wider divide between AI leaders and the majority of companies still struggling to capitalize on the technology; however, these leaders engage in a number of practices that could offer helpful hints for success. And while companies overall are making some progress in mitigating risks of AI, most still have a long way to go.

A. COUNTRY EXAMPLES: LEADING COUNTRIES IN AI ADOPTION

- China

The last two decades witnessed the rise of China as an economic power; the next 10 years will decide whether it will eventually become a superpower. For now, President Xi's approach could be summed up much as Lenin's strategy was in 1920: State capitalism is the People's Party plus artificial intelligence. Vladimir Lenin's Communist Party invented the Five-Year Plan to exploit electric power, the Chinese Communist Party announced in 2015 "The Made in China 2025" plan, which is a \$1.68 trillion investment in artificial intelligence. (Gill 2020, [6])

M. Cyril (2018) discussed that the plan is to transform the Chinese economy and dominate global manufacturing by 2030. To centralize the vision to transition the country's existing manufacturing infrastructure and labor market towards producing more specialized output; to engineer a shift for China from being a low-end manufacturer to becoming a high-end producer of goods; with targeted investments in research and development (R&D) and an emphasis on technological innovation, the government's Ministry of Industry and Information Technology released a Made in China 2025— pushing for leadership in robotics, information technology, and clean energy, among other sectors.

China's previous plans also pushed for greater investments in hi-tech manufacturing. Yet, with Made in China 2025, the difference seems to be the plan's intent to gain know-how, with expansive state support, both direct and indirect. Among its various goals, the MIC 2025 sought to raise the domestic content of core components and materials to 40 percent by 2020 and 70 percent by 2025. The plan explicitly referred to how much of China's technology market could be controlled by Chinese companies and how many component parts in different products needed to be

'Made in China'. The end goal of the MIC 2025 being self-sufficiency for domestic companies would then enable Chinese companies to compete for a greater foothold in global markets. (Cyril 2018)

- **United States of America**

State Secretary Antony J. Blinken at the National Security Commission on Artificial Intelligence's (NSCAI) Global Emerging Technology Summit (2021) laid down the AI report in the United States of America. A global technology revolution is now underway. Investments in AI have led to transformative advances now impacting people's everyday lives, including mapping technologies, voice-assisted smartphones, handwriting recognition for mail delivery, financial trading, smart logistics, spam filtering, language translation, and more. AI advances are also providing great benefits to social wellbeing in areas such as precision medicine, environmental sustainability, education, and public welfare.

Here are the steps USA had been doing to aid the advancement of AI in the country:

- *National Artificial Intelligence Act of 2020*

The Department of State is at the forefront of promoting an international policy environment and working to build partnerships that further capabilities in AI technologies, protect national and economic security, and promote values. Accordingly, the Department engages in various bilateral and multilateral discussions to support responsible development, deployment, use, and governance of trustworthy AI technologies.

- *Organization for Economic Cooperation and Development (OECD)*

The Department provides policy guidance to implement trustworthy AI through the OECD AI Policy Observatory, a platform established to facilitate dialogue between stakeholders and provide evidence-based policy analysis in the areas where AI has the most impact. Forty-seven (47) AI initiatives are associated with the Observatory that contribute to COVID-19 response, invest in workforce training, promote safety guidance for automated transportation technologies, and more.

- *Global Partnership on Artificial Intelligence (GPAI)*

GPAI is a voluntary, multi-stakeholder initiative launched in June 2020 for the advancement of AI in a manner consistent with democratic values and human rights. GPAI's mandate is focused on project-oriented collaboration, which it supports through working groups looking at responsible AI, data governance, the future of work, and commercialization and innovation.

- *United Nations Convention on Certain Conventional Weapons*

Building a better common understanding of the potential risks and benefits that are presented by weapons with autonomous functions, in particular their

potential to strengthen compliance with IHL and mitigate risk of harm to civilians, should be the focus of international discussion. The United States supports the progress in this area made by the Convention on Certain Conventional Weapons, Group of Governmental Experts on Emerging Technologies in the Area of Lethal Autonomous Weapon Systems (GGE on LAWS), which adopted by consensus 11 Guiding Principles on responsible development and use of LAWS in 2019.

- **European Union**

Among EU countries, Ireland has the highest share of businesses using AI applications. That's according to European Commission data from 2020, which found that 23pc of enterprises in Ireland used any of these four AI applications: analyzing big data internally using machine learning; analyzing big data using natural language processing, generation or speech recognition; using a chatbot or virtual agent; or using service robots. (Harford, 2021)

While Europe produces AI excellence, it has trouble scaling start-ups. Large European companies including Airbus, Bosch, Rolls-Royce and Siemens have been innovating with AI, and Europe has been the birthplace of start-ups such as DeepMind and Featurespace. Additionally, a recent report from research and advisory company Forrester (2020) said there's a widespread perception that data privacy regulations, ethical concerns and reluctance to adopt cutting-edge tech have resulted in European companies being less advanced in terms of AI adoption than companies in other regions.

But the EU is keen to give AI a boost. The European Commission aims to reach an annual investment of €20bn over the course of this decade to help Europe become a global leader in this area of tech. At the same time, it is focusing on making AI ethical and human-centered. The European Commission proposed on April 21, 2021 a new set of rules and actions aiming to turn Europe into the global hub for trustworthy AI. The proposal outlined that it would classify different AI applications depending on their risks and implement varying degrees of restrictions. This hopes to guarantee the safety and fundamental rights of people and businesses, while strengthening AI uptake, investment and innovation across the EU. While other regions may be slightly ahead of Europe when it comes to AI uptake, Forrester's report said that European companies are not lagging far behind and the bloc is certainly leading the way in terms of its focus on ethics and **trustworthy AI** (Harford, 2021).

- **United Kingdom**

The UK has played an important role in the history and development of AI. Alan Turing, a British mathematician, is considered to be the father of theoretical computer science and has deep roots in AI as well. In addition to crafting the foundations for modern computing, Turing envisioned the Turing test, which aims

to determine a machine's ability to exhibit intelligent behavior equivalent to, or indistinguishable from, that of a human.

In 2017 the UK established an All Party Parliamentary Group on Artificial Intelligence to address ethical issues, industrial norms, regulatory options and social impact for AI in Parliament. Despite AI's history with periods of little interest and funding, the times have changed. According to Lord Clement-Jones, AI is finally here to stay (Walch, 2020).

In reference to The International Trade Administration (2021), the UK has one of the most dynamic AI strategies in the world coupled with strong government funding, dynamic research activity in the field, external venture capital (VC) funding and AI startups, as well as lively enterprise activity and adoption of AI.

In addition, in 2019, the UK Government published the AI Sector Deal, outlining a package of over \$1.3 billion of support for the sector. The Government has also announced a new plan to make the UK a global center for the development, commercialization and adoption of responsible AI to be published this year.

Furthermore, the UK's AI market is estimated to grow significantly during the next 5 years and to add \$880bn to the UK economy by 2035. UK artificial intelligence investment has reached record highs with UK AI scale-ups raising almost double that of France, Germany and the rest of Europe combined. The UK is the third country in the world (after the U.S. and China) in terms of AI investment.

- **Japan**

Japan has at the moment 200 to 300 AI-related companies (Data Artist, 2020). Japan is number one in the world as a supplier of industrial robots and third, after China and the USA, in AI R&D (OSA DC, 2018). Zooming in on Japanese companies' AI patents, Toshiba is Japan's champion and the world's third, after IBM and Microsoft. (Dirksen, 2020)

The country aims to stay a prominent player in the high-tech sector with AI as one of the vital components. Japan wants to utilize AI in its policies to address its own societal issues, to have sovereignty over its fate and to actively design its own future. Therefore, the Japanese AI strategy is a key part of the transition to their envisioned Society 5.0 which stands at the core of several research programs, like the Japanese Moonshot program, similar to Europe's Horizon2020, and the cross ministerial Strategic Innovation Promotion Program (SIP).

Reinventing Japan Through AI

Technological developments can thrive during chaotic times and this crisis is no different. AI developments have not come to a complete standstill until the economy recovers. The figure below looks at macro level trends, which have an effect on the development of AI in Japan by using five different perspectives; the political, economic, societal, technological and legal dimensions, or in short PESTL. Looking

through these five glasses, this describes the present Japanese situation and also includes the current uncertainties surrounding COVID-19.

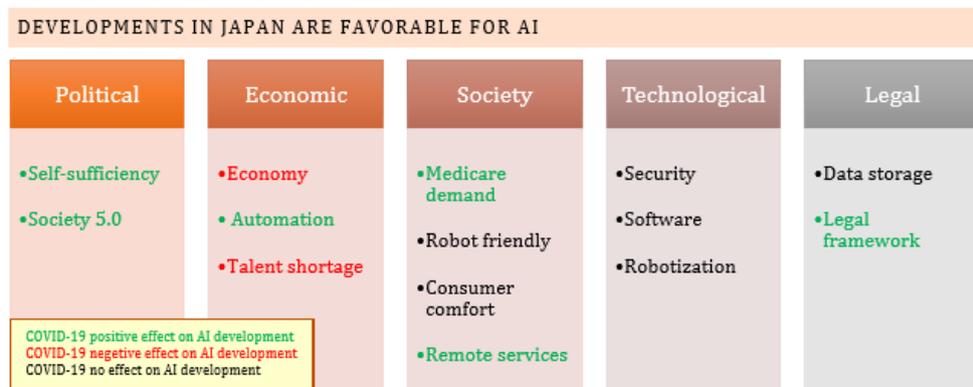


Figure 2. AI development at macro level trends

Here are the notable inventions, innovations, and actions of Japan despite the pandemic:

Autonomous robots. *Mirai's* newest invention can drive through public spaces like malls or airports to detect people with fever. It then isolates the infected person and, if necessary, startup a tele-conference with a doctor. AI technology makes autonomous navigation, detection and interaction possible (European Commission, 2020).

AI disinfecting smartphones. As electronic stores noticed an increase of infected staff members during the COVID-19 pandemic, Telecommunications firm KDDI launched an AI service for stores selling smartphone devices and comparable displayed items which customers are keen on touching. Through store cameras, AI can identify the smartphones at display and detect which surfaces are touched by customers. This technique collaborates with the robot's sectors. After the touched areas are detected on screen, a robot makes a round through the store to disinfect the phones using ultraviolet light. (NHK, 2020)

AI handwashing monitor. It stimulating employees from health care, hotel and food industries to follow the health ministry's six-step hand-washing procedure by recognizing complex hand movements, which can even detect if people use soap (Japanese Times, 2020)

ARTIFICIAL INTELLIGENCE: PHILIPPINE STATUS

The Philippines is just starting to boom its way into adapting Artificial Intelligence. The biggest move that the country made is publicizing the National AI Strategy Roadmap. The

document envisions that the Philippines could one day become a big data processing hub and emerge as a global center of excellence in AI. In line with this objective, the Roadmap calls for the establishment of the National Center for AI Research (NCAIR) by 2024 that will study scientific advances in AI, actively develop algorithms for various use-cases and, more importantly, deploy the same in addressing various socio-economic needs of the society (Anggara, 2021).

A. RESEARCH & DESIGN DEVELOPMENT

The Department of Science and Technology (DOST) introduced nine AI research and development (R&D) projects and turned over high-performance computing machines (HPCs) to each project proponent. The Philippine Council for Industry, Energy and Emerging Technology Research and Development (PCIEERD) Director Enrico Paringit said that the DOST provided less than PHP5 million grant per project, excluding the price of the HPC. He pointed out that AI has been helpful while the country deals with the Covid-19 pandemic (Arayata, 2021).

The DOST-PCIEERD virtually launched the following projects: (1) Chatbot that monitors students' health; (2) The Autonomous Societally Inspired Mission Oriented Vehicles (ASIMOV) Program for developing AI-enhanced, mission-driven robots working autonomously or with humans; (3) Philippine Sky Artificial Intelligence Program (SkAI-Pinas); (4) Tremor sensors to monitor the structural health of infrastructures; (5) Intelligent system for traffic control and management; (6) Towed camera system for marine litter monitoring; and (7) Automated software for faster spectroscopy analysis (Arayata, 2021).

B. SAMPLE APPLICATIONS, BY INDUSTRY

Healthcare

The Baguio General Hospital installed the AI COVID-19 Scan Analyzer to help doctors detect COVID-19 cases. The patient's CT scan will be compared to the database of positive COVID-19 cases examined by doctors in China, where the novel coronavirus originated. According to Baguio City Mayor Benjie Magalong, the technology transfer will be the first of its kind in the country. Results may still not be "conclusive and confirmatory but will give the city a heads-up on whether or not a patient is a probable COVID-19 case" (Rappler, 2020).

Simple AI tools also extend beyond more precise diagnosis in the medical field: doctors use natural language processing algorithms for transcribing patient-doctor interactions, surgeons use robots to improve the precision of surgeries, and hospitals employ algorithm-driven processes to replace rote tasks within hospitals. The proper use of these tools in healthcare will change the way medicine is administered: it can improve patient care, reduce fatalities with early diagnoses, and create more jobs through specialization (Jain, 2021).

Other applications of AI in healthcare include drug discovery, smart resource distribution and allocation, telemedicine, and medical supplies anticipation.

Agriculture

The Gul.AI Project is an initiative proposed by DOST – Advanced Science and Technology Institute (DOST-ASTI), which combines the concept of Information and Communications Technology (ICT) and agriculture, especially in the field of crop science. The Gul.AI system deploys plant box components capable of collecting data through onboard sensors. Collected data includes parameters such as water pH level, relative humidity, temperature, luminance, and live imaging of the monitored area (Asunto, 2020).

Other AI applications in Agriculture include demand and sales prediction; crops, livestock, and aquaculture optimization; weather forecasting and development of decision-support tools for farmers; and the creation and use of more efficient tools and machines.

Manufacturing

Based on the Philippine AI roadmap launch, many of the challenges in the manufacturing sector are on increasing productivity and efficiency of processes in factories and in supply chain and logistics. Thus, AI will be beneficial in terms of forecasting the “health” of critical machines (predictive maintenance), yielding optimization, preventing occupational health and safety risks, and optimizing machine-human interface.

ARTIFICIAL INTELLIGENCE IN TECHNICAL-VOCATIONAL EDUCATION AND TRAINING

A. AI-TVET INTEGRATION

- **South African TVET Colleges**

Myles Thies, Director of Digital Learning Services, Eiffel Corp explained at the IVETA conference 2018, that while the 4th industrial revolution will potentially affect jobs, new jobs will replace traditional jobs that **will require a different skill set** – a digitized skill that will go hand in hand with AI. TVET institutions will need to improve their way of imparting skills to students as AI is going to revolutionize the job market. Future learning is micro- and blended-learning and curriculums will be online.

For instance, in the South African TVET Colleges, Thies noted that “In the face of the 4th industrial revolution and quickly evolving technology, unless South African TVET colleges develop a technology plan, they will be irrelevant”. The workplace will be transformed and digital will be utilized to reskill staff.

- **iTrack Skills**

iTrack Skills is developed by the International Labour Organization (ILO) to be piloted in three different countries (Montenegro, Tanzania, and Bangladesh). It uses AI and new digital tools to provide an interactive platform for tracing graduates. This tool is aimed at improving tracer studies and graduate surveys for the status of employment and work trajectories of TVET graduates.

- **Education 2030 Project**

UNESCO includes TVET for disadvantaged youth in the Education 2030 project. The core concern of UNESCO is on how to increase and improve access to learning, while also enhancing its quality. Following are the UNESCO strategies that address the needs of disadvantaged learners in TVET known as 4As:

Availability

Establish the most common policies of financial relief for the costs of tuition, food, accommodation or transport for young people in the general categories of 'disadvantage' or 'vulnerability'. The Djibouti declaration is an example of the availability of TVET at regional level for forced migrants in the IGAD region.

Accessibility

One of the strategies that has been adopted by some states (i.e. Ghana, Thailand, Kyrgyzstan, Uzbekistan, the Republic of Korea, Mongolia and Australia) is the abolishment of tuition fees at upper secondary level in public institutions (UNESCO, 2013).

Acceptability

India was the largest scale intervention reported in this area. Deen Dayal Upadhyaya Grameen Kaushalya Yojana has placed more than half a million rural youth in employment since 2014.

Adaptability

The COVID-19 pandemic, digitization of the economy and the changing world of work have led to the need for more innovative, transformative ways of delivering TVET, which differ from and complement traditional approaches to TVET delivery. Some of the ways in which ICT is being utilized in TVET include curricula integration, assessment and flexible and blended learning (Mead Richardson and Herd, 2015).

As mentioned earlier, one of the core concerns of UNESCO is the expansion and progress of learning without sacrificing its quality. AI can easily help in this vision as it can advance the quality of education especially for the poor. How? AI can help design modified teaching methods to induce student engagement while at the same time also assist in devising specific lesson plans for different students. AI can help identify the specific learning challenges faced by students and counter with different

teaching styles. AI is also used as tutors in chat boards as seen in some countries in Africa. However, human administration is still required.

Another way in which AI is helping in education is improving financial access for the poor. Through AI, those who are denied formal financial services are able to have better access to money (Mhlanga 2021, 11-13).

B. AI AND THE FUTURE OF TVET

Technical and Vocational Education and Training (TVET) need to be adaptable in coping with technology and the new environment. As learners seek out new modes of learning based on their current use of technology, educators should also be equipped with digital skills to meet the changing learning needs.

Institutions should likewise embrace mobility. The ability and speed of adaptation must be robust enough to cope with the increasing pace of innovation. "TVET systems that are not proactive in considering the impact of these shifts on their curricula and training programmes run the risk of becoming irrelevant" (Shiohira, 2021).

Baseline standards for digital teaching and learning that embrace course design and content standards are essential as well. Making a serious and conscientious investment in technology is only one small part of the solution. Continuous individual professional development and reskilling in digital teaching and assessment practices is essential as well as establishing a supportive technology and innovation ecosystem for all participants in the learning continuum. (Eiffel Corp, 2021)

AI will also transform the labor market and the workforce as various processes will be subjected to digitization and digitalization and professions being prone to automation. Intermediate-level skills and occupations are at a particular risk (Shiohira & Keevy, 2020), which are the focus of TVET programs. Based on the International Labour Organization's Standard Classification of Occupations, Intermediate-Level Skills or Skill Level 2 typically involves the following tasks:

- Operating machinery
- Driving vehicles
- Maintaining and repairing electrical or mechanical equipment
- Manipulating or storing information

Given this, TVET institutions should offer a set of skills that ensure the graduates' continued employability (including digital and transversal skills) (Shiohira & Keevy, 2020).

RELEVANT POLICIES IN AI

The uprising innovation of the Artificial Intelligence (AI) Industry was backed up and aided by the following regulatory frameworks:

A. PHILIPPINE INNOVATION ACT

Republic Act No. 11293 also known as the Philippine Innovation Act pursues to adopt innovation as a vital component of national development and sustainable economic growth. This act states that the government recognizes the crucial role of the business sector, academe, scientific community and research institutions in driving economic growth through innovation. As AI is positioned as one of the key drivers of innovation, the Philippine AI Roadmap served as one of the key manifestations of this policy.

In order to support this action, the State shall (1) promote, integrate and strengthen policies that engage with innovative businesses and entrepreneurs, (2) invest in education, science, technology and innovation, (3) place innovation at the center of its development policies, (4) promote a culture of strategic planning and innovation, put efficient institutions in place, and (5) shall strive to encourage potential innovations, and at the same time protecting them from misappropriation.

Through the use of technologies, the adoption of AI is also expected to strengthen Inclusive Innovation outlined in Section 11 of RA 11293 which mandates the National Innovation Council to “integrate policies to promote women’s participation and skills development” (Republic Act 11293, 2018).

B. PHILIPPINE DEVELOPMENT PLAN 2017-2022

The Philippine Development Plan (PDP) 2017-2022 was developed to help realize the goals of AmBisyon Natin 2040. The goal is to build a prosperous, predominant middle-class society where no one is poor.

Chapter 14, which is entitled “*Vigorously Advancing Science, Technology, and Innovation*”, is where the plan for Artificial Intelligence development is included. The chapter stated that Science, Technology and Innovation (STI) plays an important role in economic and social progress. It is a key driver of the long-term growth of an economy.

The AI component in PDP 2017-2022 is also primarily focused on the manufacturing industry as the government pushes for its “Build, Build, Build” infrastructure agenda. The Plan describes AI as one of the “most promising and potentially disruptive emerging technologies”.

However, there is a low level of innovation in the country brought about by a weak STI culture; low research and development (R&D) expenditures; weaknesses in STI human capital; inadequate S&T human resources engaged in STI R&D; difficulty in increasing employment opportunities and retaining S&T human capital; absence of

a vibrant intellectual property culture; weak linkages among players in the STI ecosystem; and inadequate STI infrastructure.

Strategies were set in place to stimulate growth in STI including the promotion of commercialization and utilization of technologies from publicly funded R&D; development of a vibrant Intellectual Property Rights (IPR) culture; provision of support mechanisms for startups and MSMEs in the regions; and support research and development agenda.

Lastly, a legislative agenda was established in order to strengthen the effectiveness of the strategies.

C. AI ROADMAP

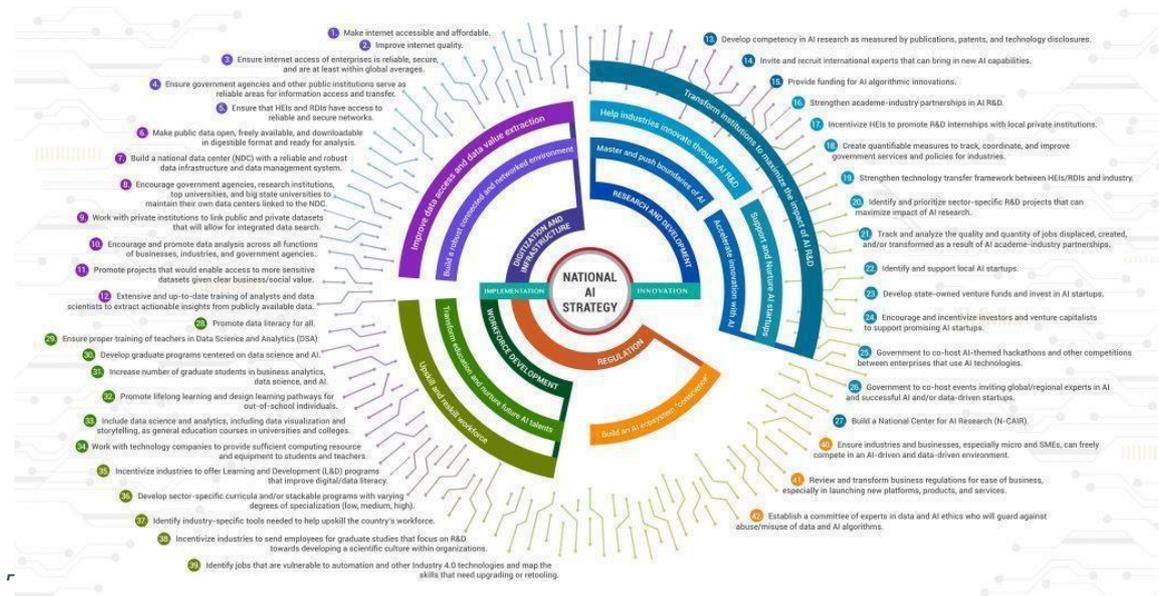


Figure 1. National AI Strategy

On May 5, 2021, the Department of Trade and Industry launched the country's Artificial Intelligence (A.I) Roadmap via zoom and was live streamed through the Department's official Facebook channel. The roadmap's goal is to increase worldwide Gross Domestic Product (GDP) by 14% by 2030 from the increasing AI industry.

The roadmap describes the implementation, infrastructure, and investments needed to cover the four (4) important dimensions for AI readiness, namely: (1) Digitization and Infrastructure, (2) Research and Development, (3) Workforce Development, and (4) Regulation. The above dimensions are then supported by seven (7) measurable strategic imperatives and forty-two (42) strategic tasks. All of which have been defined so as to ensure that there are clear metrics in terms of tracking the progress of the efforts towards a competitive AI Economy with respect to the global arena.

Central to this roadmap is the creation of a National Center for AI Research (NCAIR) that houses full-time scientists and research engineers, serving as Nexus to AI competitiveness of the country. Among its goals are to assist micro-, small, and medium enterprises (MSMEs) interested in using computational tools, especially AI technology, to help them improve their efficiency and productivity. The roadmap identifies R&D projects in agriculture, manufacturing, and services. The priority technologies where AI can be impactful are identified and validated with the help of focus group discussions with representative MSMEs from NCR, Luzon, Visayas and Mindanao.

D. OTHER RELEVANT POLICIES

- **Innovative Startup Act**

Republic Act No. 11293 also known as the Innovative Startup Act, is an act providing benefits and programs to strengthen, promote and develop Philippine Startup Ecosystem. The AI Industry, being a startup in the country will benefit from the clauses of the law. The congress had prepaid a lot of benefits and incentives to those who are planning to establish an innovative new business; businesses crucial to their growth and expansion; and to strengthen, promote, and develop an ecosystem of businesses and government and nongovernment institutions that foster an innovative entrepreneurial culture.

Chapter 2, Section 7, General Registration and Operational Benefits and Incentives that will be provided by host agencies to startups who have passed their selection and application process. This includes: Subsidy for registration expenses and application costs; endorsement and prioritized processing; subsidy for the use of facilities, office space, equipment, and/or services provided by government or private enterprises or institutions; subsidy in the use of repurposed government spaces and facilities of the host agency as the registered business address; and Grants-in-aid (GIA) for research, development, training, and expansion projects;

On the other hand, *Chapter 2, Section 8*, enumerates the benefits a startup can get for participating in local or international startup events or competitions. This includes: expedited or prioritized processing of travel documents and the subsidy for the corresponding processing fees, as well as the roundtrip airfare; subsidy for baggage allowance for materials, equipment, and/or products pertinent to the participation in the local or international startup event; and a per diem allowance.

- **Data Privacy Act of 2012**

Republic Act No. 10173, also known as Data Privacy Act of 2012, is an act that aims to protect individual personal information in Information and Communications systems in the Government and the Private sector, creating the National Privacy Commission for this purpose. The Act encompasses guidelines about Personal

Information processing including processing sensitive information and the rights of the controllers of such personal information; Rights involving Data Subjects; Security of Personal Information; Accountability for Transfer of Personal Information; Information in Government; Penalties in the case of breach in the regulations of this code; and The Miscellaneous Provisions such as how to interpret and implement the clauses of this law.

- **Intellectual Property Code of the Philippines**

Republic Act No. 8293, also known as the Intellectual Property Code of the Philippines, is an act prescribing the intellectual property code and establishing the intellectual property office, providing for its powers and functions, and for other purposes. The act shall protect and secure the exclusive rights of scientists, inventors, artists and other gifted citizens to their intellectual property and creations.

Intellectual rights protected under this code include Copyright and Related Rights; Trademarks and Service Marks; Geographic Indications; Industrial Designs; Patents; Layout-Designs (Topographies) of Integrated Circuits; and Protection of Undisclosed Information.

- **Inclusive Innovation Industrial Strategy (i3S)**

Growing innovative and globally competitive manufacturing, agriculture, and services while strengthening their linkages into domestic and global value chains with innovation at the core of the country's strategic policies and programs, is the ultimate goal of Inclusive Innovation Industrial Strategy (i3S). The identified major constraints for innovation are limited industry-academic linkages, new product development, and R&D facilities.

OPPORTUNITIES IN ARTIFICIAL INTELLIGENCE

AI is projected to provide short-term to long-term benefits especially in the area of employment and job generation, investment, and education and training.

A. ECONOMIC

Business leaders and investors universally agree about the transformative impact of Artificial Intelligence (AI) and Machine Learning (ML) in their businesses. The potential for AI to drive revenue and profit growth is enormous. This could range from companies in healthcare, e-commerce, logistics, and more (Teich, 2021).

International Data Corporation (IDC), a global market research company, forecasts worldwide revenues for the AI market to be \$327.5 billion in 2021. They expect a five-year compound annual growth rate (CAGR) of 17.5%. IDC breaks the AI market

into three segments: software, services, and hardware, with software currently making up the bulk of the revenue share (88%) for 2020.

Further, a research launched by consulting company Accenture covering 12 developed economies that generate more than 0.5% of the world's economic output, forecasts that by 2035, AI could double annual global economic growth rates. AI will drive this growth in three important ways: 1) Strong increase in labor productivity (by up to 40%) due to innovative technologies enabling more efficient workforce-related time management; 2) Creation of a new virtual workforce – described as 'intelligent automation' capable of solving problems and self-learning; and 3) Diffusion of innovation affecting different sectors and creating new revenue streams (PwC, 2018).

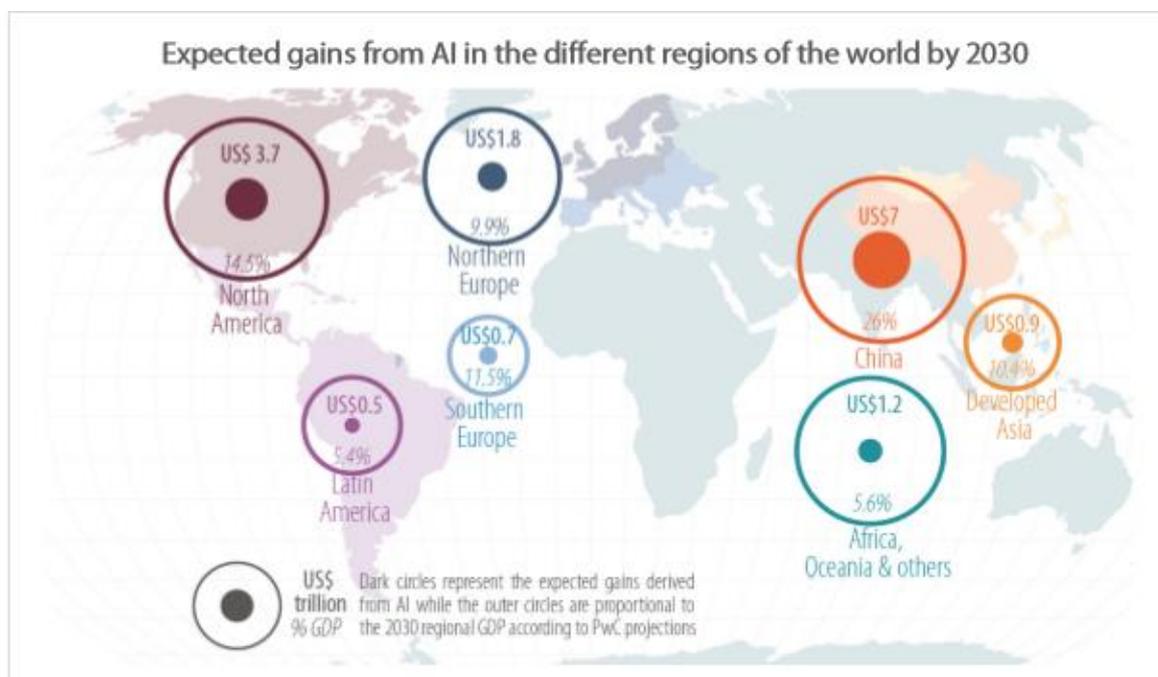


Figure 3. The macroeconomic impact of artificial intelligence

In the Philippines, part of the specific objectives of the National AI Strategy is attracting the world's leading firms to invest in the country, set up shops, and generate more jobs for Filipinos. Particularly, the country hopes to attract companies such as Amazon, Alphabet, Microsoft, Facebook, Netflix, and Baidu. Attracting R&D heavy startups based in the US (e.g. Silicon Valley), Korea (e.g. Seoul Start Up ecosystem), China (e.g. Tsinghua), and Israel are also part of the strategy, apart from supporting local startups.

B. EMPLOYMENT AND JOB GENERATION

Given the benefits AI poses to complex, high-skilled vocations, it is likely that AI-related jobs could see an increased share in the economy, a trend that would create more stable, well-paying positions. The assignment of rote tasks to machines and complex, more meaningful tasks to humans, for instance, in the case of chatbots and voice bots (Regalado, 2021 as cited in Reyes, 2021) will increase productivity and enhance economic growth. In the Philippine AI Roadmap, 10 million jobs are projected to be created in data science and big data analytics by 2023.

AI will have a striking effect on many service and white-collar jobs that have been relatively safe from automation to this point. Compared to the medical field, most routine, service-oriented roles will be phased out by the increased presence of AI. For example, the switch to automated stores has already started with AmazonGo, the prototype for an entirely contactless grocery shopping experience (Jain 2021).

But as some jobs are phased out, the rise of AI will open opportunities for redeployment. According to the study of Bessen et. al. as cited in Casey (2020), workers who are affected by automation were observed to have higher rates of job-to-job transitions. This means that the industry will have an increased opportunity to use the skills set of their labor force provided that routine tasks will be delegated to machines.

Occupations were grouped based on the extent of the transformative and destructive impact of digitalization and automation. "Rising stars" professions are characterized by great transformative effects of digitalization yet the risk of destructive digitalization is small. "Machine terrain" professions have a huge potential to be altered by both that destructive and transformative effect of digitization which can be a problem for the workforce. "Human terrain" occupations, on the other hand, face neither the transformative or destructive effects of digitalization. Yet not the same could be said for the collapsing occupations which will brunt the effects of the destructive effects of digitalization (Fossen and Zogner 2019, 10; ILO 2020, 27).

The ILO classified occupations according to the relative impact of technological changes:

- ***Rising stars*** are occupations where the potential for transformative digitalization is high, while the risk of destructive digitalization is low. Jobs under this category can be considered as growing occupations. Non-routine, cognitive jobs dominate the category, suggesting that least risk and most gains in terms of automation can be found in higher-wage types of work.
- ***Machine terrain*** includes occupations that demonstrate destructive transformation as these will most likely make human workers obsolete. Jobs found on this list are the top declining occupations, the majority of which are classified as routine jobs.
- Occupations in the ***Human Terrain*** category, as its name implies, include jobs with embedded skills that cannot still be performed by machines. As a result, these jobs

are projected to neither face destructive nor transformative digitalization. Many of these occupations serve in the agriculture, forestry, and fishing sector or in low value-added services sectors where wages are low. Close to half represent non-routine cognitive workers.

- **Collapsing occupations** have the potential for transformative digitalization, although the chances are low. Most still face the risk of destructive impact. Similar to human terrain, many of the workers are also involved in agriculture or services sectors. A large share of collapsing occupations is accounted for by non-routine manual occupations. While workers in these occupations could be deemed to be performing tasks that are mostly non-routine in nature, it is not difficult to imagine that these tasks could be replaced by AI advances in the future.

Table 1. Impact of technological changes to various occupations (ILO, 2020)

CLASSIFICATION OF OCCUPATION (IMPACT OF TECHNOLOGICAL CHANGES)	SECTOR	JOBS/SKILLS REQUIREMENTS
Rising Stars	Agriculture and Fisheries	Genomicist
		Farm business planning
		Crop and food production
		Common rice machinery facility operation and management
		Nutrient and pest management
	Automotive and Land Transportation	Mechanical engineers
		Electronics engineer
		Electrical engineers
		Order tracker/coordinator
		Transport Network Vehicle Services (TNVS) drivers/delivery riders
		Supply Chain and Logistics Specialist
	Healthcare Services	Genomicist
		Nanotechnologist
		Hair Transplant Technician
		Pharmacists

		Dieticians and nutritionists
		Optometrists and ophthalmic opticians
		Registered nurses
		Dental hygienists
		Physical therapists
		Medical and health services managers
		Technical and medical sales professionals
		Care providers
	IT-BPM Services	Graphic and multimedia designers
		Visual artists
		Computer system analysts
		Animation artistry
		IT service processors
		UI/UX experts
		Database administration
		Risk and compliance analyst
		Subject matter experts
		Account manager
		Commercial sales representatives
		Customer service representatives
	Manufacturing	Order tracker/coordinator
		Mechanical engineers
		Electrical engineers
		Industrial and production engineers
		Manufacturing managers
	General and operations managers	

		Manufacturing supervisors
		Business operations specialists
		Production technicians
	Cross-cutting Activities	Scientists and research engineers
		Research/Research and development officers
		Computer science and engineering
		Managing directors and chief executives
		Policy and planning managers
		Sales and marketing managers
		Human resources managers
		Office supervisors
		Advertising and marketing professionals
		Personnel and careers professionals
		Training and development specialists
		System analysis and evaluation
		Mobile and web design and development
		Software developers (app, web, computer)
		Advanced IT and programming
		Chief data officers
		STEM skills
Organizational development specialist		
Change management experts		
Machine Terrain	Agriculture and Fisheries	Dairy-products makers
		Fruit, vegetable and related preservers
		Agricultural and industrial machinery mechanics and repairers

	Automotive and Land Transportation	Supply, distribution and related managers
		Electrical engineering technicians
		Electronics engineering technicians
		Mechanical engineering technicians
		Metal molders and core makers
		Welders and flame cutters
		Sheet-metal workers
		Toolmakers and related workers
		Metal working machine tool setters and operators
		Metal polishers, wheel grinders and tool sharpeners
		Motor vehicle mechanics and repairers
		Car, taxi and van drivers
		Bus and tram drivers
Healthcare Services	Pharmaceutical technicians and assistants	
	Medical and dental prosthetic technicians	
	Medical and clinical laboratory technicians	
	Dental assistants and therapists	
	Medical equipment repairers/technicians	
IT-BPM Services	ICT operations technicians	
	ICT installers and servicers	
	Medical transcriptionists	
Manufacturing	Metal production process controllers	
	Metal molders and core makers	
	Welders and flame cutters	
	Sheet-metal workers	

		Metal working machine tool setters and operators
		Metal polishers, wheel grinders and tool sharpeners
		Precision-instrument makers and repairers
		Mineral and stone processing plant operators
		Metal processing plant operators
		Metal finishing, plating and coating machine operators
		Rubber products machine operators
		Plastic products machine operators
		Paper products machine operators
		Fiber preparing, spinning and winding machine operators
		Packing, bottling and labelling machine operators
		Packers and packagers
		Machine feeders and off bearers
		Manufacturing laborers
		Machinists
		Food roasting, baking, and drying machine operators
		Production clerks
		Cross-cutting Activities
	General transcriptionists	
	Secretaries (general)	
Data entry clerks/keyers		
Payroll clerks		
Personnel clerks		
Human Terrain	Agriculture and Fisheries	Farming, forestry and fisheries advisers
		Field crop and vegetable growers
		Tree and shrub crop growers

		Mixed crop growers/producers
		Apiarists and sericulturists
		Animal producers
		Inland and coastal waters fishery workers
		Deep-sea fishery workers
	Automotive and Land Transportation	Customs and border inspectors
		Transport conductors
		Companions and valets
		Service station attendants
		Bicycle and related repairers
		Motorcycle drivers
		Driving instructors
	Healthcare Services	Health services managers
		Aged care services managers
		Traditional and complementary medicine professionals
		Paramedical practitioners
		Dentists
		Physiotherapists
		Psychologists
Nursing associate professionals		
Veterinary technicians and assistants		
Physiotherapy technicians and assistants		
Medical/healthcare assistants		
Social work and counselling professionals		
Medical imaging and therapeutic equipment technicians		
Fitness and recreation instructors and program leaders		

		Home-based personal care workers
		Ambulance workers
	IT-BPM Services	Information and communications technology service managers
		Information and communications technology sales professionals
		Translators, interpreters and other linguists
	Manufacturing	
	Cross-cutting Activities	Advertising, branding, and public relations managers
		Project manager
		Research and development managers
		Vocational education teachers
		Secondary education teachers
		Primary school and early childhood teachers
		Management and organization analysts
		Policy administration professionals
Public relations professionals		
Legal professionals		
Economists		
Conference and event planners		
Collapsing Occupations	Agriculture and Fisheries	Subsistence mixed crop and livestock farmers
		Subsistence fishers, hunters, trappers and gatherers
		Rice and coconut farmers
		Gardeners, horticultural and nursery growers
		Livestock and dairy producers
		Poultry producers
		Agricultural technicians
		Forestry and related workers

		Aquaculture workers
		Mobile farm and forestry plant operators
		Livestock farm laborers
		Garden and horticultural laborers
		Forestry laborers
		Fishery and aquaculture laborers
	Automotive and Land Transportation	Clearing and forwarding agents
		Transport clerks
		Hand and pedal vehicle drivers
		Assemblers
		Shop assistants
	Healthcare Services	Medical and pathology laboratory technicians
		Medical records and health information technicians
		Dispensing opticians
		Medical secretaries
	IT-BPM Services	Medical records and health information technicians
		Coding, proof-reading and related clerks
		Contact center salespersons
		Contact center information clerks
	Manufacturing	Spray painters and varnishers/Coating, painting, and spraying machine setters
		Assemblers
	Cross-cutting Activities	Administrative and executive secretaries/assistants
		Legal and related associate professionals
		Legal secretaries
Typists and word processing operators		

	Telephone switchboard operators
	Enquiry clerks
	Survey and market research interviewers
	Mail carriers and sorting clerks
	Filing and copying clerks

Source: *The Future of Work in the Philippines: Assessing the impact of technological changes on occupations and sectors* (ILO, 2020)

C. TRAINING AND EDUCATION

As reflected in Table 1, the consequences on the job sectors vary. In the case of jobs in the “rising star” category, the proliferation of AI does not pose a threat because the human responsibilities carried out are not reduced. Nonetheless, workers should be encouraged to adopt a lifelong learning outlook to face the challenge. For workers in the machine terrain, in which digitalization brings out enormous devastation, upskilling and reskilling would be a requirement or else the human workforce becomes obsolete.

In the human terrain, the threat of AI is very low though workers should be encouraged to learn digital skills. Unfortunately, the same could not be said of the collapsing occupations category. The workers here, similarly to those in the human terrain potential, also need upskilling and reskilling either for redeployment or to prepare them to high-skill jobs that AI will create (Fossen and Zorgner 2019, 11-12; ILO 2020, 49-54).

Thus, it is crucial to equip TVET learners with skills and competencies that are not just relevant to a specific job. Essential skills, soft skills, and lifelong learning will be beneficial to prepare the workforce in the current and near future labor demand. Table 2 lists the following AI-related soft skills

Table 2. AI-related soft skills

● Collaboration	● Communication
● Ethical mindset	● Organizational awareness
● Critical thinking and decision making	● Analytical design and thinking
● Planning and organizing	● Problem solving
● Customer focus/Customer service skills	● Flexibility
● Business fundamentals	● Professional networking
● Entrepreneurship	● Leadership
● Creativity and innovativeness	● English proficiency

<ul style="list-style-type: none"> Financial literacy/Financial management 	<ul style="list-style-type: none"> Basic and advanced digital literacy
<ul style="list-style-type: none"> Social skills (including emotional and interpersonal skills) 	<ul style="list-style-type: none"> Complex information processing and interpretation
<ul style="list-style-type: none"> Project management 	<ul style="list-style-type: none"> People management
<ul style="list-style-type: none"> Conflict resolution 	<ul style="list-style-type: none"> Self-discipline

Sources: Understanding the impact of artificial intelligence on skills development (UNESCO-UNEVOC)

Skill shift: Automation and the future of the workforce (McKinsey Global Institute)

Additionally, part of the opportunity in education and training is steering a deep appreciation for Science, Technology, Engineering, and Mathematics (STEM) courses. The National Innovation Day which declares April 21 of every year as a special public working holiday could also be maximized to increase public awareness and appreciation for AI. TESDA is specifically tasked in the AI Roadmap to be responsible in ensuring the proper training of teachers, promoting lifelong learning, and designing learning pathways for out-of-school individuals wanting to learn the latest AI technologies and trends.

Currently, there are numerous jobs or skills that are emerging in the various sectors of the industry as a result of 4IR and AI (see table 3).

Table 3. Emerging jobs/skills in the AI Industry

SECTOR	EMERGING JOBS/SKILLS
Agriculture and Fisheries	Climate-Smart practices/Smart farming technology
	Chatbots and drones
	Block chain
	Nanotechnology
Automotive and Land Transportation	Logistics software
	Service and solutions designer
Healthcare Services	AI assisted health care technician
	Workers for telemedicine
IT-BPM Services	Innovation professional
	Information and network security analysts
	Search Engine Optimization analyst
	Remote healthcare management/ Telemedicine

Manufacturing	Innovation professionals
	Modeling simulation, visualization, and immersion
Cross-cutting Activities	Data and operational analytics
	Data collection and data clearing
	Data management and governance
	Data visualization and presentation
	Computing
	Data science engineering
	Data Science and Analytics (DSA)
	Design engineering and maintenance
	Big data specialist
	Use of productivity software
	Use of CRM and digital design software
	Internet of Things (IoT)/IoT-enablement languages
	Robot Maintenance
	Robotic Process Automation (RPA)
	Automation enablement
	Electronic mail and chat support agent
	E-Commerce and social media analyst
	Virtual reality
AI development manager	

*Sources: Understanding the impact of artificial intelligence on skills development (UNESCO-UNEVOC)
Skill shift: Automation and the future of the workforce (McKinsey Global Institute)*

ISSUES AND CHALLENGES IN ARTIFICIAL INTELLIGENCE

Although AI is expected to produce various benefits and opportunities, it also comes with risks from the most visible ones (i.e job loss) to the potential unintended consequences to individuals, organizations, and the society. Cheatham, Javanmardian, & Samandari (2019) describes AI as a double edged sword while the (Acemoglu & Restrepo, 2020) warns about

the potential of developing and empowering the wrong kind of AI. Even experts involved in the development of the Philippine AI roadmap recognize that AI, although can be really helpful, can also be destructive, much like any other technology, when placed in the wrong hands.

Several research has been conducted to assess these issues and challenges. For instance, Jiang, L., Wu, Z., and Xu, X. (2021) analyzed the existing problems in the field of artificial intelligence in the medical industry and proposed possible solutions. They call for the establishment of a process framework to ensure the safety and orderly development of artificial intelligence in the medical industry.

To ensure that AI will be fully maximized only in a positive and transformative manner, listed below are some of the pressing concerns that need to be given attention and require further discussion and assessment.

- **Loss of Jobs**

Although AI can help add value to a company, boost innovation, and create additional jobs, automating tasks may also lead to loss of jobs. Due to automation, the McKinsey Global Institute estimated that 48% of the work in the Philippines is automatable, which translates to about 18.2 million jobs (Moraje, 2017). From this number, the largest share is in agriculture-related sectors “where occupations involve a large proportion of physical activities in predictable environments”, followed by retail and manufacturing (Moraje, 2017). The more important concern with this automation and rise of AI is the pace of these changes in terms of creating new jobs and causing workers’ displacement.

In a separate research, ILO (2020) reported that many of the routine jobs may be obsolete as they face destructive transformation due to digitalization while non-routine manual work is at a high risk of destruction as well.

- **Cybersecurity**

One of the main concerns in AI is security and citizen protection and this also requires the most rigorous review. Several questions arise such as “Who owns the data?”, “How are the citizens protected?”, and “To what extent and to whom should information and data be shared?” Despite the Data Privacy Act of 2012, these concerns may inhibit companies and industries to fully adopt AI. “Cybersecurity failures can lead to individual harm such as information theft and unwanted publicity” (Hosie, 2017 as cited in Shiohira, 2021).

- **Education and Training**

Swain, A. (2021) enumerates some of these challenges that includes cost and vulnerability to cyberattacks. AI education comes at a high price. As new technology emerges, budgets will have to increase to cover the expenses of installing AI software as well as its maintenance. Besides costs, the inability to quickly adapt curriculum to respond to changes and industry demand may be limiting especially to learners.

Moreover, AI software is highly vulnerable to cyber-attacks. With an entire database of student, teacher, parents, and admin information, schools can only rely on installing data security protection software, which sometimes can still be breached by hackers.

- **Governance and Accountability**

Regalado (2020) explained that in light of AI, governance and accountability should be defined, meaning there should be someone who will be held accountable if things go wrong. Operational guidelines should be part of the discussion.

For Google, in its published paper entitled "*Perspectives on Issues in AI Governance*", five areas are specifically highlighted where the government, in collaboration with wider civil society and AI practitioners, has a crucial role to play in clarifying expectations about AI's application on a context-specific basis.

The five areas include Explainability Standards, Approaches to Appraising Fairness, Safety Considerations, Requirements for Human-AI Collaboration, and General Liability Frameworks. All these, when put into practice, can help boost people's confidence about AI; provide frameworks to balance competing goals and definitions of fairness; develop precautionary measures against both accidental and deliberate misuse of AI; provide guidelines in human-AI engagements; and establish legal frameworks regarding liability, as deemed necessary.

- **Overregulation**

Citing an urgent need, the EU published a detailed proposal on how AI should be regulated, explicitly banning some uses and defining those it considers "high-risk" as it threatens people's rights and safety.

The set of laws and legal framework enacted in Europe will have a profound impact on AI regulation around the world. It would limit the use cases and innovation of artificial intelligence and put the EU in a technologically inferior position globally. The overly regulated environment in the EU will lead to complete chaos when regulations in various EU bodies start contradicting. (Minevich, 2021)

Taking the example of the EU in consideration, the danger of overregulation might be seen as not AI-friendly. Thus, as the Philippines develops an AI regulatory framework, regulations should be balanced with the freedom and capacity of businesses to flourish using AI.

- **Inclusive use of AI**

Unfortunately, the economic benefits will not be evenly distributed, and rural communities will absorb the greatest costs. There is a severe digital gap between rural and urban areas. Substantial portions of rural areas still lack the infrastructure required to implement high speed internet, which makes it exceedingly difficult to bring high-growth jobs to these areas (Jain, 2021).

New technologies like artificial intelligence, machine learning, robotics, big data, and networks are expected to revolutionize production processes, but they could also have a major impact on developing economies. "Not all institutions and businesses can invest in resources that will allow them to hire more people to work with the new AI technologies" (Acemoglu & Restrepo, 2020). Cost, availability of resources, quality and quantity of manpower, education and training, are some of the factors that may affect the inclusivity and accessibility of AI between varying economies.

In the Philippines, for instance, MSMEs may be one of the most affected as the government cannot simply leave the MSMEs to take advantage of AI technologies due to the mentioned factors.

- **Increase in gig economy**

AI is causing a greater demand for gig economy workers, oftentimes referred to as freelance workers or platform-based workers. This type of new workers challenges the concept of job security and although digital labor may mean added work opportunities and economic benefits, it also comes with risks such as alienation, discrimination, lack of social security, lack of employer-employee relationship, and lowered bargaining power for workers (Graham, Hjorth, Lehdonvirta, 2017).

SKILLS NEEDED

The ILO (2020) report titled "*The Future of Work in the Philippines: Assessing the Impact of Technological Changes on Occupations and Sectors*" presented the various occupations which will be affected by the technological changes such as automation and AI technologies.

The occupations found on Table 1 were existing jobs which may either be affected in a transformative or destructive manner. Based on this table, the specific Training Regulations associated with the jobs needed for each classification of occupation were determined. Take note, however, that specific AI skills may not be embedded in the promulgated TRs as these TRs were not primarily developed for AI.

Additionally, most of the jobs which were identified to require a minimum of bachelor's degree were not included in the table below, but some may have exemptions in consideration of the ladderized education.

Table 4. Training Regulations for Artificial Intelligence-related qualifications

CLASSIFICATION OF OCCUPATION (IMPACT OF TECHNOLOGICAL CHANGES)	SECTOR	JOBS/SKILLS REQUIREMENTS	TRAINING REGULATIONS
Rising Stars	Agriculture and Fisheries	Farm business planning	<ul style="list-style-type: none"> ● Agroentrepreneurship NC II ● Agroentrepreneurship NC III ● Agroentrepreneurship NC IV
		Crop and food production	<ul style="list-style-type: none"> ● Grains Production NC II ● Sugarcane Production NC II ● Seaweeds Production NC II ● Aquaculture (Hatchery Operation) NC II ● Aquaculture (Grow-out Operation) NC II ● Aquaculture (Tilapia Culture) NC II ● Agricultural Crops Production NC I ● Agricultural Crops Production NC II ● Agricultural Crops Production NC III ● Horticulture NC III ● Animal Health Care and Management NC III ● Pest Management (Vegetables) NC II ● Organic Agriculture Production NC II ● Milking Operation NC II ● Beekeeping NC II
		Common rice machinery facility operation and management	<ul style="list-style-type: none"> ● Rice Machinery Operations NC II
		Nutrient and pest management	<ul style="list-style-type: none"> ● Pest Management (Vegetables) NC II ● Grains Production NC II ● Sugarcane Production NC II ● Agricultural Crops Production NC I ● Agricultural Crops Production NC II ● Agricultural Crops Production NC III ● Horticulture NC III
	Automotive and Land Transportation	Order tracker/coordinator	
		Transport Network Vehicle Services (TNVS) drivers/delivery riders	<ul style="list-style-type: none"> ● Driving NC II ● Driving (Passenger Bus/Straight Truck) NC III ● Driving (Articulated Vehicle) NC III
		Supply Chain and Logistics Specialist	<ul style="list-style-type: none"> ● Warehousing Services NC III ● Warehousing Services NC IV ● Multimodal Transport Operation and Logistics (Seafreight Import) Services NC II ● Multimodal Transport Operation and Logistics (Seafreight Import) Services NC III ● Multimodal Transport Operation and Logistics (Seafreight Import) Services NC IV

	Healthcare Services	Dieticians and nutritionists ¹	<ul style="list-style-type: none"> Community Nutrition Services NC II 	
		Registered nurses		
		Dental hygienists	<ul style="list-style-type: none"> Dental Hygiene NC IV* 	
		Physical therapists	<ul style="list-style-type: none"> Hilot (Wellness Massage) NC II* Massage Therapy NC II* 	
		Technical and medical sales professionals	<ul style="list-style-type: none"> Customer Services NC II* Contact Center Services NC II* 	
		Care providers	<ul style="list-style-type: none"> Caregiving (Newborn to Pre-Schooler) NC II* Caregiving (Grade Schooler to Adolescent) NC II* Caregiving (Elderly) NC II* Caregiving (Clients with Special Needs) NC II* Health Care Services NC II* Emergency Medical Services NC II* 	
	IT-BPM Services	Graphic and multimedia designers	<ul style="list-style-type: none"> Visual Graphic Design NC III 	
		Animation artistry	<ul style="list-style-type: none"> 2D Animation NC III 3D Animation NC III Animation NC II 2D Game Art Development NC III 3D Game Art Development NC III 	
		Visual artists	<ul style="list-style-type: none"> Photography NC II Visual Graphic Design NC III Illustration NC II 	
		IT service processors		
		UI/UX experts	<ul style="list-style-type: none"> Visual Graphic Design NC III 	
		Database administration	<ul style="list-style-type: none"> Programming (Oracle Database) NC III 	
		Subject matter experts		
		Commercial sales representatives	<ul style="list-style-type: none"> Contact Center Services NC II Customer Services NC II 	
		Customer service representatives/Client servicing	<ul style="list-style-type: none"> Contact Center Services NC II Customer Services NC II 	
		Order tracker/coordinator	<ul style="list-style-type: none"> Contact Center Services NC II 	
		Manufacturing	Manufacturing managers	
			General and operations managers	
	Manufacturing supervisors			
	Business operations specialists			
	Production technicians		<ul style="list-style-type: none"> Electronics-Semiconductor Production Line Machine Servicing NC III 	
	Cross-cutting Activities	Sales and marketing managers		
		Human resources managers		
		Office supervisors		
		Advertising and marketing professionals		

		Personnel and careers professionals	
		System analysis and evaluation	
		Mobile and web design and development	<ul style="list-style-type: none"> • Web Development NC III
		Software developers (app, web, computer)	<ul style="list-style-type: none"> • Web Development NC III • Game Programming NC III • Programming (.Net Technology) NC III • Programming (Oracle Database) NC III • Programming (Java) NC III
		Advanced IT and programming	<ul style="list-style-type: none"> • Programming (.Net Technology) NC III • Programming (Java) NC III • Programming (Oracle Database) NC III
		STEM skills	
Machine Terrain	Agriculture and Fisheries	Dairy-products makers**	
		Fruit, vegetable and related preservers	<ul style="list-style-type: none"> • Food Processing NC I • Food Processing NC II
		Agricultural and industrial machinery mechanics and repairers	<ul style="list-style-type: none"> • Agricultural Machinery Servicing (4-Wheel Tractor) NC III*** • Drying and Milling Plant Servicing NC III*** • Pressurized Irrigation System Installation and Maintenance NC II***
	Automotive and Land Transportation	Supply, distribution and related managers	<ul style="list-style-type: none"> • Warehousing Services NC III • Warehousing Services NC IV • Multimodal Transport Operation and Logistics (Seafreight Import) Services NC IV
		Electrical engineering technicians	
		Electronics engineering technicians	<ul style="list-style-type: none"> • Automotive Electrical Assembly NC II • Mechatronics Servicing NC II • Mechatronics Servicing NC III • Mechatronics Servicing NC IV
		Mechanical engineering technicians	<ul style="list-style-type: none"> • Automotive Mechanical Assembly NC II • Automotive Servicing (Engine Repair) NC II • Mechatronics Servicing NC II • Mechatronics Servicing NC III • Mechatronics Servicing NC IV
		Metal molders and core makers	<ul style="list-style-type: none"> • Mold Making NC III

		Welders and flamecutters	<ul style="list-style-type: none"> • Shielded Metal Arc Welding (SMAW) NC I • Shielded Metal Arc Welding (SMAW) NC II • Shielded Metal Arc Welding (SMAW) NC III • Shielded Metal Arc Welding (SMAW) NC IV • Gas Metal Arc Welding (GMAW) NC I • Gas Metal Arc Welding (GMAW) NC II • Gas Metal Arc Welding (GMAW) NC III • Flux Cored Arc Welding (FCAW) NC I • Flux Cored Arc Welding (FCAW) NC II • Flux Cored Arc Welding (FCAW) NC III • Gas Tungsten Arc Welding (GTAW) NC II • Gas Tungsten Arc Welding (GTAW) NC IV • Submerged Arc Welding (SAW) NC I • Submerged Arc Welding (SAW) NC II • Gas Welding NC I • Gas Welding NC II
		Sheet-metal workers	• Tinsmithing (Auto. Manuf.)NC II
		Toolmakers and related workers	• Tool and Die Making NC II
		Metal working machine tool setters and operators	<ul style="list-style-type: none"> • Machining NC I • Machining NC II • Machining NC III • Press Machine Operation NC I
		Metal polishers, wheel grinders and tool sharpeners	
		Motor vehicle mechanics and repairers	• Heavy Equipment Servicing (Mechanical) NC II
		Car, taxi and van drivers	• Driving NC II
		Bus and tram drivers	• Driving (Passenger Bus/Straight Truck) NC III
	Healthcare Services	Pharmaceutical technicians and assistants	• Pharmacy Services NC III*
		Medical and dental prosthetic technicians	<ul style="list-style-type: none"> • Dental Laboratory Technology Services (Fixed Dentures/Restorations) NC II* • Dental Laboratory Technology Services (Removable Dentures/Appliances) NC II* • Assistive Rehabilitation Technology Services (Prosthetics) NC II* • Assistive Rehabilitation Technology Services (Orthotics) NC II*
		Medical and clinical laboratory technicians	• Dental Laboratory Technology Services NC I*
		Dental assistants and therapists	• Dental Hygiene NC IV*

			<ul style="list-style-type: none"> • Dental Laboratory Technology Services NC I* 	
	IT-BPM Services	Medical equipment repairers/technicians	<ul style="list-style-type: none"> • Biomedical Equipment Services NC II • Emergency Medical Services NC III 	
		ICT operations technicians	<ul style="list-style-type: none"> • Cable TV Operation and Maintenance NC III 	
		ICT installers and servicers	<ul style="list-style-type: none"> • Cable TV Installation NC II • Broadband Installation (Fixed Wireless Systems) NC II • Telecom OSP and Subscriber Line Installation (Copper Cable/POTS and DSL) NC II • Telecom OSP Installation (Fiber Optic Cable) NC II 	
		Medical transcriptionists	<ul style="list-style-type: none"> • Medical Transcription NC II 	
	Manufacturing		Metal production process controllers	
			Metal molders and coremakers	<ul style="list-style-type: none"> • Mold Making NC III
			Welders and flamecutters	<ul style="list-style-type: none"> • Shielded Metal Arc Welding (SMAW) NC I • Shielded Metal Arc Welding (SMAW) NC II • Shielded Metal Arc Welding (SMAW) NC III • Shielded Metal Arc Welding (SMAW) NC IV • Gas Metal Arc Welding (GMAW) NC I • Gas Metal Arc Welding (GMAW) NC II • Gas Metal Arc Welding (GMAW) NC III • Flux Cored Arc Welding (FCAW) NC I • Flux Cored Arc Welding (FCAW) NC II • Flux Cored Arc Welding (FCAW) NC III • Gas Tungsten Arc Welding (GTAW) NC II • Gas Tungsten Arc Welding (GTAW) NC IV • Submerged Arc Welding (SAW) NC I • Submerged Arc Welding (SAW) NC II • Gas Welding NC I • Gas Welding NC II
			Sheet-metal workers	<ul style="list-style-type: none"> • Tinsmithing (Auto. Manuf.)NC II
			Metal working machine tool setters and operators	<ul style="list-style-type: none"> • Machining NC I • Machining NC II • Machining NC III • Press Machine Operation NC I
			Metal polishers, wheel grinders and tool sharpeners	
		Precision-instrument makers and repairers		

		Mineral and stone processing plant operators	
		Metal processing plant operators	<ul style="list-style-type: none"> • Machining NC II • Machining NC I • Machining NC III • CNC Lathe Machine Operation NC II • CNC Lathe Machine Operation NC III • CNC Milling Machine Operation NC II • CNC Milling Machine Operation NC III • Electric Discharge Machine (EDM) Sinking Operation NC II • CNC Electric Discharge Machine (EDM) Wire Cut Operation NC III
		Metal finishing, plating and coating machine operators	
		Rubber products machine operators	<ul style="list-style-type: none"> • Rubber Processing NC II
		Plastic products machine operators	<ul style="list-style-type: none"> • Plastic Machine Operation NC II • Plastic Machine Operation NC III
		Paper products machine operators	
		Fiber preparing, spinning and winding machine operators	
		Packing, bottling and labelling machine operators	<ul style="list-style-type: none"> • Food Processing NC III
		Packers and packagers	<ul style="list-style-type: none"> • Food Processing NC II • Fish Products Packaging NC II
		Machine feeders and offbearers	
		Manufacturing laborers	
		Machinists	<ul style="list-style-type: none"> • Auto Engine Rebuilding NC II • Moldmaking NC II • Mold Making NC III • Machining NC I • Machining NC II • Machining NC III • Tool and Die Making NC II
		Food roasting, baking, and drying machine operators	<ul style="list-style-type: none"> • Food Processing NC III
		Production clerks	
	Cross-cutting Activities	General office clerks	
		General transcriptionists	
		Secretaries (general)	
		Data entry clerks/keyers	<ul style="list-style-type: none"> • Bookkeeping NC III*
		Payroll clerks	<ul style="list-style-type: none"> • Bookkeeping NC III*
		Personnel clerks	
Human Terrain	Agriculture and Fisheries	Farming, forestry and fisheries advisers	

		Field crop and vegetable growers	<ul style="list-style-type: none"> • Grains Production NC II • Sugarcane Production NC II • Agricultural Crops Production NC I • Agricultural Crops Production NC II • Agricultural Crops Production NC III • Horticulture NC III • Organic Agriculture Production NC II • Pest Management (Vegetables) NC II
		Tree and shrub crop growers	<ul style="list-style-type: none"> • Bamboo Production NC II • Agricultural Crops Production NC I • Agricultural Crops Production NC II • Agricultural Crops Production NC III • Horticulture NC III • Landscape Installation and Maintenance (Softscape) NC II
		Mixed crop growers/producers	<ul style="list-style-type: none"> • Agricultural Crops Production NC I • Agricultural Crops Production NC II • Agricultural Crops Production NC III • Horticulture NC III
		Apiarists and sericulturists	
		Animal producers	<ul style="list-style-type: none"> • Artificial Insemination (Large Ruminants) NC II • Artificial Insemination (Swine) NC II • Animal Production (Poultry-Chicken) NC II • Animal Production (Swine) NC II • Animal Production (Ruminants) NC II • Animal Health Care and Management NC III
		Inland and coastal waters fishery workers	<ul style="list-style-type: none"> • Aquaculture (Hatchery Operation) NC II • Aquaculture (Grow-out Operation) NC II • Aquaculture (Tilapia Culture) NC II • Fishport/Wharf Operation NC I • Fish Gear Repair and Maintenance NC III
		Deep-sea fishery workers	<ul style="list-style-type: none"> • Fishport/Wharf Operation NC I • Fish Gear Repair and Maintenance NC III
	Automotive and Land Transportation	Customs and border inspectors	
		Transport conductors	
		Companions and valets	
		Service station attendants	
		Bicycle and related repairers	
		Motorcycle drivers	
Driving instructors			
Healthcare Services	Health services managers		
	Aged care services managers		

		Traditional and complementary medicine professionals	<ul style="list-style-type: none"> Barangay Health Services NC II*
		Nursing associate professionals	<ul style="list-style-type: none"> Health Care Services NC II*
		Physiotherapy technicians and assistants	
		Medical/healthcare assistants	<ul style="list-style-type: none"> Pharmacy Services NC III* Emergency Medical Services NC II* Dental Laboratory Technology Services NC I*
		Social work and counselling professionals	
		Medical imaging and therapeutic equipment technicians	<ul style="list-style-type: none"> Biomedical Equipment Services NC II
		Fitness and recreation instructors and program leaders	
		Home-based personal care workers	<ul style="list-style-type: none"> Caregiving (Newborn to Pre-Schooler) NC II* Caregiving (Grade Schooler to Adolescent) NC II* Caregiving (Elderly) NC II* Caregiving (Clients with Special Needs) NC II*
		Ambulance workers ²	<ul style="list-style-type: none"> Emergency Medical Services NC II* Emergency Medical Services NC III*
	IT-BPM Services	ICT service managers	
		ICT sales professionals	<ul style="list-style-type: none"> Contact Center Services NC II
		Translators, interpreters and other linguists	
	Manufacturing		
	Cross-cutting Activities	Advertising, branding, and public relations managers	
		Project manager	
		Research and development managers	
		Vocational education teachers	<ul style="list-style-type: none"> Trainers Methodology Level I (Trainer/Assessor) Trainers Methodology Level II (Training Designer/Developer) Trainers Methodology Level I (In-Company Trainer)
		Public relations professionals	<ul style="list-style-type: none"> Front Office Services NC III Front Office Services NC IV
		Conference and event planners	<ul style="list-style-type: none"> Events Management Services NC III
Collapsing Occupations	Agriculture and Fisheries	Subsistence mixed crop and livestock farmers	<ul style="list-style-type: none"> Organic Agriculture Production NC II
		Subsistence fishers, hunters, trappers and gatherers	<ul style="list-style-type: none"> Fish Capture NC I Fish Capture NC II Fishing Gear Repair and Maintenance NC III

			<ul style="list-style-type: none"> • Fishport/Wharf Operation NC I
		Rice and coconut farmers	<ul style="list-style-type: none"> • Grains Production NC II
		Gardeners, horticultural and nursery growers	<ul style="list-style-type: none"> • Horticulture NC III • Landscape Installation and Maintenance (Softscape) NC II • Agricultural Crops Production NC II
		Livestock and dairy producers/laborers	<ul style="list-style-type: none"> • Animal Production (Ruminants) NC II • Milking Operation NC II
		Poultry producers	<ul style="list-style-type: none"> • Animal Production (Poultry-Chicken) NC II
		Agricultural technicians	<ul style="list-style-type: none"> • Aquaculture (Tilapia Culture) NC II • Animal Health Care and Management NC III • Artificial Insemination (Large Ruminants) NC II • Drying and Milling Plant Servicing NC III • Pressurized Irrigation System Installation and Maintenance NC II
		Fishery and aquaculture workers	<ul style="list-style-type: none"> • Aquaculture (Grow-out Operation) NC II • Aquaculture (Hatchery Operation) NC II • Aquaculture (Tilapia Culture) NC II • Fishing Gear Repair and Maintenance NC III • Fishport/Wharf Operation NC I • Fish Capture NC I • Fish Capture NC II
		Mobile farm and forestry plant operators	
	Forestry laborers		
	Automotive and Land Transportation	Clearing and forwarding agents	
		Transport clerks	
		Hand and pedal vehicle drivers	
		Assemblers	
		Shop assistants	
	Healthcare Services	Medical and pathology laboratory technicians	<ul style="list-style-type: none"> • Dental Laboratory Technology Services NC I*
		Medical records and health information technicians	<ul style="list-style-type: none"> • Medical Coding and Claims Processing NC III
		Medical secretaries	
	IT-BPM Services	Medical records and health information technicians	
		Coding, proof-reading and related clerks	<ul style="list-style-type: none"> • Medical Coding and Claims Processing NC III
Contact center salespersons		<ul style="list-style-type: none"> • Contact Center Services NC II 	

		Contact center information clerks	<ul style="list-style-type: none"> • Contact Center Services NC II
	Manufacturing	Spray painters and varnishers/Coating, painting, and spraying machine setters	<ul style="list-style-type: none"> • Automotive Body Painting/Finishing NC I • Automotive Body Painting/Finishing NC II • Automotive Body Painting/Finishing NC III
		Assemblers	<ul style="list-style-type: none"> • Electronics Products Assembly and Servicing NC II
	Cross-cutting Activities	Administrative and executive secretaries/assistants	
		Typists and word processing operators	<ul style="list-style-type: none"> • Medical Transcription NC II*
		Telephone switchboard operators	
		Enquiry clerks	
		Survey and market research interviewers	
		Mail carriers and sorting clerks	
		Filing and copying clerks	<ul style="list-style-type: none"> • Bookkeeping NC III*

¹ Dietitians and nutritionists requires higher education and should be registered with the PRC. However, a TR was developed for community nutritionists as part of primary care services. The TR is yet to be promulgated and has on-going development of TR/CATs

² Type I ambulance must have completed a four-year health-related course. The ambulance personnel for the Type II ambulance must be a licensed or registered nurse. (AO 2018-0001)

*Specific job description or scope of work is needed to confirm the adequacy of the Training Regulation.

**The existing TRs are for producing and harvesting the raw material of dairy which is milk, not food processing of dairy products.

*** Only includes agricultural based on the TR descriptors and does not include industrial.

Modern AI tools have now enabled the rise of a new job profile for instance, that of an AI-Assisted Healthcare Technician, that involves a healthcare specialist with just three years of nursing experience providing quality healthcare and diagnostics services to patients.

With validation from the TESDA Qualifications and Standards Office, the Training Regulations indicated in some of the emerging job/skills have initial competencies included in the existing TRs. However, similar to the technical jobs identified in Table 4, the TRs in Table 5 are not really crafted specifically for those emerging jobs/skills in light of AI technologies and developments.

Further, most of the emerging jobs and skills related to AI still do not have any existing Training Regulations in place.

Table 5. Emerging job or skills in the AI industry

SECTOR	EMERGING JOBS/SKILLS	TRAINING REGULATIONS
Agriculture and Fisheries	Climate-Smart practices/Smart farming technology	
	Chatbots and drones	
	Block chain	
	Nanotechnology	
Automotive and Land Transportation	Logistics software	
Healthcare Services	AI assisted healthcare technician	
	Workers for telemedicine	
IT-BPM Services	Innovation professional	
	Search Engine Optimization analyst	
	Remote healthcare management/ Telemedicine	
Manufacturing	Innovation professionals	
	Modeling simulation, visualization, and immersion	
Cross-cutting Activities	Data and operational analytics	
	Data collection and data clearing	
	Data management and governance	
	Data visualization and presentation*	2D Animation NC III 3D Animation NC III Animation NC II Visual Graphic Design NC III Web Development NC III 2D Game Art Development NC III 3D Game Art Development NC III
	Computing	
	Data science engineering	
	Data Science and Analytics (DSA)	
	Design engineering and maintenance	
	Use of productivity software	Visual Graphic Design NC III Web Development NC III Game Programming NC III Programming (.Net Technology) NC III Programming (Java) NC III Programming (Oracle Database) NC III
	Use of CRM and digital design software	Visual Graphic Design NC III Web Development NC III
	Internet of Things (IoT)/IoT-enablement languages	

	Robot Maintenance*	Mechatronics Servicing NC II Mechatronics Servicing NC III Mechatronics Servicing NC IV Instrumentation and Control Servicing NC II Instrumentation and Control Servicing NC III Instrumentation and Control Servicing NC IV
	Robotic Process Automation (RPA)*	Mechatronics Servicing NC II Mechatronics Servicing NC III Mechatronics Servicing NC IV Instrumentation and Control Servicing NC II Instrumentation and Control Servicing NC III Instrumentation and Control Servicing NC IV
	Automation enablement*	Mechatronics Servicing NC II Mechatronics Servicing NC III Mechatronics Servicing NC IV Instrumentation and Control Servicing NC II Instrumentation and Control Servicing NC III Instrumentation and Control Servicing NC IV
	Electronic mail and chat support agent	
	E-Commerce and social media analyst	
	Virtual reality*	2D Animation NC III 3D Animation NC III Animation NC II Visual Graphic Design NC III Web Development NC III 2D Game Art Development NC III 3D Game Art Development NC III

* Initial competencies included in the TR

TVET CAPACITY

As what was stated in the TRs included in the section on Skills Needs, this section on TVET Capacity considered WTR (With Training Regulation) qualifications that are related to the identified jobs/skills in Tables 4 and 5. The specifics of these TRs in respect to the AI

requirements may not be sufficient and may need further review in consultation with the industry experts, spearheaded by the TESDA Planning Office and the Qualifications and Standards Office. In particular, the discussion should cover how AI will change the course of skills requirements for the identified qualifications.

Still, for the purpose of this section, the list of existing TRs in Tables 4 and 5 were considered as the data may later on serve as basis for the review and recommendation of Training Regulations or Competency Standards to be developed.

Table 6 shows the total number of enrolled and graduated as of June 2021. Some of the TRs do not have any enrollees and graduates [Agroentrepreneurship NC III, Agricultural Machinery Operations NC II, Driving (Articulated Vehicle) NC III, Customer Services NC II, Emergency Medical Services NC III, FCAW NC II, CNC Lathe Machine Operation NC II, Dental Laboratory Technology Services (Fixed Dentures/Restorations) NC II, and Trainers Methodology Level II (Training Designer/Developer)]. There are also those with enrollees but no graduates [SMAW NC IV and GMAW NC I] and with graduates but not enrollees [Drying and Milling Plant Servicing NC III, Fish Capture NC II, Animal Health Care and Management NC III, Instrumentation and Control Servicing NC III].

Based on Table 6, the most number of enrollees and graduates are in Driving NC II, SMAW NC II, and Organic Agriculture Production NC II whereas, the least number are in Photography NC II, Pharmacy Services NC III, and GMAW NC III (excluding those without available data).

Table 6. Total Number of Enrolled, Graduated by Qualification (WTR), by Sex as of June 2021.

QUALIFICATIONS (WTR)	Enrolled			Graduate		
	Male	Female	TOTAL	Male	Female	TOTAL
Agroentrepreneurship NC II	133	167	300	36	71	107
Agroentrepreneurship NC III						
Grains Production NC II	43	57	100	63	53	116
Bamboo Production NC II				11	14	25
Drying and Milling Plant Servicing NC III				26	21	47
Landscape Installation and Maintenance (Softscape) NC II	12	13	25	27	23	50
Fish Capture NC II				13	6	19
Agricultural Crops Production NC I	229	363	592	514	662	1176
Agricultural Crops Production NC II	658	663	1321	1340	1409	2749
Agricultural Crops Production NC III	105	85	190	245	357	602
Horticulture NC III	42	73	115	59	71	130
Animal Health Care and Management NC III				15	24	39
Pest Management (Vegetables) NC II	59	75	134	86	166	252
Organic Agriculture Production NC II	2472	3892	6364	4120	6434	10554
Animal Production (Poultry-Chicken) NC II	528	699	1227	1096	1391	2487
Animal Production (Swine) NC II	336	365	701	621	720	1341

Animal Production (Ruminants) NC II	199	348	547	282	292	574
Artificial Insemination (Swine) NC II	31	17	48	53	24	77
Rice Machinery Operations NC II	344	154	498	1788	446	2234
Driving NC II	9403	3871	13274	12548	4949	17497
Driving (Passenger Bus/Straight Truck) NC III	121	18	139	169	19	188
Driving (Articulated Vehicle) NC III						
Automotive Electrical Assembly NC II	17	3	20	14	3	17
Mechatronics Servicing NC II	117	25	142	117	32	149
Mechatronics Servicing NC III	23	3	26	40	7	47
Shielded Metal Arc Welding (SMAW) NC I	4620	678	5298	8820	1348	10168
Shielded Metal Arc Welding (SMAW) NC II	7223	984	8207	11821	1589	13410
Shielded Metal Arc Welding (SMAW) NC III	829	139	968	1005	170	1175
Shielded Metal Arc Welding (SMAW) NC IV	86	14	100			
Gas Metal Arc Welding (GMAW) NC I	24	2	26			
Gas Metal Arc Welding (GMAW) NC II	159	23	182	316	26	342
Gas Metal Arc Welding (GMAW) NC III	22	1	23	22	1	23
Flux Cored Arc Welding (FCAW) NC II						
Gas Tungsten Arc Welding (GTAW) NC II	259	22	281	487	35	522
CNC Lathe Machine Operation NC II						
CNC Milling Machine Operation NC II	38	0	38	43	2	45
Heavy Equipment Servicing (Mechanical) NC II	69	3	72	39	3	42
Electronics Products Assembly and Servicing NC II	1041	516	1557	1643	785	2428
Machining NC I	62	6	68	40	0	40
Machining NC II	163	19	182	126	24	150
Food Processing NC II	323	89	412	197	723	920
Food Processing NC III	36	14	50	41	56	97
Contact Center Services NC II	2156	5373	7529	2513	6447	8960
Health Care Services NC II	101	421	522	226	738	964
Emergency Medical Services NC II	201	88	289	323	175	498
Emergency Medical Services NC III						
Pharmacy Services NC III	0	7	7	4	17	21
Dental Laboratory Technology Services (Fixed Dentures/Restorations) NC II						
Biomedical Equipment Services NC II	17	10	27	12	1	13
Medical Transcription NC II	17	27	44	32	105	137
Barangay Health Services NC II	43	154	197	122	503	625
Hilot (Wellness Massage) NC II	320	777	1097	474	1293	1767
Massage Therapy NC II	42	104	146	19	33	52
Visual Graphic Design NC III	181	142	323	269	174	443
Animation NC II	65	65	130	37	43	80
Photography NC II	1	0	1	21	15	36
Game Programming NC III				18	7	25
Programming (Java) NC III	17	28	45	66	54	120
Telecom OSP Installation (Fiber Optic Cable) NC II				20	0	20

Instrumentation and Control Servicing NC II	191	41	232	155	25	180
Instrumentation and Control Servicing NC III				16	4	20
Customer Services NC II						
Events Management Services NC III	746	1729	2475	1065	2583	3648
Bookkeeping NC III	778	2420	3198	797	2570	3367
Trainers Methodology Level II (Training Designer/Developer)						
Trainers Methodology I	1102	1270	2372	1284	1488	2772

Source: ROMO-MITD

Note: Grayscale means no available data. Data for graduates may include spillover.

Based on Table 6, the top 15 TRs in terms of the total number of enrollees are listed in Table 7, with Driving NC II ranking first. Driving NC II also has the greatest number of graduates who have been assessed and certified (see table 7). Only Contact Center Services NC II do not have assessed and certified since it does not have any Assessment Centers.

It can also be deduced from Table 7 that there is a comparable difference in the number of males and females who were enrolled, graduated, assessed, and certified. Many are dominated by females in the number of enrolled, graduated, assessed, and certified. Meanwhile, many of the qualifications dominated by male include skills involving welding, and machine/electronics assembly and operation.

Table 7. Total Number of Enrolled, Graduated, Assessed and Certified by Qualification (Training Regulations), by Sex, 2021 (Top 15).

QUALIFICATIONS (WTR)	Enrolled			Graduate			Assessed			Certified		
	Male	Female	TOTAL	Male	Female	TOTAL	Male	Female	TOTAL	Male	Female	TOTAL
Agricultural Crops Production NC II	658	663	1321	1340	1409	2749	1822	1829	3651	1758	1773	3531
Organic Agriculture Production NC II	2472	3892	6364	4120	6434	10554	5309	8671	13980	4989	8009	12998
Animal Production (Poultry-Chicken) NC II	528	699	1227	1096	1391	2487	1307	1545	2852	1222	1463	2685
Driving NC II	9403	3871	13274	12548	4949	17497	19162	5239	24401	17905	4800	22705
Hilot (Wellness Massage) NC II	320	777	1097	474	1293	1767	540	1491	2031	529	1468	1997
Contact Center Services NC II	2156	5373	7529	2513	6447	8960						
Shielded Metal Arc Welding (SMAW) NC I	4620	678	5298	8820	1348	10168	9966	1385	11351	9432	1320	10752
Shielded Metal Arc Welding (SMAW) NC II	7223	984	8207	11821	1589	13410	14997	1740	16737	14105	1605	15710
Shielded Metal Arc Welding (SMAW) NC III	829	139	968	1005	170	1175	945	158	1103	914	150	1064
Bookkeeping NC III	778	2420	3198	797	2570	3367	1282	3916	5198	665	2210	2875
Trainers Methodology I	1102	1270	2372	1284	1488	2772	1033	1120	2153	712	791	1503
Events Management Services NC III	746	1729	2475	1065	2583	3648	1177	2761	3938	1099	2570	3669
Electronics Products Assembly and Servicing NC II	1041	516	1557	1643	785	2428	2729	1211	3940	2414	1075	3489

Source: ROMO-MITD

Note: Grayscale means no available data. Data for graduates may include spillover.

Unfortunately, the majority of the TRs relevant to the AI Industry do not have data for enrolled, graduated, assessed and certified as of August 2021 as seen in the table below.

Table 8. AI-related Training Regulations with no available data for enrolled, graduated, assessed, and certified as of August 2021.

QUALIFICATIONS (Training Regulations)	
Agroentrepreneurship NC IV	Caregiving (Grade Schooler to Adolescent) NC II
Sugarcane Production NC II	Caregiving (Elderly) NC II
Seaweeds Production NC II	Caregiving (Clients with Special Needs) NC II
Beekeeping NC II	2D Animation NC III
Aquaculture (Hatchery Operation) NC II	3D Animation NC III
Aquaculture (Grow-out Operation) NC II	2D Game Art Development NC III
Aquaculture (Tilapia Culture) NC II	3D Game Art Development NC III
Fish Capture NC I	Illustration NC II
Agricultural Machinery Servicing (4-Wheel Tractor) NC III	Web Development NC III
Artificial Insemination (Large Ruminants) NC II	Programming (.Net Technology) NC III
Milking Operation NC II	Programming (Oracle Database) NC III
Food Processing NC I	Mechatronics Servicing NC IV
Warehousing Services NC III	Automotive Mechanical Assembly NC II
Warehousing Services NC IV	Automotive Servicing (Engine Repair) NC II
Multimodal Transport Operation and Logistics (Seafreight Import) Services NC II	Flux Cored Arc Welding (FCAW) NC I
Multimodal Transport Operation and Logistics (Seafreight Import) Services NC III	Flux Cored Arc Welding (FCAW) NC III
Multimodal Transport Operation and Logistics (Seafreight Import) Services NC IV	Gas Tungsten Arc Welding (GTAW) NC IV
Community Nutrition Services NC II	Submerged Arc Welding (SAW) NC I
Dental Hygiene NC IV	Submerged Arc Welding (SAW) NC II
Caregiving (Newborn to Pre-Schooler) NC II	Gas Welding NC I
Gas Welding NC II	Auto Engine Rebuilding NC II

CNC Lathe Machine Operation NC III	Mold Making NC II
CNC Milling Machine Operation NC III	Mold Making NC III
Electric Discharge Machine (EDM) Sinking Operation NC II	Tool and Die Making NC II
CNC Electric Discharge Machine (EDM) Wire Cut Operation NC III	Fishport/Wharf Operation NC I
Electronics Semiconductor Production Line Machine Servicing NC III	Front Office Services NC IV
Tinsmithing (Auto Manufacturing) NC II	Fishing Gear Repair and Maintenance NC III
Press Machine Operation NC I	Pressurized Irrigation System Installation and Maintenance NC II
Instrumentation and Control Servicing NC IV	Medical Coding and Claims Processing NC III
Dental Laboratory Technology Services (Removable Dentures/Appliances) NC II	Trainers Methodology Level I (Trainer/Assessor)
Dental Laboratory Technology Services NC I	Trainers Methodology Level I (In-Company Trainer)
Assistive Rehabilitation Technology Services (Prosthetics) NC II	Trainers Methodology Level II (Training Designer/Developer)
Assistive Rehabilitation Technology Services (Orthotics) NC II	Automotive Body Painting/Finishing NC I
Cable TV Operation and Maintenance NC III	Automotive Body Painting/Finishing NC II
Cable TV Installation NC II	Automotive Body Painting/Finishing NC III
Broadband Installation (Fixed Wireless Systems) NC II	Front Office Services NC III
Telecom OSP and Subscriber Line Installation (Copper Cable/POTS and DSL) NC II	Plastic Machine Operation NC II
Machining NC III	Plastic Machine Operation NC III
Rubber Processing NC II	Fish Products Packaging NC II

TESDA INITIATIVES

1. National Technical Education and Skills Development Plan (NTESDP) 2018-2022

The Philippine TVET sector is guided by the NTESDP which is anchored to the Philippine Development Plan 2017-2022, Ambisyon Natin 2040, and the UN Sustainable Development Goals. It has embodied the strategic direction for a

globally competitive and workforce ready TVET as it envisions a “Vibrant Quality TVET for Decent Work and Sustainable Inclusive Growth”. The identified priority sectors include Agriculture, Manufacturing, Tourism, Construction, IT-BPM, Transportation, Communication & Storage, and Health and Wellness, many of which are also considered as priorities in the National AI Roadmap.

2. TVETPH 4.0 Framework

The Fourth Industrial Revolution (4IR) has brought disruptive technologies that continuously impact education and employment. Thus, TESDA crafted the TVETPH 4.0 Framework as the Agency’s decisive response to the changes and challenges brought about by 4IR. The framework presents Philippine TVET strategies that will help address the requirements of 4IR and ensure that learners will be equipped with STEM Knowledge, 21st century skills, job skills, and other essential skills critical in making Philippine TVET 4.0 ready.

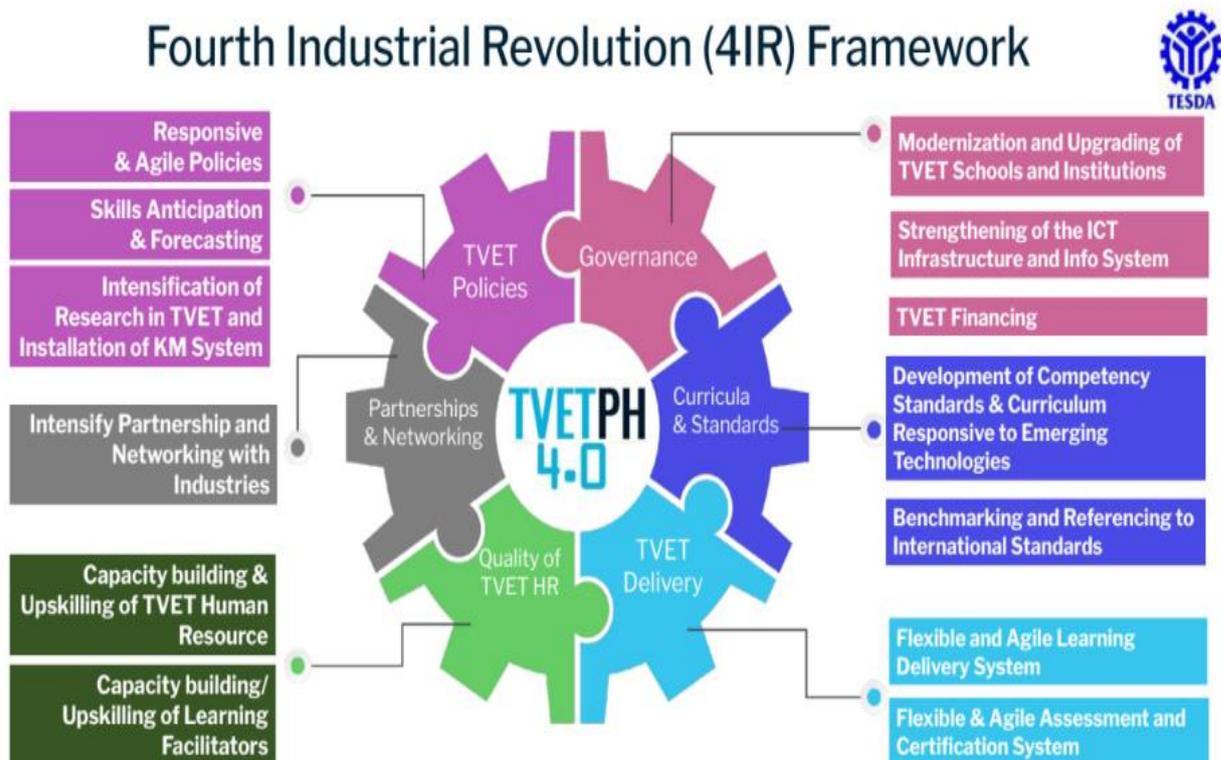


Figure 4. TVETPH 4.0 Framework

3. Incorporating 21st century and other essential skills

The Innovative Startup Act (RA 11337) mandates CHED and TESDA to develop and integrate entrepreneurship into curricula “that shall foster an environment conducive to innovation” and provide grants and incentives to academic institutions (Umali, 2019). As such, 21st century skills including entrepreneurial skills are now embedded to the Training Regulations to ensure that TVET graduates will be equipped with the necessary skills that the industry demands.

4. TESDA Regional Innovation Centers

The TVETPH 4.0 Framework, in consonance to RA 11337, led to the establishment and operation of the Regional TVET Innovation Centers. The framework points out that innovation centers should be established in strategic locations nationwide and further promote a culture of research. These strategies shall enhance the relevance and responsiveness of TESDA Technology Institutions (TTIs) especially in anticipation of 4IR requirements. The specific implementing guidelines are outlined and discussed on TESDA Circular No. 060-2020.

5. Artificial Intelligence and Data Annotation (AIDA) Training Program

In May 2021, TESDA sealed a partnership with CONNECTED WOMEN through a Memorandum of Agreement giving way to the implementation of a No Training Regulation (NTR) program called Artificial Intelligence and Data Annotation (AIDA) Training Program. The program shall benefit 1,000 women and graduates will be assisted and referred by CONNECTED WOMEN for employment as data annotators.

6. Incorporating AI in TESDA Operations

During the start of the pandemic, TESDA was able to develop a mission critical information system that will automate the processing of scholarship programs. Secretary Lapeña also mentioned TESDA's plans in using AI in monitoring the attendance of the scholars, recognizing the benefits and opportunities provided by AI technologies.

7. Industry Consultations

With focus on an area-based and demand-driven TVET, the TESDA Planning Office is conducting various industry consultations to identify specific skills requirements needed by the industry and implement necessary reforms thereafter. During the consultations conducted in 2021, many of the industries gave emphasis on the changing landscape of the sector and the needed competencies of the labor force due to technology. For instance, gadgets and modern technology tools are being

introduced in Construction to improve the productivity of road works and accuracy. IT-BPM reported the emergence in future jobs requiring complexity, higher cognitive skills, and technical competencies (all are consistent with the emergence of AI and its projected impact).

8. Workplace Skills and Satisfaction Survey

Besides measuring the satisfaction of TVET graduates, the study also aims to assess the emerging jobs/skills/competencies in the sector in light of various industry developments. The results will provide information to the TVET stakeholders about the potential future skills needs and job-skills mismatch, as well as to identify actions that can be taken to address the sector's requirements.

9. Philippine Skills Framework

TESDA and the Department of Trade and Industry (DTI) "signed a Memorandum of Understanding (MOU) with SkillsFuture Singapore (SSG) to cooperate on human capital development and the reskilling and skills upgrading of workforce", this especially in line with the 4IR and 4IR technologies, including AI. As a result, the Philippines will use the SSG as a reference in preparing for its own Philippine Skills Framework that will outline sector-specific skills and competencies. The priorities include construction, creatives, food (agriculture and fishery); health and wellness; IT-BPM; logistics and supply chain; manufacturing; and tourism, many of which are also the determined priorities in the AI roadmap.

WAY FORWARD

To face the challenge head on brought about by the 4IR and AI Technologies, TESDA should work hand in hand with various government agencies, industry leaders, and the academe.

The following steps serve as recommendations to further emphasize the Agency's effort in the AI industry in accordance to its mandate of managing and supervising Philippine technical education and skills development for middle level manpower:

TVET Policies

1. Responsive and Agile Policies

- AI will be helpful to TESDA in making more informed decisions and in enhancing the productivity of the organization. However, TESDA should always guarantee the safety and fundamental rights of people especially in the use of personal data. In addition, TESDA's training programs should also consider the ethical mindset in equal importance as with technical skills.
- TESDA should continue to conduct its consultations with various sectors and industries in order to get updates and impact of AI, specifically on the required jobs, skills and competencies.

2. Skills Anticipation and Forecasting

- In the conduct of skills anticipation and forecasting, AI developments must already be integrated so that the impact of these developments to the industries/sectors can be solicited. A mapping of skills that will need upgrading and/or retooling should also be undertaken. For this mapping, it is recommended to prioritize sectors that are anticipated for destructive or transformative occupational changes.

Training Regulations, Standards and Curricula

1. Development of Competency Standards & Curriculum Responsive to Emerging Technologies

- Accessible and inclusive AI curriculum should be developed as AI programs should not only focus on diploma or higher education degree holders. Basic AI knowledge/theories and skills in the standards (i.e data science and analytics, data visualization and storytelling) can be included in the basic competencies, while stackable and modular programs customized to specific industries can be included in the core competencies.
- In line with the industry consultations and the hand holding activities of the Planning Office to the regional and provincial TESDA offices with respect to area-based TVET, specific and appropriate competency standards on AI can be developed depending on the foreseen industry demand.

2. Development and/or review of Training Regulations

- Most of the emerging skills for AI still do not have available Training Regulations primarily focused for the qualifications, although some have initial competencies embedded in the related TRs. Besides the emerging skills, another point of interest are the occupations under the Rising Stars and

Human Terrain categories. These categories of occupation are the least to face destructive transformations due to automation, and thus, are expected to be part of the growing occupations. Skills and competencies in this line of work may increase in demand as well.

- Other TRs somehow related in the identified skills requirements are recommended to undergo review to see whether the AI related competencies are covered in the TR.

TVET Delivery

1. Flexible and Agile Learning Delivery System

- The changing nature of technological developments will require a lot of workers to constantly upskill and reskill. Deployment of skills training should be fast and in scale. Thus in the case of AI training, flexible and agile learning delivery system should be established. One way to do this is by utilizing the TESDA Online Program (TOP) to raise awareness and appreciation of AI. Appropriate learning delivery modes for AI program implementation should be explored, and industry-specific tools for upskilling or retooling be developed.
- As to the various categories of occupations, those in the “rising star” category can benefit from lifelong learning that can further help them in their jobs. For those in the machine terrain and the collapsing terrain, TESDA would be vital in offering upskilling and reskilling with its numerous training programs. For the former, the workers can stay competitive among the ranks. For the latter, the training and upskilling can assist them move to another sector.

Quality of TVET Human Resource

1. Capability building and upskilling of TVET Human Resources (Administrators, Trainers, Assessors) will require relevant and appropriate trainings such as those on AI theories, skills, and systems.

For trainers, they need to be able to implement training programs in consideration of appropriate and inclusive learning methodologies such as e-learning, distance learning and assessment simulation, flipped classroom, gamification, open education resources, and personalization to achieve quality TVET for all. These personnel should also be provided with continuing professional development.

Partnerships and Networking

1. Partnership with the industry, as well as academic and Research and Development institutions can be engaged to help in the development and enhancement of Training Regulations, competency standards, and increasing TVET capacity in actual training implementation and assessment.
2. TESDA can consider providing incentives to industries that will offer Learning and Development programs relative to AI through its various scholarship programs.
3. TESDA can also seek out partnerships, especially from international organizations and development partners that can provide funding and resource generation to support AI in TVET.

Governance

1. Modernization and Upgrading of TVET Schools and Institutions
 - TESDA needs to assess training institutions resources and needs whether they are responsive to the requirements for implementing AI and other Fourth Industrial Revolution training and assessment requirements. These should be incorporated in the establishment of TESDA's Innovation Centers.
2. Strengthening of the ICT Infrastructure and Info System
 - TESDA as an organization needs to invest in technology in order to enable the adoption of AI within the organization.
3. Prioritization in the Allocation of Budget
 - The requirement for the implementation of AI related programs can be considered as priority in the allocation of budget or even technical assistance from partners.
4. Scholarship Allocation
 - The identified priority programs should be considered in the review of programs that will be considered in the allocation of budget under the different scholarship programs of TESDA.

References

- Acemoglu, Daron, and Pascual Restrepo. 2019. "The Wrong Kind of AI? Artificial Intelligence and the Future of Labour Demand." *Cambridge Journal of Regions, Economy and Society* 13 (1): 25-35. https://www.nber.org/system/files/working_papers/w25682/w25682.pdf
- ADB (Asian Development Bank). 2021. *Technical and Vocational Education and Training in the Philippines in the Age of Industry 4.0*. Mandaluyong City: ADB. <https://www.adb.org/sites/default/files/publication/679041/tvet-philippines-age-industry.pdf>.
- Alonso, Cristian, Siddharth Kothari, and Sidra Rehman. 2020. "How Artificial Intelligence Could Widen the Gap Between Rich and Poor Nations." *IMF BLOG*, December 2. Accessed on September 24, 2021. <https://blogs.imf.org/2020/12/02/how-artificial-intelligence-could-widen-the-gap-between-rich-and-poor-nations/>.
- Angara, Sonny. 2021. "The Case for Artificial Intelligence." *Manila Bulletin*, May 3. Accessed on September 24, 2021. <https://mb.com.ph/2021/05/23/the-case-for-artificial-intelligence/>.
- Arayata, Ma. Cristina. 2021. "DOST Introduces 9 AI R&D Projects." Philippine News Agency, April 9. Accessed on September 24, 2021. <https://www.pna.gov.ph/articles/1136226>.
- Balakrishnan, Tara, Michael Chui, and Bryce Hall. 2020. "The State of AI in 2020." *McKinsey & Company*, November 17. Accessed on September 24, 2021. <https://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/global-survey-the-state-of-ai-in-2020>.
- Boden, Margaret A. 2018. *Artificial Intelligence: A Very Short Introduction*. Very Short Introductions Series. New York: Oxford University Press.
- BI (Built In). n.d. "Artificial Intelligence: What is Artificial Intelligence? How Does AI Work?". Accessed on September 24, 2021. <https://builtin.com/artificial-intelligence>.
- Cacho-Asunto, Anna. 2020. "Project Gul.AI: Promoting AI Technology in Agriculture." *Advanced Science and Technology Institute*, December 7. Accessed on September 24, 2021. <https://asti.dost.gov.ph/communications/angsurian/2019/project-gul-ai-promoting-ai-technology-in-agriculture/>.
- Cheatham, Benjamin., Kia Javanmardian,, and Hamidi Samandari. 2019. "Confronting the Risks of Artificial Intelligence." *McKinsey Quarterly*, April 26. Accessed on September 24, 2021. <https://www.mckinsey.com/business-functions/mckinsey-analytics/ourinsights/confronting-the-risks-of-artificial-intelligence>
- Cimatu, Frank. 2020. "Baguio General Hospital to Use AI Technology for Coronavirus Detection." *Rappler*, March 24. Accessed on September 24, 2021. <https://www.rappler.com/nation/baguio-general-hospital-artificial-intelligence-technology-coronavirus-detection>.
- Cyrill, Melissa. 2018. "What is Made in China 2025 and Why Has it Made the World So Nervous?" *China Briefing*, December 28. Accessed on September 24, 2021. <https://www.china-briefing.com/news/made-in-china-2025-explained/>.

- Dirksen, Nicole, and Sonoko Takahashi. 2020. *Artificial Intelligence in Japan 2020: Actors, Market, Opportunities and Digital Solutions in a Newly Transformed World*. Prinses Beatrixlaan: Netherlands Enterprise Agency. <https://www.rvo.nl/sites/default/files/2020/12/Artificial-Intelligence-in-Japan-final-IAN.pdf>.
- DTI (Department of Trade and Industry). 2021. "Artificial Intelligence Roadmap." *DTI*. Accessed on September 24, 2021. <http://innovate.dti.gov.ph/resources/roadmaps/artificial-intelligence/>.
- DTI (Department of Trade and Industry). 2021. "DTI to Launch National Artificial Intelligence Roadmap." *DTI*, May 5. Accessed on September 24, 2021. <https://www.dti.gov.ph/archives/national-artificial-intelligence-roadmap/>.
- EC (European Commission). 2021. "Europe Fit for the Digital Age: Commission Proposes New Rules and Actions for Excellence and Trust in Artificial Intelligence." Press Corner, April 21. Accessed on September 24, 2021. https://ec.europa.eu/commission/presscorner/detail/en/IP_21_1682.
- EiffelCorp. 2018. "Adapt or Die—Future Proofing TVET Colleges for a Rapidly Changing World." *Press Room*, August 22. Accessed on September 24, 2021. <https://www.eiffelcorp.co.za/adapt-or-die-future-proofing-tvet-colleges-for-a-rapidly-changing-world/>.
- Fossen, Frank, and Alina Sorgner. 2019. "Mapping the Future of Occupations: Transformative and Destructive Effects of New Digital Technologies on Jobs." *Foresight and STI Governance* 13 (2): 10-18. DOI: 10.17323/2500-2597.2019.10.18.
- Gamboa, Rey. 2021. "TESDA Faces Urgent TVET Challenges." *Philippine Star*, January 26. Accessed on September 24, 2021. <https://www.philstar.com/business/2021/01/26/2072940/tesda-faces-urgent-tvet-challenges>.
- Google. 2019. "Perspectives on Issues in AI Governance." *Google White Paper*, January. Accessed on September 24, 2021. <https://ai.google/static/documents/perspectives-on-issues-in-ai-governance.pdf>
- Graham, Mark, Isis Hjorth, and Vili Lehdonvirta. 2017. "Digital Labour and Development: Impacts of Global Digital Labour Platforms and the Gig Economy on Worker Livelihoods." *Transfer: European Review of Labour and Research* 23 (2): 135–62. <https://doi.org/10.1177/1024258916687250>.
- Harford, Sarah. 2021. "AI in Europe: Who's Leading the Way and Where is it Heading?" *Silicon Republic*, June 14. Accessed on September 24, 2021. <https://www.siliconrepublic.com/machines/ai-europe>.
- Hill, Indermit. 2020. "Whoever Leads in Artificial Intelligence in 2030 will Rule the World Until 2100." *Brookings*, January 17. Accessed on September 24, 2021. <https://www.brookings.edu/blog/future-development/2020/01/17/whoever-leads-in-artificial-intelligence-in-2030-will-rule-the-world-until-2100/>.
- ILO (International Labor Organization). 2020. *The Future of Work in the Philippines: Assessing the Impact of Technological Changes on Occupations and Sectors*. Geneva: ILO.

https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---ilo-manila/documents/publication/wcms_762207.pdf.

- ISTE. 2019. "Teach AI – Prepare Our Students for the Future." YouTube, June 25. <https://www.youtube.com/watch?v=ympzqGzfi0U>.
- ITO (International Trade Association). 2021. "United Kingdom Artificial Intelligence Market." *Market Intelligence*, May 5. Accessed on September 24, 2021. <https://www.trade.gov/market-intelligence/united-kingdom-artificial-intelligence-market>.
- Jain, Pragya. 2021. "AI and the Future of Work in the United States." *American University*, February 18. Accessed on September 24, 2021. <https://www.american.edu/sis/centers/security-technology/ai-and-the-future-of-work-in-the-united-states.cfm>.
- Jiang, Lushun, Zhe Wu, Xiaolan Xu, Yaqiong Zhan, Xuehang Jin, Li Wang, and Yunqing Qiu. 2021. "Opportunities and Challenges of Artificial Intelligence in the Medical Field: Current Application, Emerging Problems, and Problem-Solving Strategies." *Journal of International Medical Research*. <https://doi.org/10.1177/03000605211000157>.
- Lardizabal-Dado, Noemi. 2020. "How AI Can Help PH Bounce Back from Covid-19." *Manila Times*, May 3. Accessed on September 24, 2021. <https://www.manilatimes.net/2020/05/03/business/sunday-business-i-t/how-ai-can-help-ph-bounce-back-from-covid-19/721871/>.
- Minevich, Mark. 2021. "Europe AI Needs Strategic Leadership, Not Overregulation." *TechCrunch*, May 15. Accessed on September 24, 2021. <https://techcrunch.com/2021/05/15/european-ai-needs-strategic-leadership-not-overregulation/>.
- Moraje, Suraj. 2017. "Seizing the Automation Opportunity in the Philippines." McKinsey & Company, February 17. Accessed on September 24, 2021. <https://www.mckinsey.com/featured-insights/asia-pacific/seizing-the-automation-opportunity-in-the-philippines>.
- Plitnichenko, Lisa. 2020. "5 Main Roles of Artificial Intelligence in Education." *eLearning Industry*, May 30. Accessed on September 24, 2021. <https://elearningindustry.com/5-main-roles-artificial-intelligence-in-education>
- Regalado, Ralph Vincent. 2020. "AI for Health in the Philippines: Are We Ready?" *LinkedIn*, March 21. Accessed on September 24, 2021. <https://www.linkedin.com/pulse/ai-health-philippines-we-ready-ralph-vincent-regalado/>.
- Shiohira, Kelly. 2021. *Understanding the Impact of Artificial Intelligence on Skills Development*. Germany: UNESCO-UNEVOC International Centre for Technical and Vocational Education and Training.
- Shiohira, Kelly, & Keevy, James. 2020. Virtual Conference on Artificial Intelligence in Education and Training: Virtual Conference Report. 2019. Platz der Vereinten: UNESCO- UNEVOC International Centre for Technical and Vocational Education and Training. https://unevoc.unesco.org/pub/vc_synthesis_27.pdf
- Singla, Saurav. 2020. "Is investing in AI the highest ROI opportunity? AI is a revolutionizing industry." *Towards Data Science*, November 6. Accessed on September 24, 2021. <https://towardsdatascience.com/is-investing-in-ai-the-highest-roi-3d84725e315e>.

- Streim, Andreas, Lea Niedballa, Sabrina Caroli. 2020. "Bitkom Warns Against Overregulation of AI in Europe." Bitkom, May 12. Accessed on September 24, 2021. <https://www.bitkom.org/EN/List-and-detailpages/Press/Bitkom-warns-of-overregulation-for-AI-in-Europe>.
- Swain, Aaron. 2020. "Advantages and Challenges of AI in Education for Teachers and Schools." *Robotlab Blog: Everything You Need to Know About Robotics in Education and Businesses*, October 5. Accessed on September 24, 2021. <https://www.robotlab.com/blog/advantages-and-challenges-of-ai-in-education-for-teachers-and-schools>.
- Szczepański, Marcin. 2019. "Economic Impacts of Artificial Intelligence (AI)." *European Parliamentary Research Service*, 1-8. [https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/637967/EPRSBRI\(2019\)637967_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/637967/EPRSBRI(2019)637967_EN.pdf).
- Teich, David A. 2021. "The European Union Is Proposing Regulations for Artificial Intelligence." *Forbes*, April 21. Accessed on September 24, 2021. <https://www.forbes.com/sites/davidteich/2021/04/21/the-european-union-is-proposing-regulations-for-artificial-intelligence/?sh=a7fdc002b460>.
- TESDA (Technological Education and Skills Development Authority). 2019. *Labor Market Information: Information Technology—Business Process Outsourcing*. Taguig City: TESDA. [https://tesda.gov.ph/Uploads/File/Planning/Planning%202019/LMIR/19.04.03_Quick%20LMI_IT-BPO%20\(Web%20Format\).pdf](https://tesda.gov.ph/Uploads/File/Planning/Planning%202019/LMIR/19.04.03_Quick%20LMI_IT-BPO%20(Web%20Format).pdf).
- U.S. Department of State. "Artificial Intelligence (AI)." *Science, Technology, and Innovation*. Accessed on September 24, 2021. <https://www.state.gov/artificial-intelligence/>.
- Walch, Kathleen. 2021. "The United Kingdom's Role on the Future of AI." *Forbes*, April 12. Accessed on September 24, 2021. <https://www.forbes.com/sites/cognitiveworld/2020/04/12/the-united-kingdoms-role-in-the-future-of-ai/?sh=6ce9642c768d>.



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