

Asia-Pacific Tech Monitor

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Digital Innovations for Sustainable
Development in Asia and the Pacific



APCTT
Asian and Pacific Centre
for Transfer of Technology



*The shaded areas of the map indicate ESCAP members and associate members.**

The Economic and Social Commission for Asia and the Pacific (ESCAP) is the most inclusive intergovernmental platform in the Asia-Pacific region. The Commission promotes cooperation among its 53 member States and 9 associate members in pursuit of solutions to sustainable development challenges. ESCAP is one of the five regional commissions of the United Nations.

The ESCAP secretariat supports inclusive, resilient and sustainable development in the region by generating action-oriented knowledge, and by providing technical assistance and capacity-building services in support of national development objectives, regional agreements and the implementation of the 2030 Agenda for Sustainable Development.

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Introductory Note

Technology plays a pivotal role in driving economic growth and sustainable development. New and emerging technologies including digital innovations are transforming every sphere of life through automation, rapid communication, faster delivery of goods and services, digital finance, and improved efficiency across sectors. Digital technologies can address critical sustainability challenges and accelerate the progress on Sustainable Development Goals (SDGs) by improving access to vital services, increasing financial inclusion, enhancing government efficiency, reducing poverty, and improving decision-making skills.

In recent years, digital transformation has been largely driven by the Fourth Industrial Revolution (4IR) technologies (including AI, IoT, Big Data, Machine Learning, Blockchain, and Robotics) that have been unprecedented in terms of their speed, scope, and usage scale. They provide a vast and versatile range of innovative solutions in areas such as environmental monitoring, resource conservation, climate change adaptation and mitigation, urban planning, agriculture and food security, and healthcare. Key examples include digital healthcare services including telemedicine, smart meters and smart grids, transportable wi-fi systems for disaster relief, big data for early prediction of extreme weather events, drone-based solutions for sustainable agriculture, and smart sensors to improve carbon capture efficiency.

Digital technologies do come with their own set of potential challenges, such as issues related to interoperability, data capture and use, data security and privacy, the digital divide across different regions and socio-economic groups, and potential impact on employment. Policymakers and stakeholders need to be cognizant of and work towards addressing these issues to facilitate widescale use of digital technologies that are inclusive, safe, reliable, affordable, and efficient.

The Asia-Pacific Tech Monitor, Jan-Mar 2024 focuses on “Digital innovation for sustainable development in Asia and the Pacific”. It features articles that will provide different perspectives and insights on the developments in policies towards better use of digital technologies in different sectors. For example, an article highlighting the journey of Thailand toward digital education stresses the importance of government-built supporting policies while planning for digital infrastructure. Another article discusses the potentials and challenges of AI in different Asia-Pacific cities and proposes key considerations for the responsible deployment of AI in urban environments fostering sustainable development. Another interesting article is on the role of digital technology, especially crowdfunding, in addressing financial access issues. The study reveals that crowdfunding and digital innovation significantly enhance the efficiency, transparency, and impact of projects targeting the SDGs, despite challenges such as regulatory hurdles, market readiness, and technological access.

We sincerely hope you will find this Tech Monitor issue informative and useful.

Preeti Soni
Head, APCTT

Technology Market Scan

INTERNATIONAL

Multiple-central bank digital currency

In a collaborative effort of the BIS Innovation Hub, four founding central banks and over 25 observing members started Project mBridge. The founding central banks are the Hong Kong Monetary Authority, the Central Bank of the United Arab Emirates, the Digital Currency Institute of the People's Bank of China, and the Bank of Thailand.

For Project mBridge, a platform based on a new blockchain – the mBridge Ledger – was built by central banks to support real-time, peer-to-peer, cross-border payments and foreign exchange transactions using CBDCs, focusing on the use case of international trade. It also ensures compliance with jurisdiction-specific policy and legal requirements, regulations, and governance needs. In 2022, a pilot involving real corporate transactions was conducted on the platform among participating central banks, selected commercial banks, and their corporate customers in four jurisdictions.

Project mBridge experiments with a multi-central bank digital currency (multi-CBDC) common platform for wholesale cross-border payments. It seeks to solve some of the key inefficiencies of cross-border payments, such as high costs, low speed and transparency, and operational complexities. At the same time, the project aims to safeguard currency sovereignty and monetary and financial stability for each participating jurisdiction, guided by the principles of “do no harm”, compliance, and interoperability. Project mBridge’s platform is underpinned by custom-built distributed ledger technology (DLT), a set of comprehensive legal rulebook documents, and a fit-for-purpose governance structure.

<https://www.bis.org>

ASIA-PACIFIC

ASEAN roadmap for digital education

Indonesia hosted ASEAN’s Second Regional Meeting on Roadmap on Declaration on Digital Transformation of Education Systems on August 8 in Surabaya, East Java. A total of three key agenda items were discussed at the meeting: the Post Transforming Education Summit 2022: How the world reaffirms digital learning and transformation; a presentation by ASEAN member states (AMS) on the strategy to incorporate digital transformation in the education system; and the AMS overview on the Roadmap on Declaration on Digital Transformation of Education Systems in ASEAN.

The development of this roadmap is a joint effort among ASEAN member countries, with support from the ASEAN Secretariat. During the pandemic, digital technology was initially used to ensure that the teaching and learning processes could continue during the closure of some or all schools. As it developed, education stakeholders grew to realize the potential of digital technology in accelerating the education sector’s recovery and in resuming the efforts to realize Sustainable Development 4 on Quality Education.

Indonesia consistently fights for transformation at all levels of education. During last year’s G20 [Group of 20] presidency, Indonesia put forward the importance of using ICT in education to support learning recovery and to create more inclusive and relevant education.

The preparation of a roadmap is carried out to realize the commitments outlined in the Declaration on the Digital Transformation of Education Systems in ASEAN. This road map also serves as a tool for ASEAN countries to achieve the digital transformation goals in the education sector through agreed key areas, common milestones,

indicative timeframes, and potential partners. The bloc’s 2025 vision underscored the importance of skills and knowledge in the digital era, with education being the cornerstone of the vision of an inclusive ASEAN. ASEAN Community Vision 2025 puts forward efforts to increase regional integration and connectivity through digital technology and encourages a collaborative education ecosystem to support the exchange of knowledge among institutions, educators, and students throughout ASEAN. The ASEAN Declaration on Human Resources Development for the Changing World of Work recognizes the dynamic nature of the modern workforce and the imperative for continuous skills upgrading and training, given that digital transformation plays a role in reshaping industries and job markets.

<https://www.thejakartapost.com>

AUSTRALIA

Data and digital strategy

The Australian government has published a new digital and data strategy that sets a clear vision for delivering connected public services through 2030.

The Data and Digital Government Strategy outlines five missions to accelerate transformation across the Australian Public Service (APS), focusing on delivering simple and seamless services for all people and businesses, embedding solid foundations for trusted and secure digital and data, and calibrating government so that it is fit for the future.

The government said the strategy represents the first time it has a unified blueprint for how it will maximize the value of its data holdings and digital capabilities. It is accompanied by an implementation plan which includes whole-of-government scorecards for unprecedented accountability.

Minister for Finance and the Public Service, Katy Gallagher, said she wants to ensure the APS is keeping up with technology and adopting leading-edge practices while ensuring services are inclusive and accessible. “We want to provide better services that are easy to use, that save people time and money, and that are safe and secure,” she said.

Chris Fechner, CEO of the Digital Transformation Agency, said the strategy “represents the maturing of the Australian government’s digital transformation and the recognition of data and digital as vital to delivering for people and business.” He added: “Going forward, the strategy provides a blueprint for government investments in data and digital to be coordinated, driving greater impact and effectiveness, and revealing where future efforts should be focused.”

The government said achieving the 2030 vision would require an ongoing commitment and it would need to “build our data and digital expertise within the APS, and more effectively partner with industry, the community sector and academia to deliver for the Australian public”.

<https://www.globalgovernmentforum.com>

Telecommunications and disaster resilience program

The Telecommunications Disaster Resilience Innovation (TDRI) Program will encourage the development and deployment of innovative, new, or emerging technologies and/or solutions that will improve the resiliency of telecommunications against the impacts of natural disasters. The TDRI Program Innovation Round will focus on funding innovative telecommunications technologies that will improve the resiliency, redundancy, and availability of telecommunications during and/or following a natural disaster. The Innovation Round has three focus areas:

- Deployable telecommunications solutions
- Satellite connectivity
- Enhanced situational awareness

The objective of the TDRI program is to improve the preparedness of Australia’s telecommunications networks against

rising climate risks, including against an anticipated increase in the frequency and severity of natural hazards in Australia, by:

- Supporting and accelerating the development and deployment of innovative, new, or emerging technologies that will improve the resiliency of telecommunications, particularly in rural, regional, remote, or First Nations communities;
 - Demonstrating the benefits of emerging telecommunications technologies in improving disaster resiliency outcomes; and
 - Encouraging greater collaboration and partnerships between industry and government stakeholders on telecommunications disaster resilience matters
- The intended outcomes of the program are:
- Expedited adoption of emerging telecommunications technologies in Australia that will improve disaster resilience outcomes for Australian communities (including through preventing outages and/or supporting the rapid restoration of services following an outage); and
 - Reduced instances of telecommunications outages during natural disaster events, including reduced instances of communities being isolated and unable to contact Triple Zero services or access other critical services/supports such as disaster financial assistance.

<https://www.advance-africa.com>

BANGLADESH

Phygital public infrastructure

Digital Public Infrastructure holds the potential to benefit every country, provided it can effectively tailor the concept to its specific context and unique national needs. Unlike physical infrastructure, which has limited construction methods, DPI presents virtually limitless possibilities. In its pursuit of establishing a frugal and inclusive DPI, Bangladesh has adopted this searcher approach, drawing inspiration from India Stack, Estonia’s X-Road, and Sin-

gapore’s Moments of Life initiative, among others.

Bangladesh’s “phygital public infrastructure” is characterized by two key elements: Identifying Services as the Entry Point: Bangladesh has recognized services as the gateway to DPI, making the concept more accessible and relatable to policymakers and citizens alike. Expanding DPI to include an additional Access Layer: This layer encompasses physical locations and call centers, enhancing DPI accessibility for persons with disabilities and disadvantaged individuals residing in remote rural areas.

With a focus on open, modular architecture and the use of open source where possible, Bangladesh’s “phygital public infrastructure” now encompasses all three DPI layers: Identity (ID), Payments, and Data Exchange.

<https://govinsider.asia>

Digital bank guideline

The board of the Bangladesh Bank has approved the Digital Bank guideline keeping provision for paid-up capital at Tk125 crore. The license of the Digital Bank will be given under the Banking Company Act 1991. The payment service will be operated under the Bangladesh Payment and Settlement System Regulations, 2014, according to the approved guidelines.

The minimum shareholding of each sponsor will be Tk50 lakh (maximum 10% or Tk12.5 crore), according to the digital bank guideline. The ceiling of 10%, in consultation with the government, may be relaxed in case of a digital bank formed as a joint venture of banks, financial institutes, microfinance institutions, MFS providers, fintech companies, and technology firms or for a needed special case.

Digital banking is part of the broader context for the move to online banking, where banking services are delivered via the Internet. The major difference is digital banks will have only headquarters, and no other physical presence while conventional banks have physical presence across the country. The business, e-governance and operational requirements applicable to traditional banks in general shall continue

to apply to digital banks, according to the guideline

The central bank is going to introduce digital banks in Bangladesh at a time when new-generation banks across the globe are turning away from traditional brick-and-mortar banks in favor of digital banking. At present, the banking sector is oversaturated with 61 conventional banks in Bangladesh.

At present, Nagad, the country's second-largest Mobile Financial Service (MFS) provider, is planning to set up a digital bank. Nagad first approached the Bangladesh Bank for a digital bank license in 2020 and following that the regulator moved to formulate guidelines in this regard.

<https://www.tbsnews.net>

Innovation initiative

On December 12, 2022, Prime Minister Sheikh Hasina announced the vision to build a Smart Bangladesh by 2041. The vision rests on four fundamental pillars: Smart Citizen, Smart Economy, Smart Governance, and Smart Society. The journey towards Smart Bangladesh is planned to unfold over 18 years, starting from 2023 to 2041.

Aspire to Innovate (a2i) of the Cabinet Division and ICT Division, supported by the United Nations Development Program (UNDP), is working towards simplifying citizen services and making them more accessible by using modern and integrated information technology. Simultaneously, efforts are underway to develop services tailored to the specific needs of individual citizens. The a2i initiative and its associated projects have received over 17 national and international awards, demonstrating their commitment to technology-dependent services and innovation for Smart Bangladesh development.

Aspire to Innovate - a2i has received prestigious awards from the United Nations. Their 'Covid-19 Telehealth Centre' initiative has earned them the 'World Summit on the Information Society (WSIS) Prize-2023' for their remarkable work on the international stage. In addition, their 'ekShop' platform has been awarded the 'SDG Digital Game Changer Award' by the United Nations, for its contribution to extending e-commerce

services to both rural and urban areas and breaking down the distance barrier. a2i has also been recognized with the 'WITSA 2023 Global Innovation and Technology Excellence Awards' for their excellence in skill development and education through online platforms like 'National Intelligence Employment and Entrepreneurship (NISE)' and 'MuktoPaath.'

Agency to Innovate (a2i)- 2023 act has been passed in the National Parliament. The "Agency to Innovate (a2i) Act" was passed in the eleventh National Parliament with the aim of establishing the Agency to Innovate (a2i) in order to enhance citizen services and foster an innovative culture in the country. In 2009, following the establishment of the government, the Access to Information (a2i) initiative was created as part of the "Digital Bangladesh" project, which was funded by the UNDP to oversee digital initiatives in Bangladesh. In 2018, a2i was placed under the Information and Communication Technology Division and the Ministry Division for project implementation as per the Prime Minister's directives. Recently, in 2020, the "Aspire to Innovate (a2i)" project began, and a2i is gearing up to become an information technology policy agency.

The initiative aims to bridge global digital divides and promote inclusivity in technology. In addition to knowledge exchange to reduce digital disparities in countries lagging behind in technology, the E-Quality Centre has already established the I-3 Matching Fund, which provides financial support to innovative projects. The fund has already provided financial assistance to five countries, including Gambia, Uganda, Sao Tome and Principe, Somalia, and Ghana.

<https://www.dhakatribune.com>

BHUTAN

Blockchain-based digital identity system

Bhutan has decided to roll out a national digital identity system for all its citizens. National Digital ID is the platform on which digitization and online

services of banks to hospitals to taxation to universities, everything can come online. The national ID system has been built using blockchain technology, which will provide each individual a self-sovereign identity, meaning it can only be controlled by the citizen and no other entity, similar to how cryptocurrencies work. The country's crown prince, Jigme Namgyel Wangchuck, was the first to enroll in the new system, and it is expected to reach the rest of the population within the year, Dahal said.

With self-sovereign identity, the person would have verified credentials in one's wallet, and in phone. Nobody can access it. The onboarding process takes about 5 seconds. People have to download an app; and share their details, selfies, and national ID card. This timeline would differ for people who don't have smartphones or require assistance.

During Parliament's discussion on the digital ID bill, lawmakers received a total of 55 recommendations, with privacy among the major concerns. Since self-sovereignty ensures only the individual has the right to disclose their credentials, it should keep such concerns at bay. Now, it's up to the individual if I don't want service from the bank, I won't share my credentials. If I do share it, it's with one's consent. If a phone is lost, there's a process to recover the ID from a cloud but only the individual has the right to recover it from the government or any other entity.

<https://restofworld.org/2023>

CHINA

Blueprint for digital development through 2035

The Communist Party of China (CPC) Central Committee and the State Council unveiled the blueprint and timeline for the construction of a "digital China" through strengthening 5G and computing. Building a "digital China" is an important engine for promoting Chinese-style modernization in the digital age, and it is strong support for building new advantages in global competition. It is of great significance and will

have a far-reaching impact on the construction of a socialist modern country and comprehensively promoting the great rejuvenation of the Chinese nation, read the guidelines.

The guidelines set a specific timeline for China's digital construction through 2035. By 2025, the digital infrastructure will be efficiently connected through a broad range of sectors, and China will become a global leader in digital innovations. And by 2035, the level of digital development in China will enter the forefront of the world.

Major technology breakthroughs are highlighted in the document, which vows to strengthen the "key capabilities" of building a "digital China." Moreover, the guidelines also call for building a credible and manageable digital security apparatus, to maintain network security through improving the system of network security laws, regulations, and policies.

The guidelines call for an open and win-win international cooperation regime in the digital field, calling for overall plans for international cooperation in the digital field. "We will expand the space for international cooperation in the digital field, actively participate in digital cooperation platforms under multilateral frameworks such as the United Nations, the World Trade Organization, the G20, APEC, BRICS, and the Shanghai Cooperation Organization, and build a new platform for open cooperation in the digital field with high quality," read the guidelines.

<https://www.globaltimes.cn>

Action plan for metaverse industry development

On September 11, 2023, China's Ministry of Industry and Information Technology (MIIT) along with other four departments unveiled the ambitious Three-Year Action Plan for the Industrial Innovation and Development of the Metaverse (2023-2025) (hereinafter referred to as the "action plan" or "plan").

This document outlines China's visionary approach to metaverse industry development, with a focus on establishing "three to five industrial clusters" that revolve around emerging technologies. These clusters will serve as

central hubs, driving innovation and governance structures within the realm of the next-generation internet, characterized by immersive three-dimensional spaces.

The action plan, spanning the period from 2023 to 2025, underscores the versatile application of the metaverse across various sectors, including but not limited to home appliances, automotive, and aerospace industries. Furthermore, traditional manufacturing sectors, such as steel and textiles, can harness related technologies to optimize critical processes, including scheduling and material calculations, thereby enhancing their overall production procedures, as articulated in the plan.

At its core, the plan introduces five key tasks, which serve as the pillars of its strategy: Building advanced metaverse technologies and industrial systems: This task emphasizes the integration and innovation of critical technologies like artificial intelligence, blockchain, cloud computing, and virtual reality within the metaverse landscape. It places a strong focus on advancing key technologies, including intelligent generation algorithms, distributed identity authentication, and data asset circulation. Additionally, it seeks to develop fundamental software components, such as metaverse-specific operating systems and middleware, contributing to the creation of a unified metaverse development platform.

<https://www.china-briefing.com>

INDIA

Digital India Bill 2023

The Digital India Bill 2023 aims to replace India's existing Information Technology Act of 2000 and provide comprehensive oversight of the digital landscape. It seeks to address modern challenges like cybercrime, data protection, deepfakes, and online safety. The Bill introduces a classification system for intermediaries based on risk and size, allowing tailored regulations. It proposes a dedicated internet regulatory authority for effective governance. However, debates have arisen concerning certain provisions, particularly regarding safe harbor, granting

legal immunity to intermediaries for user-generated content, with stakeholders having different views on the Bill's scope and applicability.

The upcoming Digital India Bill 2023 is set to replace India's existing Information Technology Act (IT Act) of 2000. This new legislation has been designed to establish comprehensive oversight over India's digital landscape, effectively tackling contemporary challenges like cybercrime, data protection, deepfakes, competition among internet platforms, online safety, and the negative impact of artificial intelligence (AI).

This move is expected to have significant implications for businesses operating in India's digital landscape. Aligned with India's goal of achieving a US\$1 trillion digital economy by 2025-26, the Digital India Bill aims to foster global innovation, and entrepreneurship, and establish India as a trusted player in the global digital value chains.

Recent reports suggest that the draft of the Digital India Bill will soon be released for public consultation by the federal government. This move is expected to have significant implications for businesses operating in India's digital landscape.

Aligned with India's goal of achieving a US\$1 trillion digital economy by 2025-26, the Digital India Bill aims to foster global innovation, and entrepreneurship, and establish India as a trusted player in the global digital value chains. The draft of the Digital India Bill will be released for public consultation by the federal government.

The primary objective of the Digital India Bill is to streamline and unify existing laws concerning the digital domain. It must be noted that this Bill will work in conjunction with other notable legislation and policies, such as the Digital Personal Data Protection Act, the National Data Governance Policy, the Indian Penal Code amendments for cybercrime, etc. Together, these laws and policies are set to establish a comprehensive framework aimed at governing different facets of the digital sphere in India.

<https://www.india-briefing.com>

Digital public infrastructure repository

India's Ministry of Electronics and Information Technology (MeitY) has created the Global Digital Public Infrastructure Repository – a collection of code created by governments, and made freely available to other nations. Digital public infrastructure (DPI) is a signature policy of India's government, which has championed the idea that governments should open source their own apps so that other nations can more quickly create digital services by re-using existing code.

Sharing Indian projects like the Aadhaar digital identity framework, or the Unified Payments Interface – both of which are proven to operate at a billion-user scale – is seen as a way for India to enhance its relationships with other nations.

While launching the repository, Indian Prime Minister Narendra Modi advanced the cause of DPI by also announcing India has chipped in \$25 million to a "Social Impact Fund" – billed as a "government-led, multistakeholder initiative to fast-track DPI implementation in the global south." The fund was described as a platform to help accelerate the achievement of Sustainable Development Goals in Low- and Middle-Income Countries through DPIs and will offer financial support to assist to develop and implement DPIs.

<https://www.theregister.com>

Digital public infrastructure for climate finance

India is at the forefront of a groundbreaking initiative, poised to merge the forces of technology and ecology. The government, in collaboration with Niti Aayog, is developing a Digital Public Infrastructure (DPI) for climate finance. This endeavor is more than an advancement in environmental strategy; it's a blueprint for sustainable growth, signaling India's role as a pioneer in the global narrative of digital-led environmental sustainability.

In the aftermath of climate-induced disasters, the DPI is envisioned to play a critical role in providing immediate financial relief to those affected. DPIs

which enable direct digital payments can assist those persons affected by extreme weather events and who may not have ready access to banks and other physical infrastructure, highlighting the infrastructural advantage in times of crisis.

Niti Aayog's strategic involvement Niti Aayog is not merely a facilitator but a strategic collaborator in this initiative. Their role extends to policy integration and active stakeholder engagement. "NITI Aayog today is playing an active collaborative role by engaging with stakeholders about issues and measures for DPI integration in India's development. This involves a series of workshops and discussions, aiming to calibrate India's policies toward a sustainable and low-carbon future.

With the DPI, India aims to improve carbon trading markets' transparency and effectiveness, bolster forest conservation efforts through better data monitoring, and enhance weather prediction systems. Such measures are crucial as India confronts the increasing impact of climate change, underscored by reports ranking nine Indian states among the world's most at-risk regions. A sustainable blueprint for tomorrow India's DPI for climate initiatives represents a fusion of digital innovation with environmental responsibility. It is a blueprint for a sustainable future, one that promises a more resilient infrastructure capable of withstanding and responding to the climate challenges ahead. This initiative by India, in collaboration with Niti Aayog, is a testament to the country's commitment to leading the way in climate-smart governance and sustainable development.

<https://energy.economictimes.india-times.com>

Digital Personal Data Protection Act, 2023

The Digital Personal Data Protection Act, 2023 holds considerable importance as a legislative measure aimed at safeguarding individuals' privacy rights. Its primary focus lies in regulating the collection, storage, processing, and transfer of personal data in the digital landscape. The DPDP Bill underwent 81 amendments after its initial

introduction, resulting in a comprehensive overhaul to its present form.

By prioritizing privacy and security, the DPDP Act strives to create a robust framework that addresses the challenges posed by data handling in the digital age. Key provisions of the DPDP Act, 2023 are as follows:

The DPDP Act applies to all data, whether originally online or offline and later digitized, in India. Additionally, the Act applies to the processing of digital personal data beyond India's borders, particularly when it encompasses the provision of goods or services to individuals within the Indian territory.

Age verification mechanisms will be necessary for all companies in India (telcos, banks, e-commerce, etc.) under the new DPDP law. The compliance requirement is not just limited to social media platforms. This is essential to record the verifiable consent of users per legal experts.

<https://www.india-briefing.com>

MALAYSIA

Blueprint to achieve digital economy

Technology continues to drive advances throughout the economies of many countries and Malaysia is no exception. The government has introduced MyDIGITAL, a national initiative to transform Malaysia into a country with a high-income status that is focused on digitalization and a regional pioneer in the digital economy.

The Malaysian Digital Economy Blueprint outlines the efforts and initiatives taken to fulfil MyDIGITAL's aspirations. The blueprint will determine the trajectory of the digital economy's contributions to the Malaysian economy and build the foundation to drive digitalization nationwide, including bridging the digital divide.

Malaysia's digital transformation is anchored in artificial intelligence (AI), data analytics, cloud computing, Internet of Things (IoT), cybersecurity, and robotics. Malaysia's technology sector has accelerated into the Fourth Industrial Revolution with the National 4IR

Policy from July 2021. The policies outlined in the Malaysia Digital Economy Blueprint and MyDIGITAL would play a pivotal role in fostering Malaysia's technology sector.

By identifying emerging technologies and actively involving all stakeholders, Malaysia has bridged digital divides across income, gender, and age groups. The workforce has adapted to higher-value jobs, extending beyond 4IR core areas to encompass emerging fields such as blockchain technology, digital forensics, and robotic process automation.

<https://thesun.my>

NEW ZEALAND

Digital services tax

New Zealand has announced it will impose a digital services tax on multinational companies from 2025 following delays in talks for the global rollout of international tax rules at the Organization for Economic Cooperation and Development (OECD). New Zealand is seeking a 3% levy for multinationals that earn more than US\$812 million annually from global services and make more than US\$2.1m a year from digital services in New Zealand.

The global tax accord was agreed upon in full in 2021. The accord aims to designate how, where and how much multinational companies are taxed. OECD talks in Paris last month agreed a one-year delay in implementing the first phase of the tax accord, to 2025. The proposed legislation could generate around NZ\$222m over four years.

Efforts in recent years to create a global corporate tax system have failed to gain traction. This has led some nations, including the UK, to implement special taxes on digital services. In April 2020, the UK launched its Digital Services Tax, which subjects search engines, social media platforms, and online marketplaces that make revenue from users in the UK to a 2% tax on those revenues.

<https://www.wsj.com>

PAKISTAN

Digital census

Pakistan's National Database and Registration Authority (NADRA) has introduced a service intended to put people in charge of their biometric data. NADRA now offers a service called 'Ijazat Aap Ki, that decentralizes citizen data, at least to some extent. People will be able to give their consent – or refuse it – before a transaction requiring their Pakistani ID card.

The government is calling the move, making personal information just like any other precious personal possession, unprecedented. For the government, according to officials, it means the creation of a "digital consent regime."

Verification transactions now require that a six-digit code be sent to a mobile phone registered to a citizen. Sharing the code is a means of authentication and will be a person's agreement for a third party to get verification of their ID number. People will have to update NADRA when they change their phone numbers.

The agency is promoting what it says is Pakistan's first digital census, the deepest and broadest collection of personal information most people will ever experience. The digital census is conducted by the Pakistan Bureau of Statistics (PBS), with hardware and software support from NADRA.

<https://www.biometricupdate.com>

PHILIPPINES

Digital PhilID rollout

According to the Philippines Statistics Authority (PSA), there is continued progress in issuing the two digital versions of the Philippines ID card (PhilID) as the push to enhance user experience in accessing public services advances. The digital PhilID has printed and downloadable versions. The two versions of the digital PhilID have the same functionality. The downloadable version in PDF format would make it available on mobile phones, this will contribute to furthering the country's ambitions of having a highly digital society.

The Central Bank of the Philippines (BSP) recently revised its digital Know Your Customer (KYC) rules for customer due diligence (CDD), making the PhilID one of the digital ID credentials required for customer onboarding. The adjustments fall in line with the BSP's financial inclusion strategy which aims to allow holders of the PhilID to have access to bank accounts and other financial services. As Per the new requirements, when the PhilID is presented for KYC, the front section which has the photo of the holder is scanned and the number on the back of the card must not be disclosed. The amendment also sets out certain rules that entities carrying out digital KYC through digital ID systems must take note of.

According to the new rules, firms are expected to understand the basic components of the digital ID system particularly how they apply to the CDD requirements; utilize anti-fraud and cyber-security processes to support digital identity authentication and ensure all practices of digital KYC comply with relevant data sharing and protection privacy laws and rules about data processing, storage, and management. Institutions have one year to comply with the new rules.

The publication notes that the Philippines is the latest country in the Asia-Pacific region to adjust its digital KYC rules to enable financial institutions to meet requirements of anti-money laundering and the fight against the financing of terrorism. It also cites Hong Kong and Malaysia as the other nations having done similar rule changes for digital KYC recently in the region.

<https://www.biometricupdate.com>

THE REPUBLIC OF KOREA

Sci-tech deal

The United Kingdom and the Republic of Korea formalized a series of science and tech deals in the presence of Secretary of State Michelle Donelan, Minister of Trade, Industry and Energy Bang Moon-kyu, and Minister of Science and ICT Lee Jong Ho. These have

been agreed as part of an Accord between the two countries. As two of the world's most innovative economies, the UK and the Republic of Korea are natural partners, with both countries placing in the top five of the Global Innovation Index.

The two countries will work closer together than ever before to harness the potential of critical technologies like AI, quantum, and semiconductors to create jobs and unlock economic growth, alongside a new £4.5 million fund to create joint research and innovation partnerships. This builds on the recent international progress on safe, responsible AI development achieved at the AI Safety Summit, the next edition of which will be co-hosted by the Republic of Korea and the UK next year.

New commitments to collaborate in space, and on digital tech, as well as an over-arching agreement on science and technology, will open up new opportunities for trade, innovation and investment in both countries – ultimately helping to grow the economy, one of the Prime Minister's five priorities.

The science and technology agreements being signed as part of the UK-Republic of Korea bilateral Accord are:

- A new Framework for Semiconductor Cooperation to enhance our collaboration on skills, R&D, supply chain resilience and trade, and deepen industry links.
- A broad new Digital Partnership, boosting joint work in priority areas such as data, telecoms, AI, and digital competition.
- A new Memorandum of Understanding on space cooperation, bringing our space industries closer together and paving the way to joint space endeavors
- A new Implementation Arrangement, which updates and reboots a Science & Tech cooperation agreement from 1985, to modernize the two countries' science and tech partnerships for the 21st century
- A new dialogue on quantum, which will include talent exchanges
- A commitment to closer cooperation on engineering biology

<https://www.gov.uk/government>

A new digital order

The "Digital Bill of Rights," crystallizing President Yoon's digital vision, is announced as the manifesto for a universal digital order.

This announcement is a comprehensive result derived from many global discussions, from the New York Initiative in September 2022 and the Davos Forum, to lectures at Harvard University and Sorbonne University, and public conversations integrating diverse input from scholars, the younger generation, and more.

Values and five principles for a digital community of mutual prosperity that global citizens should collectively embrace are announced.

The Ministry of Science and ICT (Minister Lee Jong Ho, hereinafter referred to as "MSIT") announced on September 25th (Mon.) that the "Digital Bill of Rights" will now be formally reported, with its full contents disclosed for the first time, at the cabinet meeting chaired by President Yoon Suk Yeol.

MSIT has been actively supporting the establishment of the "Digital Bill of Rights," which will in turn set out the foundation for the establishment of a "new digital order," in line with the President's digital vision. After the New York Initiative last year, MSIT organized a body of experts and representatives from various sectors to drive the formulation process and conducted many activities, namely: 1) Drafting a foresight of future digital society, 2) Provision of advice on legal and philosophical matters, 3) Case studies of important digital charters and declarations made overseas, and 4) Analysis of digital issues with currency. Moreover, MSIT has led the public conversation by operating the "Council for a New Digital Order," and a series of roundtables that invited a diverse range of stakeholders, such as university presidents, major academic societies, and CEOs, to listen to different voices coming from different parts of our society.

The "Digital Bill of Rights" is a charter codifying nation-level standards and principles to synchronize with this era of deepening digitalization, as well as outlining the basic direction for universal digital order for guiding the interna-

tional community. It consists of a preamble, which lays out the background and objectives of the document, and the main text, a total of 6 chapters and 28 articles.

The "Digital Bill of Rights" sets forth a blueprint for a digital society of mutual prosperity, in which the pursuit of digital innovation comes with just and fair distribution of its benefits. To achieve this exemplary vision of how future society should be shaped together with all members of the international community, the "Digital Bill of Rights" defines principles for action.

<https://www.korea.net>

RUSSIAN FEDERATION

Digital ruble

Russia's digital ruble has been integrated into the nation's tax code after its President Vladimir Putin signed the move into law. The tax code now contains a definition of "digital ruble account" and has rules for the taxation of transactions with digital rubles. The Bank of Russia has been working on the Digital ruble as a central bank digital currency project since 2020.

The new law will allow authorities to recover digital currency if the taxpayer does not have enough funds in their bank accounts. It also permits authorities to suspend transactions on digital ruble accounts and requires that the platform operator provide documents to reflect funds have been written off from the taxpayer's account.

<https://www.coindesk.com>

SINGAPORE

National AI strategy

Singapore government has announced its updated national AI strategy, dubbed the National AI Strategy (NAIS) 2.0, as AI technology development gains momentum across the globe. The new policy introduces three major changes. The first key policy shift is that Singapore now believes that AI is a necessity and no longer "good to have." In this context, it aims to triple the talent

pool of AI experts to 15,000 by training and hiring people. As the technology continues to progress, AI professionals and data scientists are in high demand in all geographies, so the country plans to train people and hire from overseas markets to gain an edge.

The second policy change is that the country now harbors global ambitions and aims to make a significant contribution to AI breakthroughs at a global level.

The third significant change is to adopt a projects-to-systems approach. "We will take a systems approach, bringing together stakeholders within and outside Singapore to add to our resources, capabilities, and infrastructure, accelerate the exchange of ideas, and administer AI-enabled solutions at scale," the new policy document read.

Singapore was one of the first countries to come up with a National AI Strategy in 2019 and the country committed an investment of about \$373 million (S\$500 million) through AI Singapore (AISG) for the Research, Innovation, and Enterprise (RIE) 2020 and 2025 plans. However, the recent advances in AI technology, with the advent of generative AI, demanded a relook at the existing policies, which led to the launch of NAIS 2.0.

NAIS 2.0 defines excellence and empowerment as the twin goals of the policy. The country hopes to excel in AI to "maximize value creation" by empowering people and businesses to use the technology with confidence.

It further defines ten enablers in three categories: activity drivers (industry, Government, and research), people and communities (talent, capabilities, and placemaking), and infrastructure and environment (compute, data, trusted environment, and leader in thought and action).

The launch of ChatGPT by OpenAI last year put the technology in the spotlight and brought forth the transformative impact it will have on various industry verticals.

<https://www.financialexpress.com>

Blueprint for digital financial infrastructure

The Monetary Authority of Singapore (MAS) unveiled three initiatives to ensure the safe and innovative use of digital money in Singapore, namely: a blueprint outlining the infrastructure required for a digital Singapore dollar; expanding digital money trials; and a plan to issue a "live" central bank digital currency (CBDC) for wholesale settlement. The three forms of digital money that MAS is promoting are wholesale CBDCs, tokenized bank liabilities, and regulated stablecoins.

MAS published the Orchid Blueprint which sets out the technology infrastructure that would be required to facilitate digital money transactions in the future. The blueprint builds on learnings from the Project Orchid and industry trials, and identifies the following infrastructure building blocks for the sound use of digital money in Singapore:

Settlement ledger – to record digital money transfers, with supporting features such as native programmability and atomic settlement of digital tokens.

Tokenization bridge – to connect existing account-based settlement systems with ledgers compatible with tokenized forms of digital money.

Programmability protocol – to use Purpose Bound Money (PBM) as a common protocol to specify the conditions for the use of digital money.

Name Service – to translate between unwieldy wallet addresses and alternative name identifiers that are readable and meaningful for verification.

To complement the digital money trials by the financial industry involving retail and corporate users, MAS will commence the development of CBDC for wholesale interbank settlement next year. MAS will pilot the "live" issuance of wholesale CBDCs for the first time, after previously simulating issuance within test environments. The first pilot will involve the use of "live" wholesale CBDC to settle retail payments between commercial banks. Future pilots could include the use of "live" wholesale CBDC for the settlement of cross-border securities trade. The issuance of wholesale CBDC reinforces the role that central bank money plays in facilitating safe and efficient payments."

<https://www.marketsmedia.com>

Technology Scan

Focus: Digital Innovations for Sustainable Development

ASIA-PACIFIC

AUSTRALIA

Digital tool for water management

Southeast Water's Environmental Sensitivity Map, is a tool created to proactively protect the environment within Melbourne's south-east in the event of a sewer spill. This initiative is just one of the multiple projects that are helping the organization protect its environment and deliver for its customers. This tool will help to better understand the biodiversity in the region and to act faster and more responsibly to protect it if there's a risk to the health of the environment.

Southeast Water has also embarked on a significant digital transformation and is progressing with a substantial expansion of its recycled water network. To date, its digital metering program has saved customers close to one billion liters of water and more than \$4.4 million by detecting household leaks. The next phase of the digital metering program will see it supporting businesses and industry to save water through the installation of next-generation digital data loggers.

In recent years, the organization has embarked on multiple innovative projects to rise to the challenges of this critical decade for water in the face of changing weather patterns and evolving customer expectations.

<https://utilitymagazine.com.au>

BHUTAN

Digital Dzongkha Braille Board

A group of former students of the College of Science and Technology have created Bhutan's first-ever prototype of electronic Dzongkha Braille. The device developed by former college students

is called as Digital Dzongkha Braille Board. Initially, it was a college project, however, the innovation has evolved into a passion to help the visually impaired in reading and writing Dzongkha, according to *The Bhutan Live* report.

The group of young people - Mani Kumar Basnet, 24, Ugyen Tshering, 25, Sonam Wangmo, 24, and Garab Gyeltshen, 23 decided to have Digital Dzongkha Braille Board as a project for the final year of their bachelor's in electronic and communication engineering course at the College of Science and Technology. However, the college project turned into a passion. The aim of young people was fueled by the lack of accessible Dzongkha electronic Braille machines and the high price of Braille devices available in other nations. The device developed by young people features six buttons that enable users to effortlessly write Braille alphabets. The device converts the input into an audible sound or tactile pop-up that can be read by touch, providing multiple ways for the visually impaired to interact with the text.

The aim of the founders was to work on assistive technology to help those in need. They decided to help the visually impaired. While researching, they found that there are lots of devices to help the visually impaired, but they were also very expensive. Less than Nu 15,000 have been used to develop the prototype. The team has planned to further reduce the price to less than Nu 10,000 to make it accessible to more people.

The team is currently focused on writing, reading, and saving files. Saving happens over SD cards right now but eventually, it will be through cloud storage in the future. In the future, the team wants to design it so that it can interface with our mobile phones through Bluetooth or Wi-Fi connections.

<https://www.freepressjournal.in>

CHINA

AI-based satellite

China's Taiyuan Satellite Launch Centre launched the world's first in-orbit artificial intelligence (AI) commercial hypersatellite from waters off the coast of Yangjiang City in south China's Guangdong Province. A Smart Dragon-3 (SD-3) carrier rocket blasted off from the launch site, sending a group of nine satellites, including the AI commercial hypersatellite and a distant retrograde orbit (DRO) satellite, into planned orbit. In addition, the SD-03 sent the Egyptian NExSat-1 satellite into orbit this time as well, marking its first international payload launch.

Developed by Guoxing Aerospace Technology Co., Ltd. in Chengdu City of southwest China's Sichuan Province, the AI commercial hypersatellite, named "Rongpiao" or "Xingshidai-18," is a new integrated sensing network satellite equipped with the company's sixth generation "satellite brain" system.

The AI satellite is designed to carry out on-orbit verification of the synaesthesia fusion AI algorithm once entering the orbit and will have remote integrated platform capability for future communication networks.

<https://news.cgtn.com>

Superconducting quantum chip

The third-generation superconducting quantum computer, "Origin Wukong," was launched at Origin Quantum Computing Technology in Hefei. According to the news outlets, the "Origin Wukong" is powered by a 72-qubit superconducting quantum chip, known as the "Wukong chip." This development marks a new milestone in China's quantum computing journey as it's the most advanced programmable and deliverable superconducting quantum computer in China, as per a joint statement

from the Anhui Quantum Computing Engineering Research Centre and the Anhui Provincial Key Laboratory of Quantum Computing Chips, shared with the Global Times.

Superconducting quantum computers, such as the “Origin Wukong,” rely on an approach being investigated by several other quantum computer makers, including IBM and Google quantum devices.

The “Origin Wukong” is equipped with Origin Quantum’s third-generation quantum computing measurement and control system, according to the media. This system has enabled China’s first automated batch testing of quantum chips, significantly increasing the efficiency of quantum computing operations. “Wukong chip” comprises a total of 198 qubits, including 72 working qubits and 126 coupler qubits. As its name suggests, a coupler qubit is used to facilitate interactions between other qubits, sometimes referred to as working qubits.

<https://thequantuminsider.com>

INDIA

Robots for logistics

Addverb, a global robotics company based in India, revolutionizes intralogistics operations with advanced technology, combining in-house hardware and software for optimal automation efficiency. Their team focuses on innovation to lead in warehouse and supply chain solutions. With manufacturing capabilities, they offer flexible solutions across Robotics, AS/RS, Picking, and Software verticals.

Addverb’s participation in INDIA is not just a display of automation capabilities; it represents a commitment to contributing to India’s ongoing discussion on technological trends. It is entering the Indian market through this platform solidifies its dedication to the growing logistics sector.

Addverb Technologies is set to exhibit a range of innovative products that represent efficiency, precision, and advancements in the logistics and intralogistics sector. The Zippy family, including the highspeed robotic sorter Zippy, autonomously navigates using

grid markers and obstacle detection, handling various payloads and achieving up to 30,000 sorts per hour.

Veloce, Addverb’s Multi-Carton Picking Robot, offers adaptable storage solutions for cartons, crates, and totes, utilizing grid-based navigation for precise movement in narrow aisles and enabling efficient double-deep storage and recovery.

Quadron, the versatile carton shuttle, automates the storage and recovery of goods weighing up to 50 kg, enhancing productivity with double-deep storage, high output, and up to 25 units per aisle, reaching 20m in height.

The Dynamo family introduces the intelligent mobile robot Dynamo, navigating complex environments using LiDARs and SLAM algorithms. With a durable design sticking to safety standards, Dynamo supports material movement of up to 1500 kg, showcasing advanced AI capabilities.

Addverb’s Autonomous Forklift integrates SLAM navigation, dynamic pallet detection, and obstacle avoidance for efficient material handling. With a payload capacity of 1500 kg and variants offering up to 3000 mm lifting height, it provides flexibility and safety in logistics operations.

<https://themachinemaker.com>

AI-enabled smart energy management system

Tata Power has initiated a trial of an AI-enabled smart energy management system. In the pilot, they will be testing this system on 55,000 residential and 6,000 commercial and industrial consumers of Mumbai. As a part of this pilot project, when power-guzzling air conditioners are switched on in the coming days, Tata Power expects its ‘Demand Response Program’ to help its consumers optimize electricity demand. A message will be sent to these consumers, who are part of the pilot project, about the peak hour, probable market rate, and time when the peak hour might end. These consumers also include big office spaces, commercial complexes, and government agencies.

The customers can defer the use of AC and switch it off during the peak

hours and cool the room before the peak hour hits. By doing this, the load will come down. Also, it will be able to monitor these customers on how they optimized their use of electricity.

The company proposed to provide a one-time incentive of ₹25 and ₹1 per unit saved by all residential consumers who have participated in this pilot project. At present, Mumbai’s electricity demand is cruising at around 2,800-2,900 Mw, which is expected to increase in the coming days. This system would be helpful, especially with the rising temperatures and demand for electricity expected to go up. The power distributing companies of Mumbai have long-term power purchase agreements but still have to buy from the open market owing to the swelling demand.

In the initial period, Tata Power expects to prevent the use of 75 Mw in six months and aims to touch 200 Mw by the summer of 2025. During peak hours, the power distribution companies buy electricity from the open market. At present, the open market rate per unit of electricity is around ₹3-3.50 or so, which zooms upwards to even ₹6-8 per unit during summers. Incidentally, last year when there was a coal shortage all around the country, per unit cost in the open market had touched even ₹16-18.

<https://www.hindustantimes.com>

INDONESIA

Parcel sorting robots

PT Pos Indonesia has introduced robotic parcel sorting technology at its processing center in Surabaya, a port city on the island of Java, as part of its move toward full automation. The t-Sort system from Libiao Robotics has been integrated with Pos Indonesia’s existing IT system along with RFID parcel scanning software; to enable parcels and letters to be tracked from the moment they leave the sender until they arrive at the delivery address. “Everything is connected,” explained Faizal Rohmat, a director of Pos Indonesia. “This means we will be able to ensure the fast and safe parcel and letter delivery that our customers expect.”

The t-Sort system consists of sorting robots, an easy-to-assemble operating platform, and control software. Its modular design means it is quick and easy to relocate, so Pos Indonesia can reconfigure the sorting process with minimal disruption to the business. Robots can be added or removed in line with parcel volumes to ensure optimum throughput speeds and maximum energy efficiency. The switch from manual to automated parcel sorting at the Surabaya processing facility means Pos Indonesia has been able to reassign 80% of its staff to more profitable tasks within the business.

<https://www.parcelandpostaltechnologyinternational.com>

JAPAN

Digital technology for sustainable farming

Japan's dairy farming industry has been struggling in recent years. Demand for milk dropped during the pandemic, leading to concerns that huge volumes of milk would go to waste in 2021 and again in 2022. The rising prices of imported feed and soaring fuel and energy costs only added to the pressure on dairy farmers. A July 2023 survey by the Japan Dairy Council found that 85 percent of Japanese dairy farmers were operating at a loss, and roughly 60 percent of them were considering leaving the dairy farming industry.

In response to these challenges, both the government and the industry have implemented a range of initiatives; but as Shinya Kobayashi — president and CEO of Farmnote Holdings Inc. — points out, "It's vital that dairy farmers understand management practices and aim to enhance productivity." Kobayashi founded an IT startup in 2004 and learned of the difficulties dairy farmers face in keeping tabs on each individual dairy cow through conversations with a dairy farming client.

Aiming to help tackle these challenges, Kobayashi established Farmnote Holdings in 2013; and in 2014, the company launched a smartphone app for dairy and beef cattle farmers called Farmnote Cloud. The company then

introduced wearable sensors for cows called Farmnote Color. By attaching these devices to the cows' necks, the system enables 24-hour monitoring of their activities and heat cycles, signs of calving, and changes to their health. The system uses artificial intelligence to learn and analyze individual differences, allowing for remote cattle management — thereby helping dairy farmers to enhance productivity and utilize their time more effectively.

Increasing per-cow productivity leads not only to reduced water and energy use and the lowering of cattle stress levels, but it also enables greenhouse gas emissions reductions. By centrally managing a variety of data sets and automatically identifying individual cows requiring attention, our system can also make the work of dairy farmers easier.

In 2019, the Farmnote Group established Farmnote Dairy Platform Inc. and set up a farm in the town of Nishibetsu in Hokkaido. Through dairy-farming digital transformation initiatives based on systems they have developed in-house; they are working to create a framework that combines high profitability with sustainability.

The team has made significant progress with automation and mechanization — including installing cow-milking robots that enable up to 120 cows to be milked per day, and curtains and ventilation fans that operate in response to sunlight and temperature conditions. This reduction in human intervention also helps to alleviate stress among the cattle, and it is common to see the cows in the barn calmly resting and eating.

To enhance dairy-farming productivity, analyzing cows' genetics to increase the number of high-productivity cows is crucial. To achieve this, Farmnote conducts genetic testing and provides services such as Farmnote Gene — which presents test results in an easily understandable manner and provides guidance on the next steps to take, as well as a genetics service distributing frozen fertilized eggs nationwide. These wide-ranging services are all aimed at the core goal of providing dairy farmers with visualization tools and support for decision-making.

In addition, the company has begun developing solutions aimed at reducing dairy farming greenhouse gas emissions — including sensors that measure the emissions of each cow — and has also become the first in Japan's dairy industry to be registered in a carbon credit scheme (the J-Credit Scheme) for its slurry-processing method. In August 2023, Farmnote Holdings entered into a capital and business partnership with Meiji Holdings Co., Ltd. Leveraging both companies' expertise and technologies for gathering data on individual cows, they aim to work together to support dairy farmers in reducing their greenhouse gas emissions and help make the dairy-farming industry more sustainable.

<https://sustainablebrands.com>

Flood and traffic management

Hexagon's Safety, Infrastructure & Geospatial division and Fujitsu Limited announced the joint development of digital twin applications for predicting and mitigating natural disasters and traffic accidents. The solutions reflect the two companies' ongoing efforts to realize resilient, disaster-resistant cities based on an alliance formed in June 2022.

To support disaster mitigation, the two companies are developing a prediction model that calculates the extent and impact of flooding from precipitation data, visualizes the extent of flooding, and performs damage prediction analysis. Based on the analysis, cities can develop disaster response plans.

To support traffic safety, the companies have focused on an application that identifies areas where heavy traffic and road design heighten the risk of accidents and proposes measures for improvement. The application would allow city planners and road administrators to develop safer, more resilient transportation networks.

Going forward, Fujitsu and Hexagon will continue conducting field trials with customers in the administrative, municipal, and transportation sectors to support decision-making for urban environmental optimization, with an

aim to develop solutions globally by the end of fiscal 2023 ending March 2024.

Coordinating and visualizing data across multiple areas, including medicine, transportation, energy, and the environment is vital to protect people and social infrastructure from the various threats posed by natural disasters and other dangers in an increasingly unpredictable world. Leveraging Fujitsu's Computing as a Service (CaaS) platform, which offers users a powerful suite of easy-to-use services based on Fujitsu's advanced computing and software technologies, alongside Hexagon's M.App Enterprise real-time geospatial application, the two companies will use Fujitsu's 'digital rehearsal' technology to analyze and verify disaster threats and optimal disaster preparedness in advance on a digital twin that replicates real-world conditions with incredible detail.

The combined solution uses flood forecasting models and precipitation data to perform sophisticated calculations and visualize flooding, as well as to address challenges and use cases in the medical, financial, public, and distribution industries, such as infrastructure damage forecasting, formulation of disaster response plans, and estimation of damage amounts. In addition, it aims to secure safe evacuation routes and support infrastructure protection in the event of abnormal weather and natural disasters by leveraging weather IoT sensors and weather forecast services that monitor temperature and rainfall.

Through a combination of Hexagon's geospatial visualization tool M. App Enterprise and Fujitsu's infrastructure services, the companies have developed an application that visualizes areas with high levels of traffic accidents; analyses traffic volumes, road design, signs, and other factors; and provides recommendations for reducing traffic accidents in accordance with the Road Safety Toolkit of the International Road Assessment Program (IRAP).

For example, in a spot where traffic volume is low but accidents frequently occur, several improvement measures, such as speed control, installation of warning signs, and separation of traffic routes between pedestrians and vehicles by guardrails, are presented

together for a cost-effective solution. These proposals for city planners, road administrators, local governments, and consulting services contribute to the reduction of traffic accidents and the creation of safe and secure communities.

<https://www.fujitsu.com>

Quantum computing with qubits

For a quantum computer to work, it is necessary to establish and manipulate subtle quantum interactions among multiple qubits — a state known as entanglement. However, for this to work, the qubits themselves need to remain stable or "coherent", which means keeping them in a well-defined quantum state. The problem is, that coherence is difficult to maintain as it easily crumbles when qubits interact with their surroundings — even radiation from space can throw them.

To solve this, a team of Japanese researchers led by Nobuhiro Yanai, associate professor at Kyushu University, has engineered a stable qubit using a special structure called a metal-organic framework. This structure involves combining pentacene molecules (made up of five connected benzene rings) with zirconium ions and organic dicarboxylate ligands. The pentacene molecules act like bridges, linking the ligands and ions together into a framework made up of both organic molecules and metal ions—hence the name.

The role of the qubit was played by a pair of neighboring pentacene molecules, which were coupled and exist within five different quantum states achieved by irradiating the metal-organic framework with various wavelengths of microwave radiation. The metal-organic framework's nanoscale voids offer the pentacene molecules a degree of freedom but ultimately restrict their full movement under the radiation's influence, ensuring they form a desired quantum state and remain trapped in it for a significant amount of time. The metal-organic framework in this work is a unique system that can densely accumulate [pentacene molecules]," said Yanai in a press release. Additionally, the nanopores inside the crystal enable [them] to rotate, but at a very restrained angle."

The most important result of the study was that the team could maintain coherence for more than a hundred nanoseconds at room temperature, whereas previously this could only be achieved in similar systems at incredibly cold temperatures of about -200 degrees Celsius. At such temperatures, it was possible to maintain coherence only in photonic qubits, but in addition to needing such extreme conditions to operate, quantum computers using these photon qubits suffer from photon leakage.

Maintaining cryogenic temperatures is not only expensive but complicates the entire computing setup. Thus, creating a stable qubit that operates at room temperature is an impressive and practical achievement. Looking ahead, the scientists are optimistic about extending coherence for even longer periods. They believe that by designing improved metal-organic frameworks and identifying more suitable molecules for qubits, they can push the boundaries further.

THE REPUBLIC OF KOREA

AI-based phone interpreting

The Republic of Korea's top mobile carrier SK Telecom Co. has launched an artificial intelligence-based telephone interpreting service in real-time for the first time in the country. SK Telecom introduced the A. Call Translator for its subscribers using the iPhone series through the A. app, which allows users of Apple smartphones to record calls based on AI.

The interpretation service, which is currently available in Korean, English, Chinese, and Japanese, is activated when an SK Telecom customer makes a call on the A. app and presses the service icon at the bottom of the dial pad. The recipient does not need to be an SK Telecom subscriber nor use an iPhone or the A. app.

When a caller uses the service, the recipient will be informed that the call will be interpreted. The company aims to increase the number of languages available for the real-time interpreting service and extend it for users of Android smartphones such as the Sam-

sung Galaxy series. When a Korean speaker calls a hotel in the US for a reservation using the A. Call Translator, the AI-based service will interpret the hotel employee's English responses into Korean, for example.

The service will be useful to foreign residents in the Republic of Korea, SK Telecom said. Foreigners living in the country who cannot speak Korean will be able to access services at government offices or make reservations for hotels and call hospitals in their own language.

<https://www.kedglobal.com>

<https://www.advancedsciencenews.com>

SAUDI ARABIA

AI-powered eye care solution

A consortium, consisting Saudi Authority for Data and Artificial Intelligence (SDAIA), King Khalid Eye Specialist Hospital (KKESH), Lean Business Services, and Saudi Company for Artificial Intelligence (SCAI) announced the unveiling of "Eyenai," the first AI-powered ophthalmic solution developed locally by Saudi AI engineers and experts in the field. This groundbreaking advancement in the realm of medical diagnostics in the region represents a significant milestone in the field.

Eyenai is set to become Saudi Arabia's pioneering eye screening solution that harnesses the power of artificial intelligence to precisely detect and diagnose diabetic retinopathy. By leveraging advanced analytics and intelligent algorithms, the solution is designed to simplify and expedite the screening process, addressing the challenges posed by limited resources, time-consuming examinations, and high costs.

Commenting on this launch, Dr. Adi Alowaifeer, Consultant and Assistant Professor of Ophthalmology, Chairman of Eyenai Management Committee, said: "The launch of Eyenai embodies the spirit of ingenuity and cooperation that defines Saudi Arabia's healthcare ecosystem. This solution has the potential to revolutionize diabetic reti-

nopathy screening by making it more accessible, affordable, and accurate. Our collective mission is to safeguard the vision of countless people and improve the overall quality of healthcare in the Kingdom."

The launch of Eyenai marks a significant milestone in the journey towards enhancing the nation's healthcare landscape. By leveraging cutting-edge AI and computer vision technologies, the new solution is setting benchmarks for early detection and intervention in diabetic retinopathy. Eyenai screening stations are currently available in multiple locations in Riyadh to be expanded across the Kingdom shortly. To learn more about Eyenai and where to find it, visit www.eyenai.

<https://www.zawya.com>

SINGAPORE

Transportable WiFi for disaster relief

CommsBox Ultra provides instant connectivity to quickly re-establish communications for civil defense and aid agencies in Asia-Pacific. In response to escalating natural disasters impacting remote communities across the Asia-Pacific region, Kacific introduces the new and enhanced CommsBox – CommsBox Ultra, a game-changing advancement in disaster communication technology aimed at redefining emergency preparedness and response capabilities in high-risk areas. This introduction expands Kacific's range of disaster communication products, offering an enhanced version alongside the existing and trusted CommsBox.

Building upon the success of CommsBox, CommsBox Ultra emerges in response to invaluable feedback from communities in disaster-prone regions. CommsBox Ultra brings forth a suite of unique features designed to fortify disaster response efforts:

Crafted with durable materials and advanced engineering, CommsBox Ultra features a reinforced structure, ensuring resilience in disaster zones and physical impacts during transportation across challenging terrains.

CommsBox Ultra sets a new standard in adaptability with three innovative detachable modules, including the antenna module, the electrical component module, and a dedicated wheel component. This user-friendly design harmonizes efficiency and flexibility by simplifying transportation, equipment compartmentalization, and rapid access to components. The integration of the wheel component significantly improves portability, enabling effortless deployment and repositioning in dynamic disaster scenarios.

<https://www.scoop.co.nz>

Climate data centre for tropical climate

The Sustainable Tropical Data Centre Testbed (STDCT) – the first of its kind for the tropical environment – hosted by the National University of Singapore's College of Design and Engineering (NUS CDE) is up and running, marking a significant milestone in data center (DC) innovation in Singapore. The initiative, led by NUS and the Nanyang Technological University, Singapore (NTU Singapore), is funded by the National Research Foundation in line with the Research, Innovation, and Enterprise (RIE) 2025 plan to position Singapore as a leading center for green services and solutions to transform sustainable industries.

Bridging the gap between research and practical applications, this pioneering initiative brings together academia and industry partners to fast-track the adoption of innovative and sustainable DC cooling solutions tailored for the tropical climate. These collaborative efforts will set new sustainability standards for DC operations in the tropics.

The Sustainable Tropical Data Centre Testbed brings together researchers and companies to drive innovations in cooling technologies and improve the sustainability of data centers in the region. The STDCT programme, jointly led by NUS and NTU in close partnership with the industry, has been fostering a thriving ecosystem for innovative cooling ideas to flourish. The opening of the testbed facility today will accelerate the creation and translation of game-changing DC cooling technol-

ogies that are well-suited for tropical urban settings like Singapore, further advancing the sustainability efforts of the DC sector locally and beyond.

The STDCT is an infrastructure that supports a comprehensive research programme to develop cooling solutions for the sustainable operation of DCs in the tropics which was initiated in June 2021. Since the programme's inception, 20 industry collaborators have contributed state-of-the-art technologies and are actively engaged in technology co-development. The test-bed facility provides a platform for co-innovation, capitalizing on the synergy between academia and industry to generate important discoveries and transformative advancements that would benefit the tropical DC sector.

The STDCT stands as a flexible, full-scale live facility that combines cutting-edge research and real-world application. Occupying a floor area of 770 m², this is a living lab for scientists to experiment and validate innovative cooling ideas, and it also serves as a de-risking platform for companies to test and optimize new technologies in a realistic, tropical setting.

Ultimately, the STDCT programme aims to demonstrate the following outcomes in a tropical setting by mid-2024:

- Reduce energy consumption by up to 40 percent
- Reduce water usage by 30 to 40 percent
- Reduce carbon dioxide emissions by about 40 percent to less than 0.54 million tons per year

Achieve Power Usage Effectiveness (PUE) of less than 1.2 for a combination of air and liquid cooling (This is below the current requirement of 1.3 set by the Singapore government, and the global average of 1.5 in 2022.)

A whitepaper will also be developed to provide recommendations on optimum DC design and operations, and this is expected to be released in the fourth quarter of 2024. Liquid-cooled heat sink with air-cooled fin array to mitigate the risk of single-point failure associated with liquid cooling.

The STDCT will support five research projects.

Three projects will focus on the development of cutting-edge cooling technologies. A research team led by NUS is designing a unique heat sink coupled with immersion cooling for enhanced cooling performance. Another NUS team is pioneering the world's first direct chip hybrid cooling system, which consists of a high-performance hybrid sink design with two modes of cooling – air and liquid cooling. The third NUS team is validating the potential of a novel cooling solution that uses a high-performance hygroscopic material to significantly improve cooling efficiency.

In tandem, scientists from NTU are leading two research projects: one project aims to establish the optimum temperature and humidity setpoints for air-cooling of data centers in the tropics, and the second project will develop a digital replica, i.e., a digital twin, for multiple innovative cooling technologies of the testbed facility, to enable real-time performance modelling and prediction, and empower AI-based optimization toward energy efficiency and sustainability.

The STDCT programme not only addresses the immediate demand for sustainable DC operation practices in the tropics but also nurtures talents to prepare the industry for future growth.

<https://indiaeducationdiary.in/>

EUROPE

GERMANY

Digital infrastructure for ocean cleanup

CleanHub, a German company stopping plastic from entering our oceans, addresses the waste management gap in developing countries and the funding shortfalls for efficient waste infrastructure. Two billion people in coastal regions worldwide do not have access to proper waste management. It establishes waste management connections in coastal regions previously underserved and offers plastic credits to eco-conscious businesses in alignment with the growing consumer

demand for sustainable products and practices. In the process, this offers brands an opportunity to enhance their sustainability credentials and gain a competitive edge in the market.

With heightened scrutiny on greenwashing, brands are increasingly seeking transparency in their climate initiatives. CleanHub has developed a track and trace system, with each bag of waste weighed, photographed, and monitored through AI and manual checks, ensuring accountability. CleanHub became the first plastic credit system verified by TÜV SÜD under the ISO 14064-3 standard, adapted for plastic credit verification, setting a new benchmark for transparency and rigor within the plastic credit market.

Founded in 2020, CleanHub collaborates with partners to drive the circular economy, assuring the efficient collection, processing, and reintroduction of plastic waste. As recycling rates are expected to rise from 9% to 30% by 2030, the market for recycled material feedstock is projected to increase more than fivefold to \$170 billion during the same period. This growth emphasizes the sizable potential and importance of CleanHub's work in this sector.

<https://www.eu-startups.com>

AI-powered exoskeletons

Bavaria, Germany-based German Bionic, a robotics firm that develops and manufactures smart power suits and other wearable technologies. Their manufactured exoskeletons automatically apply self-learning and artificial intelligence to support lifting movements and prevent poor posture, thereby becoming an intelligent link between humans and machines.

The German Bionic smart power suits and wearables protect workers' health, reducing the risk of accidents and injuries, and improving work processes. Both the Apogee and the Apogee+, which were specially developed for the care sector, are the world's first AI-based, fully connected robotic wearables for the workplace. The Apogee+, which was launched last summer, provides active support for nursing staff in hospitals and care facilities when lifting and mobilizing patients.

In contrast to non-electrically powered passive exoskeletons with exposed mechanical components, the Apogee+ features a closed unibody design that is not only easy to disinfect but also ensures effective protection against the risk of injury. An ergonomic early warning system provides real-time data to protect employees' health, reduce accidents, and improve work processes.

The company said that it has secured €15M in an extension Series A round of funding. The funding round was led by German automotive supplier Mubea, with participation from existing investors Benhamou Global Ventures, Bayern Kapital, IT Farm, Kailua Ventures, Cumberland VC, and Family Office Klein. The German company says it will use the funds to scale up its market activities and production to meet the increasing demand from industry, logistics, and healthcare. German Bionic is benefiting from today's trend towards investing in occupational health and safety to ensure a resilient and motivated workforce of tomorrow.

<https://siliconcanals.com>

SWEDEN

Advanced vacuum system for waste management

As the world continues to evolve at a rapid pace, the area of automated waste collection is also undergoing significant advancements. Envac, a Swedish company is committed to driving progress towards a cleaner and more efficient waste management system. One of the considerable benefits of automated waste collection is its high degree of automation. With its advanced vacuum system, the technology significantly reduces the need for manual labor, makes the waste collection process more hygienic, and reduces its environmental impact. Apart from automation, it also profoundly impacts cleanliness and hygiene. Swiftly removing waste from public spaces minimizes the spread of diseases and promotes better hygiene. This is particularly important for hospitals where patients and staff need a safe and healthy environment. Additionally, it has the po-

tential to lower expenses while simultaneously enhancing productivity.

The Envac system only requires users to interact with the waste inlet, where they deposit their waste. The inlets are typically placed within 30 meters of residential or office buildings in a group, with separate inlets for each type of waste. Users sort their waste at home and dispose of it in the appropriate unit, making the sorting process simple and encouraging recycling.

Compared to traditional waste rooms or bins, the inlets are completely sealed, minimizing unpleasant smells, mess, and unsanitary conditions, as well as reducing the risk of vermin. The waste inlets are connected to an underground pipe network, and emptying occurs when the inlets are full, improving energy efficiency. The waste is transported through the pipe network using negative airflow that sucks the bags to a remote collection station at a speed of 70km/h. Emptying takes only a few minutes per waste stream.

Being underground makes the Envac system resilient to extreme weather events, and with smart automation, it remains reliable even during times of societal pressure. The waste collection station can be two kilometers, or further, from the central urban area, reducing the impact of heavy traffic, such as noise, air pollution, and traffic jams. All the waste streams are transported through a single pipe network, with each waste stream emptied separately and directed to the corresponding waste container at the collection station. The air used for transportation is cleaned through an industrial filter before it is released from the building.

When a container is full, a standard collection vehicle takes it away for processing, reducing heavy waste-related traffic and carbon emissions by up to 90% compared to traditional, multiple collections. This makes the Envac system key to achieving sustainable urban development goals and creating a greener planet. Digitalization has significantly impacted waste collection in recent years, allowing waste management companies to monitor their operations, leading to more efficient and cost-effective waste collection processes. For example, sensors are

installed in waste inlets to detect when they are full, enabling the system to be energy efficient.

The automated waste collection system has transported approximately 240,775 tons of waste so far. The system has improved urban planning and management by eliminating heavy-duty collection vehicles and bulky waste storage containers on the streets. From an environmental perspective, it has prevented approximately eight tons of carbon emissions annually, equivalent to 232 tons over the last 25 years. Additionally, it has eliminated 15 tons of nitrogen oxide and 58 tons of carbon monoxide over time.

<https://www.innovationnewsnetwork.com>

UNITED KINGDOM

AI-based Robo guide

This innovative AI-powered robot, equipped with four legs, is designed to advance the mobility requirements of visually impaired individuals in various public settings such as museums, shopping centers, and hospitals. Through cutting-edge technology, RoboGuide aims to provide newfound independence for those with visual impairments, enabling them to navigate these spaces with greater ease and confidence. To aid the 2.2 billion individuals globally, including two million in the UK, living with sight loss, the project is committed to launching an enhanced version of the technology in the foreseeable future.

In a similar project, engineers from Binghamton University's Computer Science Department in New York State developed a robotic seeing-eye dog to enhance accessibility for the visually impaired. Recently, they showcased a robot dog guiding a person down a lab hallway, responding adeptly to instructions.

Researchers at the University of Glasgow (UOG) claim that four-legged, two-legged, and wheeled robots often face a significant limitation in their ability to assist the visually impaired due to their navigation technology. While GPS-dependent robots excel

outdoors, they falter indoors, where signal strength diminishes. Conversely, camera-based robots rely on the line of sight, posing challenges in safely maneuvering around obstacles or corners. This discrepancy hinders their effectiveness as reliable guides for individuals with visual impairments.

The quest for a comprehensive solution continues, aiming to bridge these gaps and enhance the autonomy and safety of visually impaired individuals in diverse environments. Utilizing a network of advanced sensors integrated into its structure, the RoboGuide system adeptly surveys and evaluates its environment with precision. Developed software on Unitree Go1 quadruped enables the robot to acquire knowledge of optimal routes between destinations and interpret real-time sensor data to navigate dynamic obstacles effectively while assisting individuals.

Additionally, leveraging state-of-the-art large language model technology, the RoboGuide can comprehend user inquiries and comments, responding with verbal feedback accordingly, as per the team.

<https://interestingengineering.com>

Construction ready 3d-printer

A joint venture between Holcim and British International Investment (BII) looks to accelerate access to 3D construction printing from Africa to the world. 14Trees, a joint venture between Holcim and British International Investment (BII), the UK's development finance institution and impact investor, launched a new construction-ready 3D printer, the Iroko. The new machine, which externally looks very similar to other existing systems, looks to improve construction speed, cost, and flexibility – scaling up digital automation to build resilient and affordable housing, education infrastructure, and commercial real estate worldwide.

Iroko introduces performance advantages that enable multi-story construction and building with more reliability and mobility – opening up global access to state-of-the-art construction methods – no matter the terrain. The 14Trees printer is a robust solution to

maintain affordability and deliver on structural performance. This would enhance the sustainability and profitability of 3D printing for construction – a sector positioned for yield and growth.”

Co-designed and manufactured with PMSA, a leader in construction equipment, Iroko's mobility and optimized assembly are key tenets of the design by 14Trees. The printer's aluminum frame is quick to assemble and light yet robust – meaning it can be mounted without cranes, and stored in a compact container, making transportation and deployment rapid and efficient. The 14Trees printer specializes in single to two-story residential and commercial applications and does not need extensions to take smarter construction to the next level.

Iroko is equipped with a unique multi-laser system controlling the print quality 50 times per second to improve the overall performance of the end product and enhance operator safety. The new design is fitted with a material preparation and feed system, compatible with Holcim's ink, TectorPrint, and 14Trees' growing range of low-carbon inks, which lowers a building's carbon footprint by up to 70 percent compared to traditional processes.

The innovative approach reduces CO2 emissions typical to standard methods of cement production, contributing to the achievement of the United Nations' Sustainable Development Goals on Industry, Innovation, and Infrastructure (SDG 9) and Sustainable Cities and Communities (SDG 11).

<https://www.voxelmatters.com>

NORTH AMERICA

UNITED STATES OF AMERICA

AI that communicates with machines and the brain

Arnav Kapur, a Delhi-born student of Massachusetts Institute of Technology (MIT), developed a device that has the potential to change the relation between man and machine. 'AlterEgo',

as per MIT, is a non-invasive, wearable, peripheral neural interface that allows users to “converse in natural language with machines, artificial intelligence (AI) assistants, services, and other people without any voice—without opening their mouth, and without externally observable movements—simply by articulating words internally.

In a demonstration, it is displayed that the device is placed behind the ear of a person, and difficult questions such as “the largest city in Bulgaria and its population” are asked. In the blink of an eye, the answer came post a Google search which the person conducted via his brain, without using speech or typing it on a search bar.

According to MIT, the primary focus of this project is to help support communication for people with speech disorders, including conditions like ALS (amyotrophic lateral sclerosis) and MS (multiple sclerosis). Beyond that, the system has the potential to seamlessly integrate humans and computers—such that computing, the internet, and AI would weave into our daily life as a ‘second self’ and augment our cognition and abilities.

The wearable device records neural signals as and when a person hears or thinks of words. The information is then transmitted to machines and the internet to find answers/solutions to the information sent. Without using any speech, typing keywords, or any visible actions, the user can send and receive information discreetly. The system provides feedback through audio using bone conduction, creating a closed-loop interface. This gives the feeling of speaking internally to oneself during human-computer interaction, without interfering with the user's normal auditory experience.

The device is also capable of doing tasks such as ordering a pizza without using any app/phone. The idea behind the device is for a user to have the entire internet in their head—eventually becoming an expert on any subject. According to MIT, Arnav's work explores whether AI and computing could instead be woven into human experience as a direct extension of our cognition, rather than via external devices. In this way, computers would ex-

tend human ability multifold, instead of diminishing or replacing humans from our environment.

<https://www.forbesindia.com>

Machine learning-based test to detect ovarian cancer

Scientists have combined machine learning with information on blood metabolites to develop a new test able to detect ovarian cancer with 93 percent accuracy. For over three decades, a highly accurate early diagnostic test for ovarian cancer has eluded physicians. Ovarian cancer is often referred to as the silent killer because the disease is typically asymptomatic when it first arises — and is usually not detected until later stages of development when it is difficult to treat.

According to John McDonald, Professor in the School of Biological Sciences at Georgia Institute of Technology, US, the new test's accuracy is better in detecting ovarian cancer than existing tests for women clinically classified as normal, with a particular improvement in detecting early-stage ovarian disease in that cohort.

The new test, published in the online issue of the medical journal *Gynecologic Oncology*, uses a patient's individual metabolic profile to assign a more accurate probability of the presence or absence of the disease.

"This personalized, probabilistic approach to cancer diagnostics is more clinically informative and accurate than traditional binary (yes/no) tests," McDonald said. "It represents a promising new direction in the early detection of ovarian cancer, and perhaps other cancers as well." McDonald said that while the average five-year survival rate for late-stage ovarian cancer patients, even after treatment, is around 31 percent — but that if ovarian cancer is detected and treated early, the average five-year survival rate is more than 90 percent. "Clearly, there is a tremendous need for an accurate early diagnostic test for this insidious disease," McDonald said.

The researchers developed their integrative approach by combining metabolomic profiles and machine learning-based classifiers to establish a diagnostic test with 93 percent accuracy when tested on 564 women from Georgia, North Carolina, Philadelphia, and western Canada.

As many as 431 of the participants were active ovarian cancer patients, and the remaining 133 women in the study did not have the cancer. Further studies have been initiated to study the possibility that the test can detect very early-stage disease in women displaying no clinical symptoms, McDonald said.

<https://www.thestatesman.com>

AI for fraud detection

Mastercard has introduced a generative artificial intelligence (AI) solution to help prevent fraudulent transactions. The company has upgraded its Decision Intelligence solution to let it scan an unprecedented one trillion data points to predict whether a transaction is likely to be genuine or not. The tool, dubbed Decision Intelligence Pro, examines the relationships between the entities involved in a transaction to assess its risk, Mastercard said in the release. It arrives as banks are increasingly using AI to ferret out criminal activity.

In less than 50 milliseconds, this technology improves the overall DI score, sharpening the data provided to banks," the release said. "Initial modelling shows AI enhancements boost fraud detection rates on average by 20 percent and as high as 300 percent in some instances."

According to the release, the new version of AI will give banks greater ability to protect customers from fraud and help reduce false positives, or legitimate transactions incorrectly marked as fraudulent.

The precision of the solution — achieved by scanning potential points of sale in real-time — has been shown in our own analysis to not only increase accuracy but also reduce the number

of false positives by more than 85 percent," said Ajay Bhalla, president of Cyber and Intelligence at Mastercard.

<https://www.pymnts.com>

Humanoid robot

Agility Robotics has developed a new "RoboFab" manufacturing plant to produce digital humanoid robots. A 175-cm-tall (5-ft 9-in) tall bipedal robot weighing around 65 kg (141 lb.) can carry loads up to 16 kg (35 lb.) in a pair of claw-like gripper hands, and it charges itself autonomously to theoretically stay on duty for 16 hours out of 24 — the equivalent of covering two full-time shifts.

It runs a similar set of bird-like backward-looking legs to the company's Cassie robot, which broke the Guinness World Record for the fastest 100-meter sprint by a bipedal robot in 2022. Both have short upper legs that typically stay oriented forward in a knees-up stance, then long "calves" extending back behind the torso, and a high ankle joint where you'd normally expect to see a knee, leading down to smallish toe pads in contact with the ground.

The advantage is that Digit can fold its legs up behind it in a way that would cause loud noises from the average human. It can also squat down in front of shelves to grab boxes without its knees protruding forward, so it can pick them up with less of a need to lean forward. It is equipped with camera vision and LiDAR.

It can be controlled via a game-pad-style tablet (and e-stop shutdown initiator) and hard-coded with various tasks — mainly in the 'picking things up and putting them down' category. Interestingly though, in the last few months, Agility has been experimenting with using large language model (LLM) AIs, effectively to get Digit to program itself in response to natural language verbal commands, as shown in the video below.

<https://newatlas.com>

Digital Innovations for Sustainable Development in Asia and the Pacific

DIGITALIZING EDUCATION FOR SUSTAINABLE DEVELOPMENT

A Path to Equity, Inclusion and Life-Long Learning in Thailand

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Abstract

ASEAN countries have demonstrated a strong commitment to achieving Sustainable Development Goal 4 (SDG4) emphasizing quality education. To achieve this goal, technology plays a crucial role in helping ASEAN countries enhance quality education by promoting inclusive and high-quality learning opportunities. Despite its potential, digitalizing education faces several challenges that need to be addressed for successful outcomes. This article discusses the importance of digitalizing education in achieving sustainable development with a focus on the case study in Thailand. During the past 20 years, Thailand has strategically utilized technology to advance toward SDG 4, implementing various initiatives that showcase the country's commitment to leveraging digital solutions for educational development. In addition, several challenges and recommendations are addressed for improving the quality of education in Thailand through equitable access to technology and resources, investment in education, and collaboration among stakeholders.

Introduction

ASEAN countries have made progress in improving incomes, reducing poverty, and enhancing economic opportunities since 2000. However, challenges remain in achieving more inclusive and environmentally sustainable growth. Income inequality persists in several countries, emphasizing the need for comprehensive Sustainable Development Goals (SDG) strategies tailored to each country's context (IMF, 2018). Education plays a vital role in sustainable development, with educational attainment crucial for improving lives and health outcomes. Inequality in education can hinder progress towards SDGs related to gender equality, inclusive learning

opportunities, and equitable quality education (ESCAP, 2017). For instance, CLMV countries (Cambodia, Lao PDR, Myanmar, and Viet Nam) have the lowest higher education enrolment ratios in the region (ASEAN, 2022). In addition, in Thailand specifically, education inequality is a pressing issue. The country's education system has faced challenges as reflected in its rankings on international assessments like the Programme for International Student Assessment (PISA). Thailand's rankings have shown struggles over the years, indicating the need for improvements in the quality of education to address inequality effectively (PISA, 2022). Efforts to address these disparities include initiatives like the Roadmap on the Declaration on Digital Transformation adopted at the

ASEAN Summit, focusing on education, resource mobilization, and capacity building (ASEAN, 2022).

Technology is one of the most promising solutions to tackle education inequality in ASEAN countries, offering innovative strategies to overcome traditional limitations and promoting life-long learning. By harnessing the power of digital tools, ASEAN member States can amplify the accessibility, affordability, and effectiveness of education systems. The ASEAN Declaration on Strengthening Education for Out-of-School Children and Youth, established in response to the pandemic, highlights the commitment to developing digital initiatives to reach marginalized populations (ASEAN, 2007). For instance, the Roadmap on the Declaration encourages the sharing of resources, such as platforms, curriculum, and assessments, to facilitate the digital transformation of schools (ASEAN, 2007). In addition, EdTech companies, such as Ruangguru in Indonesia, exemplify the potential of technology to scale up quality instruction, offer personalized learning, and expand opportunities to practice, potentially leading to lifelong learning (EDTECH, 2022). However, it is crucial to consider other factors, such as the digital divide, the effectiveness of platforms, and instructors' competency in utilizing these technologies, to ensure that technology reaches underserved communities.

While there are numerous approaches for ASEAN countries to address education inequality, this article focuses on the case study of education inequality in Thailand and its use of technology to tackle this issue. Although initial results show promising outcomes, there are many challenges and recommendations that all parties, both from the public and private sectors, must consider

achieving the SDG 4 goal of equity, inclusion, and lifelong learning in Thailand.

Education inequity issues in ASEAN countries

Education inequity in ASEAN is a complex issue that stems from various factors: economic disparities, access to quality education, cultural norms, and government policies. Economic inequality plays a significant role in perpetuating learning inequality, as wealthier families can afford better educational resources and infrastructure, giving their children a distinct advantage over those from lower-income households (ADB, 2022). Generally, higher incomes and standards of living are correlated with higher educational attainment. This is also the case for ASEAN countries as shown in Figure 1 where countries with higher GDP

per capita yield higher average years in education. Disparities in access to educational infrastructure widen this economic gap, with rural and marginalized communities often lacking adequate schools and facilities compared to urban areas (ADB, 2022). Additionally, schools in rural areas often struggle with a lack of well-trained teachers and up-to-date educational resources, leading to lower learning outcomes than in urban areas.

Cultural norms and attitudes towards education also contribute to learning inequality in ASEAN. In some cultures, there may be a preference for boys' education over girls', leading to disparities in educational opportunities (UNICEF, 2018). Traditional beliefs about education's role and valued skills can also impact outcomes. For instance, an emphasis on rote memorization and examinations may hinder critical thinking and problem-solving skills needed for the modern economy.

Government policies and education systems also play a significant role in shaping learning quality in ASEAN. While many ASEAN countries have made efforts to improve educational access and quality, there are still gaps in policy implementation and resource allocation. Insufficient funding for education can lead to overcrowded classrooms, inadequate teaching materials, and a lack of teacher training, all of which can contribute to learning inequality (World Bank, 2017). Additionally, rigid education systems that do not cater to diverse learning needs can further exacerbate disparities in educational outcomes (C. Faikhamta, J. Ketsing, A. Tanak, and S. Chamrat, 2018).

One particular group that faces significant challenges in accessing quality education in ASEAN is people with disabilities. They often encounter physical accessibility challenges, discriminatory

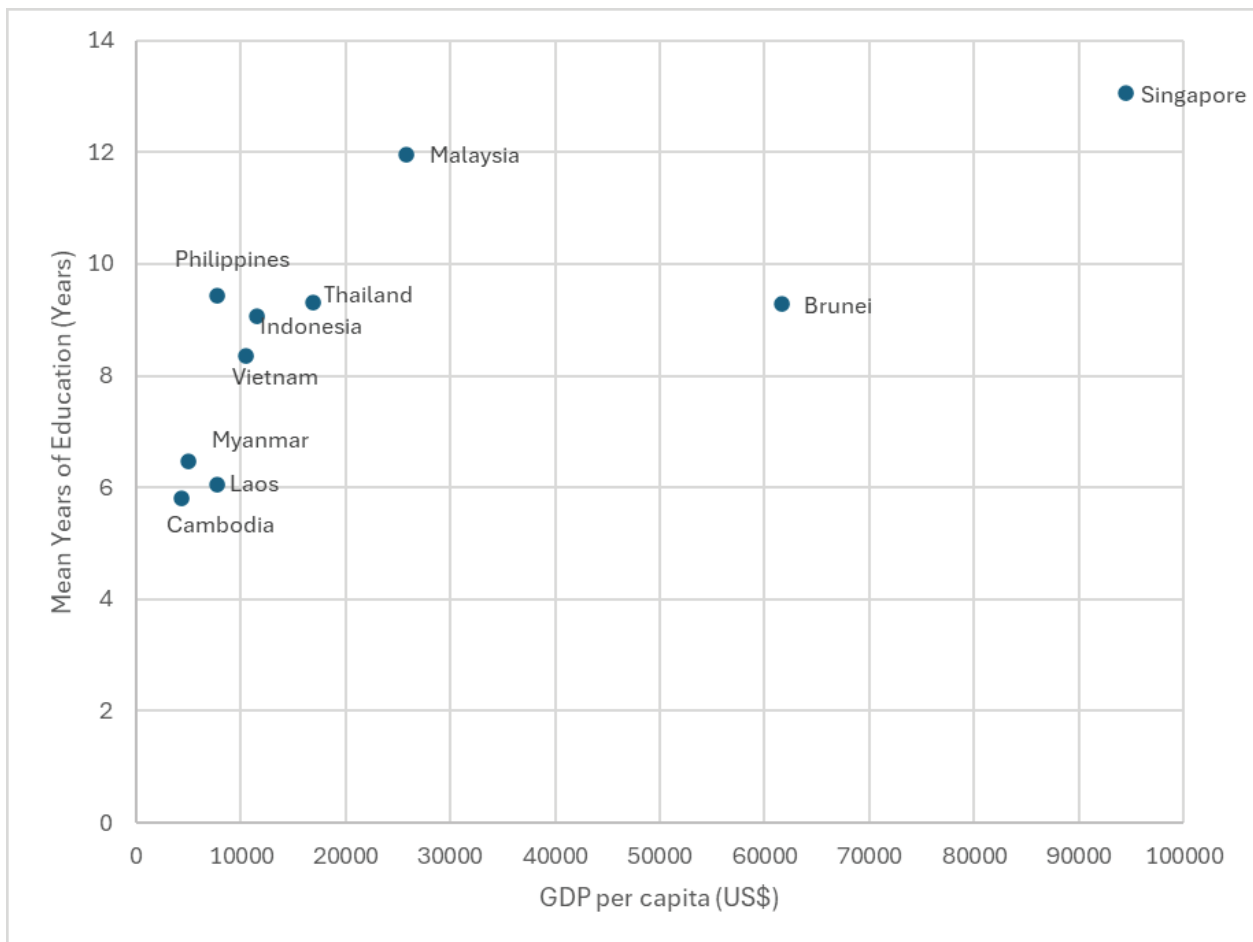


Figure 1: GDP per capita and mean years of education in ASEAN countries.

(Source: OurWorldInData, 2020)

attitudes, and a lack of specialized resources and support. Addressing the needs of people with disabilities requires a comprehensive approach that includes improving physical accessibility, providing specialized support services, and promoting inclusive educational practices (ESCAP, 2017).

Digitalizing education: A case study of Thailand

Digitalizing education, also known as digital transformation in education, involves integrating digital technologies into the education sector to enhance teaching and learning methods, broaden access to education, improve the quality of education processes and delivery, and ultimately foster better learning outcomes (UNESCO, 2021). This section explores Thailand's efforts in advancing digital education initiatives to ensure inclusive and equitable quality education, while also promoting lifelong learning opportunities for all.

a. Policies and roadmap

Education in Thailand is provided by the Thai government with the aim of expanding educational opportunities for all citizens, encompassing formal, non-formal, and informal education. Access to at least 12 years of quality basic education is provided for free, with nine years being compulsory, ensuring the enrolment of all children up to the lower secondary level. The Ministry of Education (MOE) is the primary government body responsible for promoting and overseeing basic education at all levels. Conversely, the Ministry of Higher Education, Science, Research, and Innovation (MHESI) plays a key role in managing, administering, and providing higher education.

Over the past few decades, Information and Communications Technology (ICT) and digital technologies have been recognized as potential enablers for enhancing the efficiency of education provision, increasing access to education for learners of all ages, reducing gaps, and promoting equality throughout the education system. These technologies can boost literacy rates through

mobile technology-based literacy programmes, enhance quality through suitable pedagogical approaches, and facilitate lifelong learning for all through technology-supported non-formal and informal learning.

Thailand has made significant initiatives and achievements in integrating ICT and digital technologies into national policies and practices. The country has promoted the adoption of ICT in education and has actively enhanced the technological skills of teachers and students over the past two decades. The government initially introduced the National IT Policy (IT2000) in 1996 and the IT2010 Policy in 2001 to further advance Thailand into a knowledge-based society. The use of ICT in distance education was explicitly included in the National Education Act A.D. 1999 to enable access for all citizens, regardless of age, profession, distance, or geography, for continuous education and skills upgrading.

The recent 20-Year National Strategy (2018-2037), the National Scheme of Education (2017-2036), as well as the MOE Digital Transformation Roadmap 2023-2027, have affirmed that transforming and digitalizing education is one of the country's priorities. The government has committed to achieving the UN's SDG 4 under the supervision of the MOE and relevant agencies.

b. Implementation

This section highlights key priorities and implementations aimed at digitalizing education in Thailand.

Digital Connectivity for All

School and campus network access: UniNet (Inter-University Network) and the National Education Network (NEd-Net) are nationwide networks for education and research connectivity, covering all primary and secondary schools, vocational and higher education institutes, libraries, and offices under the MOE/MHESI, as well as other international research networks worldwide. In 2022, the network reached over 10,000 schools or institutes throughout Thailand (UniNet, 2022).

Internet accessibility in rural and remote areas: To bridge the digital divide, Universal Service Obligation

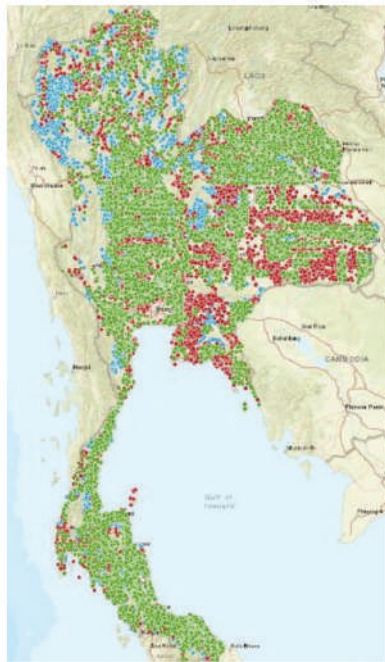
(USO) NET Centers have been established since 2005. These centers aim to promote accessibility and the use of telecommunication and internet services in rural areas throughout the country through cooperation between the National Broadcasting and Telecommunication Commission (NBTC) and the International Telecommunication Union (ITU). By 2016, there were over 900 USO Net Centers established, also serving as school and community internet centers. Rural children can freely use the internet and computing services available in these centers to develop their ICT literacy and learn the fundamental use of technology.

In 2017, the Village Broadband Internet (Net Pracharat) project was launched under the Ministry of Digital Economy and Society (MDES) to expand high-speed broadband internet networks to every village in rural and border areas of Thailand, targeting a total of 24,700 villages. Each village was equipped with a Wi-Fi hotspot offering speeds of 30/10 Mbps (Download/Upload), available in public places such as community centers, village headman offices, temples, schools, or hospitals for convenient access by villagers (APT, 2019). The Wi-Fi speed was later upgraded to 100/50 Mbps. In 2021 (MDES, 2021), reports indicated that the government's nationwide high-speed Internet connectivity had expanded to cover nearly 75,000 villages, encompassing nearly 9.5 million people across the country, as illustrated in Figure 2.

Internet users and ICT accessibility by households: Figure 3 illustrates the increasing trend of Internet users in Thailand over the past decade. With a total population of 65.86 million (considering only Thai citizens aged over 6 years old), Thailand had 58.97 million Internet users in 2023, representing a growth rate of approximately 39.31% over the past five years and an Internet penetration rate of 89.54% as of 2023. A similar trend is observed for the proportion of households with Internet access, which reached 90.95% in 2023.

Interestingly, prior to COVID-19 (2014-2018), the proportion of households with a computer showed a declining trend. However, during and after COVID-19, the trend shifted upwards,

Net Pracharat Project: Village Internet Broadband



- **MDES** 24,700 villages (completed Dec 2017)
- **NBTC** 15,732 villages
- **NBTC** 3,920 villages
- **Urban Area** 30,635 villages

● **Open Access Network**
Local operators provide connecting services to household

Speed 100/50 Mbps (Download/Upload)

Total: 74,987 villages
9,493,312 registered users
11,361,367 devices

Figure 2: Net Pracharat Project: Coverage of high-speed broadband internet networks to every village in rural and border areas of Thailand as of January 2021.

(Source: <https://www.mdes.go.th/mission/detail/416>)

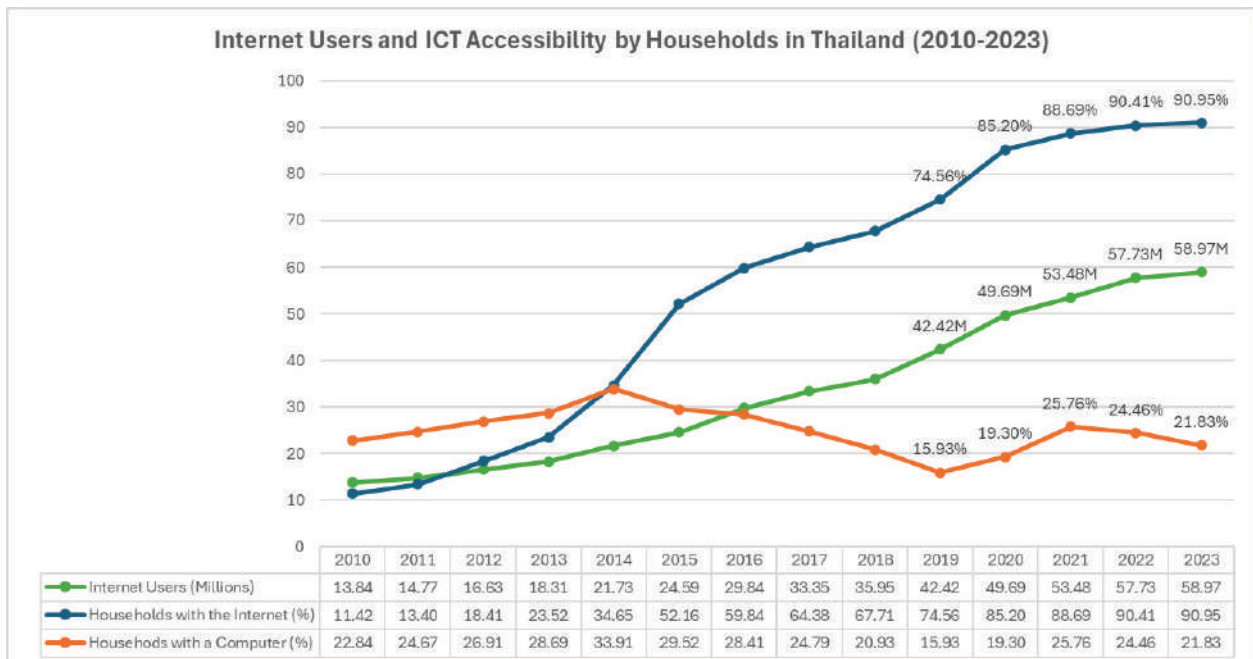


Figure 3: Internet users and ICT accessibility by households, author generated chart.

(Source: Internet User Survey and Household Survey on the Use of ICT (NSO, 2024))

reaching 25.76% in 2021, before decreasing again in 2022 and 2023. By the end of 2023, the percentage of households with a computer was approximately 21.83%. Nonetheless, according to the NSO (2021) ICT Indicator Survey, Internet activities related to learning purposes accounted for only 10.5% of all activities.

Open digital learning platforms and open educational resources

A Digital Learning Platform is a comprehensive set of resources, tools, and interactive online services designed for teachers, learners, and others involved in education. Its purpose is to support and enhance educational delivery and management. In contrast, Open Educational Resources (OERs) are materials utilized for learning, teaching, and research, accessible in various formats and mediums. Typically, these resources are either in the public domain or are made available under an open license, permitting free access, reuse, repurposing, adaptation, and redistribution by educators and learners.

Recognizing the significance of digital learning platforms and OERs in improving teaching and learning activities, the government has initiated several related projects. Below are some of the available public Digital Learning and OER platforms.

1. *OBEC Content Centre*¹ maintains open educational resources covering learning materials of 8 core subject areas of basic education, suitable for students, teachers, and the public. The platform is developed and provided by the Office of the Basic Education Commission (OBEC), MOE, and hosts a digital ecosystem that comprises the following 5 key components: Authoring Tools, Content Centre, Content Verification system, Content Management System, and Local Content Server.
2. *Digital Learning Centre*², developed by the Office of Private Education Commission (OPEC), is an online learning portal that collects and shares instructional resources, and tutorial video clips of key subjects in basic education. The portal focuses on compiling and categorizing such digital resources published by other platforms and available nationwide during the COVID-19 pandemic.
3. *IPST Learning Space*³ is a national digital learning center for learning mathematics, science, and technology, developed by the Institute for the Promotion of Teaching Science and Technology (IPST), MOE. The platform consists of a *Teacher Professional Development System*⁴, *Online Testing System*⁵, and *SciMath Knowledge System*⁶ which archives digital learning resources developed by IPST.
4. *Project14*⁷ and *Project14+*⁸, recently initiated and developed by IPST in 2021, are public platform that allows students to freely learn online courses, comprising quality assured video lectures of STEM subjects in all levels of basic education from primary level to secondary level. The published online courses have been developed in accordance with the country's Basic Education Core Curriculum 2008 (Revised 2017). The platform does not only encourage students to independently learn, practice, and review the content based on their interests and potentials, but it also enables teachers to apply it as part of the blended learning or flipped learning approach.
5. *Thai Open Educational Resources (Thai OER)*⁹, initiated in 2015, is a project which encourages teachers, learners, educators, and academic institutions to collaboratively produce and share high-quality educational resources under the open license concept. The platform has over 70,000 OERs free of charge and services growing the number of users up to 2.0 million users.
6. *ThaiMOOC*¹⁰, established in 2017, is a national platform that promotes lifelong learning by providing free, high-quality online courses for any Thai citizen by means of Massive Open Online Courses (MOOCs). The platform has been developed under the Thailand Cyber University Project, MHESI. According to the 2023 statistics, ThaiMOOC had over 630 MOOCs available, developed by 104 higher education institutes and serving more than 1.5 million registered users.
7. *LearnBig*¹¹, developed by UNESCO Bangkok's initiative, is a public digital platform developed to enhance the basic reading, numeracy, and literacy skills of unreached and out-of-school children. It offers over 700 open e-books, teacher's guides, exercises, and multimedia content in Thai and Myanmar languages, supported by over 20 organizations.

1 <https://contentcenter.obec.go.th>

2 <https://odlc.opec.go.th>

3 <https://learningspace.ipst.ac.th>

4 <http://teacherpd.ipst.ac.th>

5 <https://onlinetesting.ipst.ac.th>

6 <https://www.scimath.org>

7 <https://proj14.ipst.ac.th>

8 <https://project14plus.ipst.ac.th>

9 <https://oer.learn.in.th>

10 <https://thaimooc.org>

11 <https://www.learnbig.net>

Table 1: Publicly available digital educational platforms and OERs (in Thai Language).

Digital Educational Platform	Available Resources													
	Platform Provider	Education Level & Purpose				Subject					Type			
		Basic Education	Higher Education	Teacher Professional Development	Non-formal Education & Lifelong learning	STEM	English	Social Science	Health	Other Subjects	Learning Objects	Exercises/Quizzes	E-books	Others
OBEC Content Centre	OBEC/MOE	✓				✓	✓	✓	✓	✓		✓	✓	
Digital Learning Centre	OPEC/MOE	✓												✓
IPST Teacher PD System	IPST/MOE			✓		✓					✓		✓	✓
IPST Online Testing System	IPSTMOE	✓				✓					✓			
IPST SciMath Knowledge System	IPST/MOE	✓		✓		✓							✓	
Project14 and Project14+	IPST/MOE	✓				✓					✓			
Thai Open Educational Resources (Thai OER)	MHESI/MOE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ThaiMOOC	TCU/MHESI		✓		✓					✓	✓	✓		
LearnBig	UNESCO	✓				✓	✓	✓	✓	✓			✓	
Thailand Learning	NGO	✓	✓			✓	✓	✓	✓	✓				✓
True Plook Panya	Private	✓				✓	✓	✓	✓	✓	✓	✓		
Khan Academy Thai	Private	✓				✓					✓			

8. *Thailand Learning*¹² is a Web portal compiling existing online learning and cultural resources as well as educational tools useful for children to learn and explore?
9. *True Plook Panya*¹³ is a public digital knowledge hub initiated and

supported by True Corporation, a telecommunication service provider in Thailand. The platform offers diverse learning content and tools appropriate for students at all levels of basic education in various formats, such as tutorial

video clips of popular teachers and/or tutors, interactive lessons, quizzes, and test papers of past years.

10. *Khan Academy Thai*¹⁴ publishes video lessons in the Thai language instructing important mathemat-

12 www.thailandlearning.org

13 <https://www.trueplookpanya.com>

14 <https://th.khanacademy.org>

ics topics at primary and secondary levels.

11. *Coding Colosseum Platform*¹⁵: a gamified coding arena for learning to program online.

Table 1 presents various educational resource platforms categorized by several dimensions, including their providers, education levels and purposes, subjects, and types.

Remark: Platform Provider indicates the organization and/or ministry supporting and hosting the platform, as well as providing the learning resources. It is important to note that the table primarily focuses on platforms supported by government offices, with a few examples provided by the private sector and other types of organizations. Education Level & Purpose defines the specific education levels and purposes of the available resources, categorized into four broad categories: (i) Basic Education Resources, which support student learning in basic education, (ii) Higher Education Resources, which assist learners in higher education, (iii) Professional Development Resources, which aim to professionally develop teachers in various dimensions such as improving effective instructions, administration, and career guidance, and (iv) Non-formal Education & Lifelong Learning Resources, which support non-formal education and promote lifelong learning for the general public. Subject categorizes the subject knowledge of the available resources. Type refers to the content type of the resources. This can include: (i) Learning Objects, which are resources such as video clips designed to meet course learning outcomes and can support a wide range of learning activities, (ii) Exercises/Quizzes, used for testing student understanding, (iii) E-books, and (iv) Others, such as simulations, demonstrations, and tutorial video clips.

Teacher support and capacity development for technology-enabled teaching

Ensuring the successful digitalization of education and advancing the country's development in the digital era hinges on the capacity development of teachers in digital skills. Teachers must be proficient in utilizing ICT and digital tools to design educational materials, deliver instructions through digital platforms, and effectively monitor and assess student learning outcomes.

To address this need, numerous capacity development programs have been established and launched, both online and offline. These initiatives are not solely driven by the Ministry of Education and relevant agencies but also involve collaborations through public-private partnerships. Examples of such programs include EDUCATORS THAILAND¹⁶, Class for Super Teachers¹⁷, and the DEPA Teacher Boost Camp¹⁸.

Furthermore, the formation of a Professional Learning Community (PLC), akin to the concept of a Community of Practice (CoP) in the education sector, encourages teachers from all disciplines to share their expertise and collaborate to enhance teaching and learning processes.

ICT and digital literacy education

With reference to the Basic Education Core Curriculum 2008 (MOE, 2008), Thailand by the Institute for the Promotion of Teaching Science and Technology (IPST), has redefined IT skills from being specialized to foundational since 2017. Thus, Computing knowledge and skills have been integrated into the Science learning area rather than the Occupations and Technology learning area. This has been reflected in the Revised Edition 2017 of the Learning Standards and Indicators (IPST, 2017), where the Computing Science subject consists of three main strands:

Digital Literacy (DL), Information and Communication Technology (ICT), and Computer Science (CS). DL covers safe, respectful, and ethical ways to use technology. ICT focuses on using computers and applications as tools to create, organize, analyze, and visualize data to support decision-making. CS emphasizes computational thinking, teaching students to solve problems using logic and algorithms. The implementation of the revised curriculum took 3 years of roll-out plan. In the academic year 2018, the curriculum was applied for Grade 1st and Grade 4th, then applied for Grade 2nd and Grade 5th in 2019, and since the academic year 2020, the curriculum has been applied for all grades.

c. Challenges and way forward

As previously discussed, Thailand has implemented various significant initiatives to drive digital transformation in its education sector. These efforts include formulating national policies, strategies, and action plans, providing accessible ICT infrastructure, offering open digital learning platforms and content, supporting and developing teachers' capacities, and launching updated ICT and digital literacy curricula as part of basic education. These drivers have contributed to achieving SDG 4 by providing inclusive, equitable, and quality education, improving the capacities of the education system and teachers, applying technology in the education sector, and ensuring lifelong learning. However, the country still faces several obstacles that must be effectively addressed for the impact of these initiatives to be fully realized.

Digital divide

The digital divide refers to the gap between those who have access to digital technologies and those who do not or have limited access. In the context of education, this divide can significantly impact inequality. Students without

15 <https://thecodingcolosseum.com>

16 <https://www.aisacademy.com/theeducatorsthailand>

17 https://www.depa.or.th/en/article-view/20200817_02

18 <https://www.depateacher-boostcamp.com>

or with limited access to digital resources such as computers and the Internet face challenges in accessing educational materials, completing assignments, and communicating with teachers and peers. This can lead to a lack of engagement, falling behind in coursework, and ultimately, lower academic achievement. In addition, as education increasingly relies on digital tools for learning, the digital divide exacerbates existing inequalities. Students from lower-income families or marginalized communities are more likely to lack access to digital devices and reliable internet connections, putting them at a disadvantage compared to their more affluent peers. This inequality in access to digital resources can perpetuate socio-economic disparities, limiting opportunities for those already marginalized. In Thailand, the digital divide poses a significant challenge, impacting access to reliable broadband internet, computing devices, and quality education resources in schools. Although most schools have optical fiber Internet, a staggering 29% still rely on low-end computing devices and slower and less reliable Internet connections such as ADSL, 3G, and satellite (UNESCO, 2023). Furthermore, there is a significant variation in the student-to-computer ratio across regions, underscoring the urgent need for policies that prioritize the equitable distribution of educational resources and technology access nationwide. Closing the digital divide is essential for ensuring equitable access to education and reducing educational inequality.

Lack of teacher competency in teaching ICT and computing subjects

During the implementation of the revised computing curriculum, Thailand has faced significant challenges in three areas: teachers, students, and the learning environment (Katchapakirin and Anutariya, 2019). Teachers have limited fundamental knowledge and lack confidence in teaching computational thinking (CT) in the classroom. Challenges related to students include differentiation, limited computing literacy skills, low mathematics knowledge, lack of understanding of the topics, and limited problem-solving skills.

Challenges related to the learning environment include insufficient time in the curriculum and a lack of materials. To address these challenges, teacher training programs, the development of open educational resources, and the organization of extracurricular activities for students have been prioritized.

Lack of child online protection

Another crucial challenge that Thailand encountered when adopting digitalization education is the lack of child online protection. The recently published *Disrupting Harm in Thailand* (UNICEF, 2022) report pinpoints the need for a comprehensive approach to creating a safe online environment for children in Thailand. Despite several efforts from the public sector, Thailand faces several child online protection challenges. One major issue is the prevalence of inappropriate content online, including pornography and violent material, which children can easily access. Additionally, cyberbullying is a growing concern, with children being targeted on social media platforms. Another challenge is the lack of awareness and education among parents, teachers, and children about online safety practices. Furthermore, the enforcement of existing laws and regulations related to child online protection is often inadequate, leading to gaps in protection. Limited resources and capacity also hinder the government's ability to address these issues effectively. For instance, serious instances of online sexual exploitation and abuse affected 9% of internet-active children aged 12-17 (UNICEF, 2024). While numerous private sector and non-governmental efforts are ongoing to address this issue, there is still much work to be implemented to ensure that Thai children are adequately protected from online harm. It is crucial to have policies and initiatives that increase public awareness about safe and responsible Internet use, especially among children and youth.

Low performance in international assessments

Despite significant efforts and investments from both the public and private sectors to enhance education, Thailand

is still grappling with the persistent challenge of the achievement gap and lower performance in international assessments such as the Programme for International Student Assessment (PISA). The PISA scores, which measure literacy and competencies in real-life situations, have shown a decline in Thai students' performance in reading, mathematics, and science over the past two decades. Despite some improvement in access to primary education, there are still serious concerns regarding the quality and equity of education across the country. The trend of Thailand's PISA scores reflects these challenges, showing relatively low performance in reading, mathematics, and science over the years (UNESCO, 2023) compared to the average OECD score from other 23 countries as shown in Figure 4. This can be attributed to disparities in educational resources and opportunities between urban and rural areas, inadequate teacher training and support, and a curriculum that fails to adequately prepare students for the demands of the modern economy. Possible approaches to address these challenges include comprehensive education reform to improve the quality of teaching and learning, enhancing the relevance of the curriculum, and ensuring equitable access to education for all students in Thailand.

Decreasing investment

The Thai education system is facing a significant challenge due to the decreasing investment in education from 2010 to 2024 as shown in Figure 5. Despite the growth in total budget spending in Thailand, the percentage of the budget allocated to education has been decreasing, with a noticeable decline in recent years. This trend is concerning as it may impact the quality of education and restrict access to education for the Thai population especially those from lower socio-economic backgrounds. It is important to maintain equitable financing in education at every level to promote access to technology and ensure that all students have the necessary resources for a quality education.

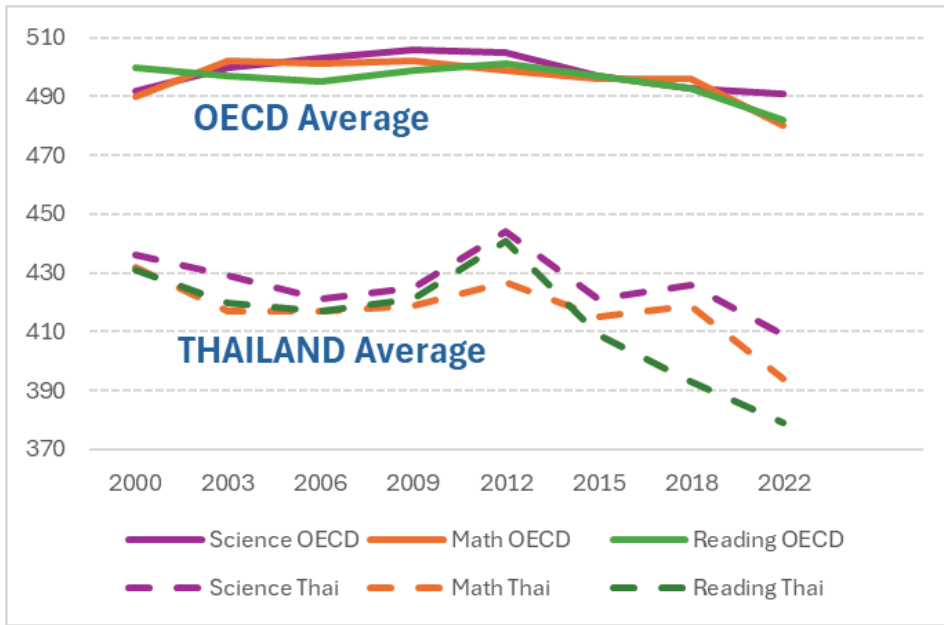


Figure 4: Trends of PISA performance in mathematics, reading, and science in Thailand

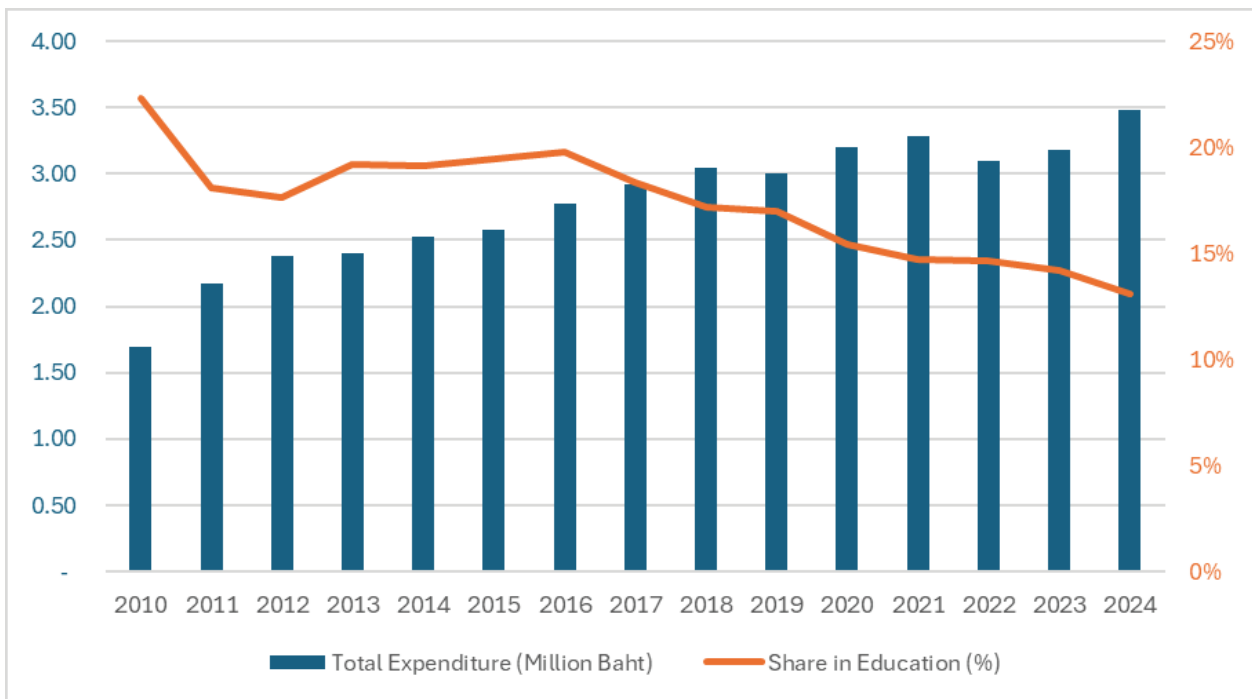


Figure 5: Comparison of the trend of budget spending in Thailand and the percentage of the budget allocated to education (Source: Budget Bureau 2010-2024).

d. Lessons learned & recommendations

According to the World Bank’s teacher demand model, given the current distribution and size of schools, Thailand would need to recruit, train, and deploy

around 65,400 additional instructors (a 13.8% increase in the teaching force) to sufficiently manage all classes in the schools (World Bank, 2023). This is economically almost impossible to achieve given Thailand’s economic situation after COVID-19. However, the World Bank model recommends

that a better and more cost-efficient approach is to drastically downsize the vast network of schools to ensure that teachers and other educational resources are equitably distributed to improve both the quality and equity of the system. The report suggests that the proposed merger of most primary

schools would yield more than 15% surplus teachers, and could potentially be expected to reduce per-student spending at the primary level by as much as 11.2%. This reorganization process could be gradually implemented without the need for any teachers to be laid off.

To address access and infrastructure challenges, investments in infrastructure are crucial, especially in rural areas, to expand Internet access and provide affordable devices to bridge the digital divide. In addition, introducing public-private partnerships in the education sector in Thailand could have significant positive impacts on mitigating education inequality. These partnerships, potentially with several EdTech firms, tailored to Thailand's social and economic context, have the potential to address challenges such as the basic quality of education, gender gaps, regional disparities in college access, and socioeconomic distribution of education. By leveraging private sector expertise and resources, Thailand can enhance access to quality schooling for marginalized groups and improve education outcomes, especially for disadvantaged students. Public-private cooperation could help bridge the gap between public and private schools, ensuring equitable access to quality education for all students regardless of their socio-economic background.

Conclusion

Digitalizing education, aligned with SDG4, has the potential to significantly impact lifelong learning and sustainable development in ASEAN countries. Initiatives such as providing digital connectivity and infrastructure to learning platforms and online educational resources can ensure that all learners, regardless of their background, have equal access to quality education. Embracing digital technology can create inclusive, accessible, and innovative learning environments, empowering individuals to realize their potential and contribute to society. However, realizing the full benefits of digital education requires collaborative efforts from governments, policymakers, educators, and businesses, possibly through public-private partnerships and civil

society organizations. Through such collective action and strategic investments, the ASEAN region can leverage digital education's transformative power to create a more equitable and sustainable future for everyone.

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RESPONSIBLE ARTIFICIAL INTELLIGENCE FOR SUSTAINABLE DEVELOPMENT

Evidences from Asia-Pacific cities

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Abstract:

Artificial intelligence (AI) technologies demonstrated significant potential in the public sector both nationally and locally, addressing multiple urban challenges for sustainable development in cities. However, acknowledging and mitigating inherent technological challenges is critical. This paper explores how the “responsible” adoption, implementation, and governance of AI in cities address the risks and challenges of AI across various application areas, such as healthcare, public services, public safety, social welfare, transportation, environment, education, energy, and tourism. It examines how these AI applications contribute to urban sustainability and their role in achieving the Sustainable Development Goals (SDGs). Based on the study of thirty cases from the Asia-Pacific region, the findings reveal diverse AI landscapes, presenting advantages and challenges. The results will be illustrated using the example of the Philippines’ KIRA Chatbot and Data Management Platform. Insights gleaned contribute to enhancing effective and ethical implementation, and fostering urban sustainability. The paper proposes key considerations and policies for responsible AI adoption in cities, offering actionable strategies for aligning AI initiatives with the SDGs.

Keywords: Artificial intelligence, Smart Cities, Sustainability, Asia Pacific, Philippines, Sustainable Development Goals

Introduction

Many cities worldwide face acute challenges in managing rapid urbanization, from ensuring adequate housing and infrastructure to support growing populations to confronting the environmental impact of urban sprawl and reducing vulnerability to disasters. The need for sustainable and inclusive urban development has never been more pressing. The aftermath of the global pandemic has accentuated socioeconomic inequalities, emphasizing the urgency for innovative solutions to build resilient and equitable urban environments. The United Nations’ Sustainable Development Goals (SDGs), particularly Goal 11, focus on inclusive, safe, resilient, and sustainable cities, and stand as a comprehensive frame-

work to guide cities toward a more sustainable future.

Artificial Intelligence (AI), an emerging technology with the capacity to exhibit intelligent behaviors and accomplish tasks traditionally associated with human intelligence (Misuraca & van Noordt, 2020), emerges as a transformative force capable of navigating the intricacies of urban challenges. Projections indicate that by 2025, AI will power over 30% of urban applications, presenting a significant opportunity to enhance resilience and sustainability globally. However, the adoption of AI in cities is not without its challenges. Concerns about algorithmic bias or the phenomenon when a technology

unintentionally reflects the prejudices that exist in society leading to unfair or discriminating behavior against certain groups (Baker, Hawn, & Lee, 2023) and privacy violations necessitate a responsible and ethical approach. The concept of responsible AI, as defined by the United Nations Human Settlement Programme (UN-Habitat), becomes critical in ensuring the alignment of AI technologies with core values, including human rights and the SDGs.

This study is motivated by a dual imperative: to harness the transformative potential of responsible AI in cities for the SDGs and address the persistent risks and challenges accompanying its adoption. While AI holds promise in optimizing operational efficiency, enhancing service delivery, and fostering citizen engagement, it also introduces complexities related to security, data privacy, and the potential exacerbation of societal inequalities. As cities make efforts to become more inclusive, safe, resilient, and sustainable, they grapple with the need for standardized AI implementation processes and transparent regulatory frameworks. The challenges are multifaceted, from security and privacy concerns to a lack of municipal AI adoption resources.

The paper takes a comprehensive approach, aiming to describe the potentials and challenges of AI in cities in relation to the SDGs. Through a meticulous examination of 30 case studies from 14 countries (Figure 1) across the Asia-Pacific region captured through purposive geographic sampling, it seeks to address crucial research questions: *how AI facilitates sustainable development in cities*, and *how cities can mitigate the risks associated with AI to maximize its potential for achieving the SDGs*. The subsequent sections of this paper will systematically explore these dimensions, offering insights into the diverse AI landscape in Asia-Pacific by presenting a comprehensive illustration of the case of the KIRA chatbot

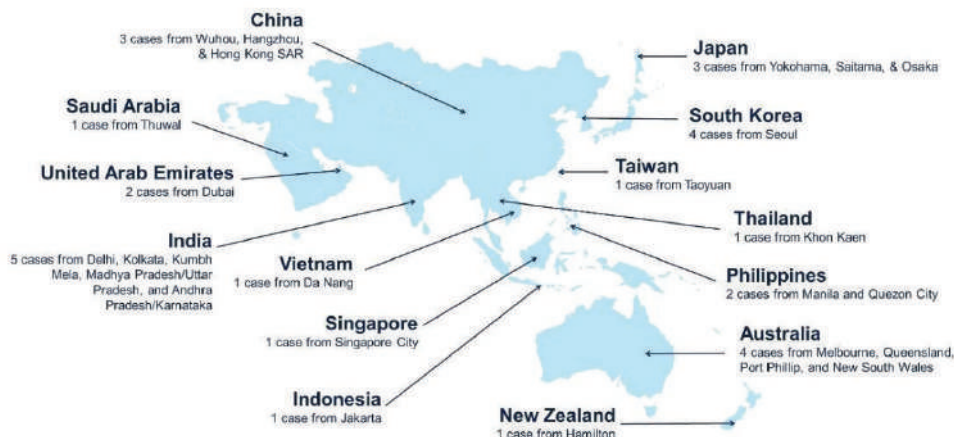


Figure 1: Distribution of AI in cities cases in Asia-Pacific (N=30)

in the Philippines. Finally, the paper proposes key considerations for the responsible deployment of AI in urban environments.

Artificial intelligence in Asia-Pacific cities

Rapid technological advancements have positioned the Asia-Pacific region as a dynamic and influential player in the global AI landscape. With diverse economies, cultures, and governance structures, countries in this region exhibit varying levels of AI readiness, ranging from the top leaders in AI to the least advanced countries in digital governance in general. The transformative potential of AI to address urban challenges and catalyze economic growth has led to a surge in adoption across Asia-Pacific cities.

The 2023 Government AI Readiness Index report by Oxford Insights, reveals the heterogeneous AI landscape in the Asia-Pacific region, highlighting a spectrum of capabilities marked by pronounced disparities. Notable front-runners like Singapore, the Republic of Korea, Japan, Australia, and China showcase high government readiness. At the same time, a stark contrast emerges with islands such as Samoa, and Kiribati, and countries such as the Republic of Korea, reflecting significant discrepancies. Despite these divergent trajectories in government readiness for AI adoption, AI has a significant po-

tential to act as a catalyst for bridging this gap. A study suggests that by 2030, leveraging AI could catalyze a 16% increase in the gross domestic product in the region, offering transformative solutions to regional challenges, including hunger alleviation and bolstered transportation safety (Haseeb et al., 2019).

This paper undertakes a comprehensive examination of 30 AI use cases from 14 nations within urban settings across the Asia-Pacific region, providing insights into the current landscape of AI implementation.

Figure 1 illustrates the study across 14 countries, with India, the Republic of Korea and Australia prominently featured. The Philippines and the United Arab Emirates contribute two cases each, while other nations each present one use case, showcasing the breadth and depth of AI utilization within diverse urban contexts across the region.

Within the dataset, a prevalent form of AI technology emerges through its integration with other emerging technologies, particularly IoT and blockchain, encompassing 13 cases. A summary of the diverse AI typologies and corresponding example cases is provided in Table 1.

Seoul, the Republic of Korea’s implementation of smart poles equipped with a suite of technologies is a notable example. Similarly, the sowing advisory

app and commodity price forecasting tool deployed in Andhra Pradesh and Karnataka (India) aimed to enhance smallholder farmer incomes (Smart City Korea, 2021; UNESCAP, 2019).

Furthermore, 9 cases are identified as chatbots and virtual assistants programmed to deliver automated assistance to users, exemplified by Da Nang, Vietnam’s *Fantasticity* for tourism, Quezon City, Philippines’ *KIRA* for COVID-19 information dissemination, and Jakarta, Indonesia’s *PetaBencana* for disaster response (Da Nang Department of Tourism, 2018; Distor & Moon, 2022; Diwakar, 2021).

Six cases are categorized as predictive analytics, simulations, and pattern matching, representing AI’s utilization in learning from vast datasets to discern data patterns for visualization, simulation, or prediction purposes. Noteworthy examples include Saitama, Japan’s utilization of AI to match children with daycare centers, considering familial preferences such as siblings attending the same facility (Kyushu University, 2017), and New South Wales, Australia’s *LandiQ*, facilitating land use analysis encompassing social, economic, environmental, and financial considerations (New South Wales Government, 2022).

Additionally, 2 cases are identified as examples of robotics and process automation, exemplified by the autonomous shuttle buses at the King

Table 1: AI typologies and examples from the Asia-Pacific region

AI Typology	Description	Examples
Integration with IoT and other emerging technologies	AI technologies are integrated or complemented with other emerging technologies like IoT, blockchain, cloud computing, and digital twin in the deployment stage	<i>Example: Seoul, South Korea's smart poles equipped with traffic lights, intelligent CCTV, public Wi-Fi, and charging ports for electric vehicles</i>
Chatbots and virtual assistants*	Includes virtualized assistants or online "bots" currently used in not only to provide generic advice but also behavior-related recommendations to users	<i>Example: Da Nang, Vietnam's Fantasticity chatbot for tourism information</i>
Predictive analytics, simulations, pattern matching*	Learns from large datasets to identify patterns in the data that are consequently used to visualize, simulate, or predict new configurations	<i>Example: Saitama, Japan's Children-Daycare Centre Matching</i>
Robotics and process automation*	The common trait of these AI technologies is process automation, which can be achieved through robotized hardware or software	<i>Example: Thuwal, Saudi Arabia's KAUST autonomous shuttle buses</i>
Machine learning**	Enables computers to think and learn on their own	<i>Example: Queensland, Australia's Land Use Mapping Program for disaster and biosecurity response</i>
Natural language processing*	Capable of recognizing and analyzing speech, and written text, and communicating back	<i>Example: Manila, Philippines' Public Information Office Complaints Desk for analyzing citizen complaints</i>

*Definition adopted from Misuraca & Van Noordt, 2020;

**Definition adopted from Alzubi, Nayyar, & Kumar, 2018

Abdullah University of Science and Technology (KAUST) in Thuwal, Saudi Arabia, and the AI-enabled Administrative Approval Bureau (AAB) system in Wuhou, China (Bashraheel, 2019; Chen, Ran, & Gao, 2019).

While most AI typologies incorporate machine learning, defined as enabling computers to think and learn autonomously (Alzubi, Nayyar, & Kumar, 2018), notable applications include Queensland, Australia's utilization of machine learning alongside computer vision for land use mapping, aiding in disaster response efforts (OECD-OP-SI, 2018). Moreover, natural language processing emerges as a critical AI typology capable of recognizing and analyzing written or spoken content, as exemplified by the Public Information Office in Manila, Philippines, utilizing this technology for analyzing citizen complaints (Newsbytes, 2020).

The diverse AI landscape across the Asia-Pacific region provides a picture of both challenges and opportunities, with AI leaders showcasing remarkable government readiness. At the same time, important disparities persist in the region. As we observe AI implementation in urban settings, it becomes evident that the transformative power of AI extends beyond technological advancements, offering solutions to multifaceted challenges. In some cases, these technological innovations are also harnessed to create meaningful impact and steer urban development towards a more sustainable and equitable future.

The potential of AI in achieving the sustainable development goals

The potential of responsible AI in urban contexts, as evidenced by the Global

Assessment of Responsible AI in Cities (UN-Habitat, 2024), is far-reaching and transformative. The adoption of AI technologies presents significant positive impacts on various facets of urban life, ranging from enhanced public services to societal well-being (UN-Habitat, 2024). Cities can leverage AI to optimize operational costs and resources, fostering proactive citizen engagement and creating more equitable and livable urban environments (Islam et al., 2022). The efficiency gains, productivity enhancements, and tailored digital platforms promise faster, better, and more cost-effective services. However, cities must navigate critical capacity gaps to harness these benefits fully. Addressing these needs requires substantial investments in infrastructure, comprehensive training programs, and robust regulatory frameworks (Birkstedt et al., 2023). This proactive approach is essential to unlock

the full potential of AI, contributing to operational efficiency, equitable service delivery, and overall urban livability. The motivation to harness responsible AI aligns with the shared vision of creating sustainable urban environments with the potential to contribute to achieving 134 targets of the SDGs. It can also hinder progress on 59 targets, including addressing issues on gender, labor, and carbon emissions (Vinuesa et al., 2020), ushering in a future where technology catalyzes positive change and collective prosperity.

This study enquired into 30 AI use cases across various sectors in the Asia-Pacific region, categorized in Figure 2. Environmental applications accounted for 21%, with notable examples, such as Melbourne’s laneway waste management system, and Yokohama City’s *Iio*

waste management chatbot (Murphy, 2021; Aoki, 2020). Transportation and public service sectors each constituted 18% of the cases, featuring notable implementations such as Hangzhou, China’s *City Brain* addressing traffic congestion, and Hamilton, New Zealand’s *Frankly* chatbot for citizen feedback (Marvin et al., 2022; Inside Government, 2021). Social welfare accounted for 13% of cases, including Seoul, the Republic of Korea’s utilization of AI speakers to aid senior citizens in caregiving (OECD-OPSI, 2017).

Health and public safety sectors comprised 9% each, such as Singapore’s *BotMD* chatbot providing clinical information for medical practitioners, and the City of Port Phillip in Australia employing *AI Road Surveys* for sustainable transportation initiatives (World Bank,

2020; Powell, 2021). The energy sector represented 6%, exemplified by Taoyuan, Taiwan’s AI-powered energy-saving streetlamps (Gan, 2020). Additionally, the tourism and education sectors each contributed a case study (3% each), with Da Nang, Vietnam’s *Fantasticity* tourism chatbot, and the deployment of the *Class Saathi* edtech solution in India’s Madhya Pradesh and Uttar Pradesh regions (Da Nang Department of Tourism, 2018; India AI, 2021).

Analyzing AI use cases in the Asia-Pacific region reveals a diverse landscape contributing to several SDGs (summarized in Figure 3). The study showcases significant contributions to SDG 9 (Industry, Innovation, and Infrastructure), with 21% of cases exemplifying advancements in this domain. Additionally, SDG 11 (Sustainable Cities and

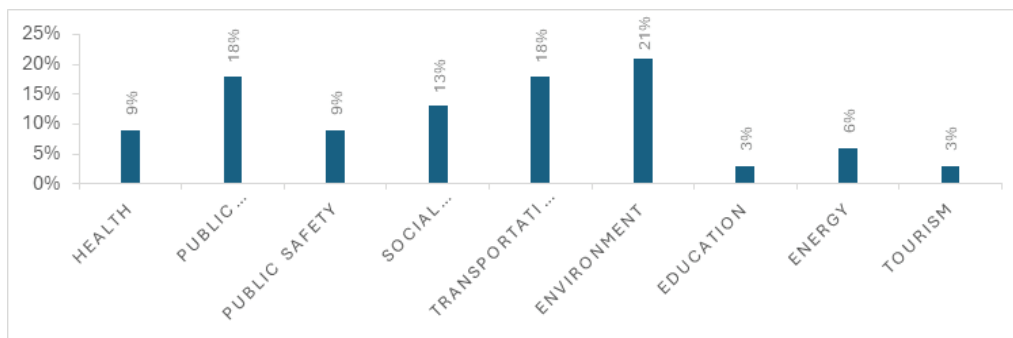


Figure 2: Distribution of AI in cities cases in the Asia-Pacific region based on sectors



Figure 3: Distribution of AI in cities cases in the Asia-Pacific region in relation to the SDGs

Communities) emerges prominently, with 24% of cases demonstrating the role of AI in fostering urban sustainability and development.

Furthermore, AI applications are aligned with SDG 16 (Peace, Justice, and Strong Institutions), evidenced by 22% of cases illustrating the potential of AI to enhance governance and institutional capacities. Other notable contributions include SDG 13 (Climate Action), with 7% of cases addressing environmental challenges. SDG 15 (Life on Land), with 8% of cases focusing on land conservation and biodiversity, and SDG 3 (Good Health and Well-being), with 5% highlighting AI's impact on healthcare services. While some SDGs, such as SDG 1 (No Poverty), SDG 2 (Zero Hunger), and SDG 5 (Gender Equality), are represented by fewer cases, the comprehensive analysis underscores AI's multifaceted role in advancing sustainable development across the Asia-Pacific region. As specific applications of AI in achieving Sustainable Development Goals are explored in this paper, the next section will focus on the specific case of the Philippines, examining the KIRA chatbot as a case study that provides valuable insights into the practical implementation of AI technologies at the local level for better sustainability and resilience.

Despite the potential benefits and opportunities associated with AI applications, cities aiming to become more inclusive, safe, resilient, and sustainable are confronted with persistent risks and challenges in adopting AI technology. Security complexities and data privacy concerns are real. Thus, introducing AI into urban environments, especially when combined with technologies such as the Internet of Things (IoT) or blockchain, adds layers of complexity to security measures. Moreover, citizens are constantly required to share sensitive and personal data or be under constant surveillance due to the prevalence of cameras on city streets. These findings are supported by literature, exemplified by Ghallab (2019). To further understand the nuances of the potentials and challenges brought by AI implementation in cities, the next section shall delve into this through a use case from the Philippines.

Insights from the Philippines' KIRA Chatbot

The case of Knowledge Informs Responsible Action (*Katuwang na Impormasyon para sa Responsableng Aksyon in Filipino*) or KIRA in the Philippines is a concrete manifestation of AI contributing to the SDGs, particularly in public health and disaster management. Initially conceived by AI4GOV, one of the start-ups and tech partners of the Department of Health – Philippines (DOH), for disaster management during a volcanic eruption, KIRA swiftly adapted to address the pressing challenges posed by the COVID-19 pandemic. This dual-purpose application underscores the agility and replicability of AI models and algorithms for diverse use cases.

KIRA was launched in 2020 to help address the COVID-19 pandemic. KIRA's primary focus is on providing verified information, combating misinformation, and connecting citizens with local health units. This helps to address SDG3 (Good Health and Well-being) and extend its contribution to SDG 16 (Peace, Justice, and Strong Institutions) by enhancing governance capacities through efficient data processing and contact tracing. The chatbot's extensive reach, with over 1 million users and engagement with 1,400 local health units, yielding nearly 35 million interactions demonstrates its significant impact on enhancing pandemic response and citizen awareness. Data processing speed also increased 12-fold, whereas contact tracing speed increased six times. Since 2021, the focus of KIRA has shifted towards vaccination, leading to additional features, including educational information about vaccines, crowdsourced vaccine demand, hesitancy data, and citizen satisfaction.

KIRA is composed of a chatbot deployed on several platforms, such as the DOH's website and its official pages on Viber and Facebook Messenger (Figure 4), as well as a real-time dashboard that can help national and local governments make a data-driven decision. Citizens submit their information, which undergoes classification based on the current policy framework, utilizing natural language processing and understanding techniques. To

cater to citizens who cannot access the web version of KIRA, a free short messaging service or SMS version was also launched linked to the same dashboard.

Several partners collaborated with the DOH in the development and deployment of KIRA. Their technology partners include start-ups such as AI4GOV, Aiah, and Senti. Big tech companies like Google, Facebook, and Viber also provided advertising and platform support. Implementation was also aided by development support from various organizations such as Plan International, the United Nations Development Programme, and the World Health Organization.

KIRA's design and implementation abide by national policies such as the country's 2021 National AI Roadmap, the 2012 Data Privacy Law, and the 2018 Mandatory Reporting of Diseases Law. DOH also provided technology partners internally with specific guidelines on how to use the data for KIRA.

The technical implementation of KIRA has several challenges, particularly in adapting to citizens' evolving concerns during the COVID-19 pandemic. The shifts in public priorities lead to promptly adjusting the topic modelling behind KIRA while maintaining an accurate representation of the unfolding health crisis. This balancing act between responsiveness and precision imposed internal pressures, reflecting the intricate nature of aligning AI technologies with real-time public needs.

Moreover, KIRA encountered challenges in managing human resources. Despite knowledge and skills transfer initiatives between technology partners and focal persons from national and local governments, a significant difficulty emerged due to a repetitive cycle caused by the resignation or reassignment of trained focal persons. This turnover, attributed to the demanding workload, impeded the continuity of knowledge and skills within the project team. Particularly, the departure of trained personnel created a gap in maintaining the designed approach to verify symptoms reported by citizens, which relies heavily on the availability and capacity of focal persons, predominantly healthcare workers already

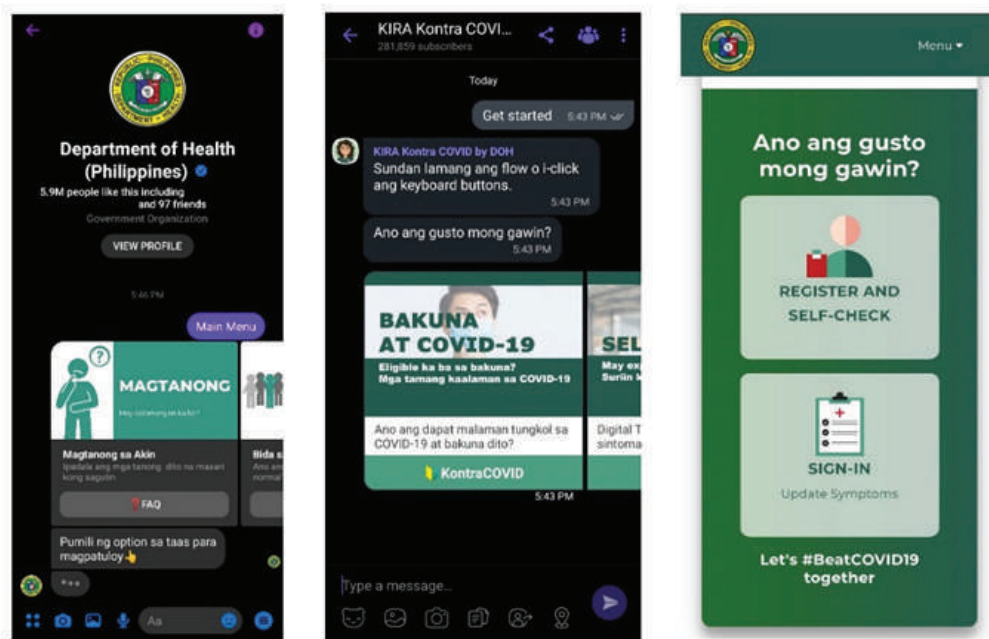


Figure 4: KIRA chatbot on Facebook, Viber, and DOH website (Distor & Moon, 2022)

grappling with the demands of pandemic-related responsibilities.

These challenges underscore the importance of integrating sustainable practices in AI deployment, especially in healthcare. To address the turnover of trained personnel, there is a need for sustainable capacity-building initiatives and measures to ensure knowledge continuity. Implementing practices that alleviate the burden on healthcare workers, such as optimizing the digital triage feature (e.g., the COVID-19 self-assessment and linking with relevant local health units) for efficiency, becomes essential. This aligns with the broader goal of promoting sustainable and responsible AI, ensuring that these technologies enhance, rather than strain, the capabilities of those at the forefront of public health.

There are several takeaways from the implementation of KIRA. While KIRA operates as an AI-powered solution, its effectiveness stems from a collaborative approach that intertwines information and communications technology expertise with insights from the health and medical fields. Moreover, KIRA's implementation underscores the role of partnership in guiding and empowering governmental stakeholders. This proactive engagement helps

mitigate potential apprehensions and challenges related to the complexity of AI, fostering a conducive environment for responsible and sustainable AI deployment. Also, KIRA's ongoing nature is a testament to the agility and adaptability inherent in AI technology. The project demonstrates that AI can evolve to meet stakeholders' changing needs, responding dynamically to shifts in citizen usage patterns. This adaptability ensures that AI remains a responsive tool aligned with evolving public health priorities. An essential takeaway from KIRA's implementation is the observed shift in citizens' engagement—from seeking information to actively reporting information. This transformation reflects the platform's responsiveness to the evolving demands of the community, contributing to a more engaged and participatory public health approach.

Finally, the ongoing modelling and replication of KIRA for additional health concerns, such as measles, rubella, and polio, showcase the scalability and versatility of AI in addressing a spectrum of health challenges. This scalability enhances the long-term impact of AI solutions, demonstrating their potential to contribute sustainably to diverse healthcare needs.

In essence, KIRA's implementation underlines the importance of responsible AI practices that address immediate challenges and foster sustainability by adapting to evolving needs, promoting interdisciplinary collaboration, and empowering stakeholders for informed decision-making.

Aligning AI initiatives with the SDGs: key considerations and policies

Implementing AI in the Asia-Pacific region is confronted with multifaceted challenges, which not only impede its efficacy but may also hinder progress toward achieving the SDGs. Foremost among these challenges is the issue of policies and ethical standards for AI deployment. While most Asia-Pacific countries covered in this study have their respective AI policies, plans, or roadmaps at the national level, their localization is still almost non-existent. Only Hong Kong, China was found to have a published local AI guideline among the 30 cases (Office of the Privacy Commissioner for Personal Data Hong Kong, 2021).

Furthermore, poor infrastructure continues to be a significant hurdle to effective AI implementation in the region, which undermines the functionality of

AI systems and impedes their accessibility to the broader population. For instance, the implementation of the AI-enabled sowing advisory app and commodity price forecasting in Andhra Pradesh and Karnataka, India, faced challenges from its target users, who are smallholder farmers as they still have unreliable internet connections and limited smartphone penetration (UNESCAP, 2019). Additionally, challenges related to digital inclusion further exacerbate disparities in AI utilization and access, with marginalized communities facing barriers to accessing AI technologies.

Moreover, challenges related to data management pose substantial barriers to AI deployment. For instance, there is still a need to develop dictionary data in English and local languages and alphabets to improve search accuracy, such as in the case of the family register administration system in Osaka, Japan (Okazaki, 2019). At the same time, the lack of timely verification mechanisms for citizen-contributed information may also pose an issue, especially during disasters such as in chatbots like Indonesia's *PetaBencana* (Diwakar, 2021). Dependence on data availability from third-party sources like Google Maps, such as the case of Kolkata, India's traffic management analytics, may also hinder the sustainability of AI initiatives (Ghosh, 2022).

Similarly, the robotic approach and lack of human contact in AI systems, particularly chatbots, impedes communication and engagement with citizens. This deficiency not only limits the gathering of important user feedback but also detracts from the user experience, which may hinder inclusive citizen participation in governance processes such as in Hamilton, New Zealand's *Frankly* chatbot (Inside Government, 2021). While the intent of having the chatbot to gather citizen feedback for the council's policies is beneficial, it may unintentionally exclude citizens who do not have access to the chatbot. Some governments have also recognized the importance of having humans in the loop in AI initiatives. Still, as evident in the KIRA chatbot case from the Philippines, implementers indicated this added additional admin-

istrative and workload burdens to the civil servants.

The importance of skills transfers for utilizing AI in the public sector extends beyond technical proficiency exclusive to tech professionals to also encompass civil servants and citizen users. Equipping civil servants with the necessary skills to leverage AI technologies is paramount for enhancing governance efficiency and service delivery. Moreover, empowering citizen users with AI awareness and literacy fosters broader participation in decision-making processes and facilitates informed engagement with AI-enabled services. At the same time, promoting coordination among various stakeholders, including big tech companies, academe, and civil society, is essential for maximizing the societal benefits of AI.

These challenges underscore the urgent need for comprehensive strategies to address the ethical, infrastructural, and operational complexities inherent in AI deployment, ensuring that AI technologies contribute effectively to sustainable development efforts in the Asia-Pacific region. While the insights garnered from the cases in the Asia-Pacific are vital in scoping the regional context, future research is still necessary to provide evidence that can shape effective policy and programs relevant to AI governance.

Acknowledgment

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Crowdfunding and digital innovation for sustainable development in Asia and the Pacific

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Abstract

This study investigates the role of crowdfunding and digital innovation in advancing sustainable development in Asia and the Pacific by focusing on how these mechanisms can overcome the limitations of traditional financing to address environmental, social, and economic challenges. Utilizing a literature review approach, this study explains various crowdfunding models (donation-based, reward-based, equity-based, and debt-based) alongside emerging digital technologies such as blockchain, artificial intelligence (AI), and the Internet of Things (IoT). It also examines the integration of Islamic finance principles and highlights their contribution to ethical and socially responsible investments. The findings reveal that crowdfunding and digital innovation significantly enhance the efficiency, transparency, and impact of projects targeting Sustainable Development Goals (SDGs), despite facing challenges such as regulatory hurdles, market readiness, and technological access. The originality of this research lies in its comprehensive analysis of crowdfunding and digital innovation within the context of sustainable development, offering novel insights into leveraging these tools for societal benefits. These limitations include the need for further empirical studies to validate the proposed recommendations. This study provides recommendations for policymakers to create supportive environments to highlight the potential of crowdfunding and digital innovation to increase inclusive growth and environmental stewardship, thus contributing to a sustainable future for the region. This analysis aims to inform stakeholders, including policymakers, entrepreneurs, and investors, about harnessing alternative financing and digital solutions for sustainable development.

Keywords: Crowdfunding, Digital Innovation, Sustainable Development, Asia and the Pacific, Islamic Finance

Introduction

Crowdfunding and digital innovation have emerged as potential tools for addressing sustainable development challenges in Asia and the Pacific. Crowdfunding is the practice of raising small amounts of capital from many individuals to finance a new business venture and is typically facilitated through online platforms (Rambaud et al., 2022). This complies with the concept of an open call, primarily conduct-

ed over the internet, to gather financial resources either through donations or in exchange for rewards to support specific initiatives (Ahlers et al., 2015). The essence of crowdfunding lies in the collective effort of individuals pooling their resources, often in small amounts, to back projects or businesses initiated by others (Yu et al., 2020). Crowdfunding for sustainability-oriented ventures and clean production tech-

nologies has gained attention as an alternative means of financing (Hörisch, 2015). This is particularly relevant given the scale of human action regarding the Earth's capacity to sustain it, emphasizing the need for innovative approaches to address sustainable development challenges (Rockström et al., 2009). As a group behavior facilitated through the Internet, crowdfunding has been recognized as a supporting activity initiated by organizations and individuals, contributing to sustainable economic development (Liang et al., 2020; Usman et al., 2019). Furthermore, the potential of crowdfunding to contribute to sustainable development has been highlighted, particularly in filling the financial gap for entrepreneurs and small to medium enterprises (Testa et al., 2022). Additionally, crowdfunding has been recognized as an instrument for achieving the United Nations' SDGs, emphasizing its role in supporting sustainability ventures (Martínez-Gómez et al., 2020).

Moreover, the role of crowdfunding for entrepreneurship towards sustainable development has been emphasized, highlighting the challenge of transforming sustainability goals into product features that contribute to customer value (Belz and Binder, 2015). The behavior of sustainability-related crowdfunders and the factors influencing their involvement in crowdfunding rounds have been the subjects of research, highlighting the importance of personality and subjective well-being in influencing crowdfunding for sustainable development initiatives (Kim et al., 2021; Kim and Petrick, 2021). Additionally, the potential of crowdfunding to positively influence sustainability in the retail sector has been highlighted, particularly when project owners focus on sustainability criteria categories (Konhäusner, 2021). Crowdfunding has been recognized as financing green initiatives, particularly in countries where institutions are less oriented toward

environmental sustainability, thereby relaxing constraints on green entrepreneurs' access to external resources (Butticé et al. 2019).

Existing literature on crowdfunding, digital innovation, and sustainable development in Asia and the Pacific highlights the potential impact of these tools in addressing sustainability challenges. Studies have emphasized the role of crowdfunding in financing sustainability-oriented ventures, particularly in filling financial gaps for entrepreneurs and small to medium enterprises. Furthermore, the literature explores the influence of digital innovation and crowdfunding on entrepreneurship towards sustainable development, emphasizing the challenge of transforming sustainability goals into product features that contribute to customer value. Additionally, the potential of crowdfunding to positively influence sustainability in the retail sector has been highlighted, particularly when project owners focus on sustainability criteria.

However, there are gaps in the current research. For instance, there is a limited representation of studies examining how crowdfunding has been used to develop sustainable products (Corsini and Frey, 2021). Additionally, there is a lack of comprehensive understanding of the impact of crowdfunding on ventures and whether it contributes substantially to sustainable development (Hörisch, 2018). Moreover, minimal attention has been given to economic and social issues in the corporate social responsibility reporting of Asia-Pacific, indicating a gap in understanding the broader impact of sustainability initiatives in the region (Zhang, 2021). To address these gaps, a theoretical framework for understanding the impact of digital finance and innovation on sustainable development is essential. Owing to the increasing expectations of digital innovation, it is crucial to improve the blueprint of digital activities (Chenglei Xu, 2023). This framework should consider the influence of crowdfunding on sustainability-oriented ventures, the role of digital innovation in promoting sustainable entrepreneurship, and the crowdfunding's potential to positively influence sustainability in various sectors. Addition-

ally, the framework should integrate the financial, economic, and environmental dimensions of sustainability to provide a comprehensive understanding of the impact of digital finance and innovation on sustainable development in the Asia and Pacific regions.

This study begins with an introduction that outlines sustainable development challenges and opportunities within the region, highlighting the role of digital innovation and crowdfunding as pivotal tools for addressing these challenges. The objectives and scope of the review are clearly defined, laying the groundwork for a thorough exploration of the subject. Following the introduction, a literature review highlights existing research on crowdfunding, digital innovation, and their impact on sustainable development, identifying gaps, and establishing a theoretical framework for understanding the influence of digital finance on sustainability efforts. The research design adopts a systematic literature review approach to synthesize existing knowledge on crowdfunding, digital innovation, and sustainable development in Asia and the Pacific. a search of academic databases, including Scopus, Web of Science, and Google Scholar, to identify relevant peer-reviewed articles, books, and research studies was conducted. The systematic analysis to identify key themes and patterns across the literature was carried. This provided an overview of the current state of knowledge in the field. In the subsequent sections an overview of the current state of digital innovation and crowdfunding in the region, detailed case studies of successful initiatives are shared and a description of different crowdfunding models and their suitability for sustainable development projects is also shared.

The criteria for selecting case studies or empirical evidence prioritize studies directly addressing the convergence of crowdfunding, digital innovation, and sustainable development in Asia and the Pacific. Specifically, we include studies that focus on the impact of digital finance and innovation on sustainable entrepreneurship, the role of crowdfunding in financing sustainability-oriented ventures, and the potential of digital innovation to promote sustainability. However, this study had

certain limitations. First, the scope of the review may be limited by the availability of literature specifically focused on Asia and the Pacific. Second, the quality and heterogeneity of the selected literature may pose challenges in synthesizing the findings. Third, the generalizability of the findings to all countries within the region may be limited due to economic, social, and environmental variations. This study also addresses the challenges and opportunities presented by these innovative financing mechanisms, including the role of Islamic finance in promoting ethical investments. Policy recommendations offer guidance for enhancing a supportive environment for these initiatives, with suggestions for international cooperation and partnership models. Finally, the study concludes with a summary of the key findings, reflecting the role of crowdfunding and digital innovation in achieving development goals to contribute to ethical and sustainable investment in the region.

Crowdfunding and digital innovation in Asia and the Pacific: An overview

Crowdfunding has emerged as a mechanism for financing innovative projects, startups, and small and medium enterprises (SMEs) in Asia and the Pacific, contributing significantly to digital innovation. This case evokes some questions, especially about the role of technology in mediating the role of allowing some organizations to crowdsource to support the digital humanities (Pratono, 2020). This financial model leverages the power of the Internet to gather small amounts of capital from many individuals to support a wide range of activities, including artistic endeavors, product development, and entrepreneurial ventures. The growth of crowdfunding in Asia and the Pacific can be attributed to several factors including technological advancements, changes in consumer behavior, and an evolving regulatory framework that creates a conducive environment for digital innovation.

The Asia-Pacific region, with its diverse economies ranging from high-income

countries, such as Japan and Singapore, to emerging markets, such as India and Indonesia, presents a unique ecosystem for crowdfunding. The adoption and impact of crowdfunding in this region are influenced by varying levels of technological penetration, digital literacy, and regulatory landscapes across countries. In countries such as China and India, crowdfunding has experienced rapid growth, partly due to the expanding middle class with increasing disposable income and a growing appetite for digital platforms. In China, the success of crowdfunding practices is linked to internal factors (updates and predefined durations), whereas the role of external factors (platform and award) is less certain (Xiao Pan, 2023).

In contrast to traditional funding methods that often prioritize established priorities and individualistic intervention approaches, crowdfunding represents a shift towards a more inclusive and market-driven financing approach. The collective wisdom of a crowd plays a crucial role in determining the success of a project. Crowdfunding diversifies funding sources and provides a platform for entrepreneurs to showcase their expertise and innovative ideas, thereby attracting support from a broad range of funders (Wang et al., 2022).

Linkages digital technologies and crowdfunding

Crowdfunding plays a crucial role in digital innovation and contributes significantly to regional economic development. It provides startups and projects with access to essential funding that may be difficult to obtain through traditional financing channels. This democratization of capital not only empowers entrepreneurs but also validates new concepts through market feedback, enabling project creators to enhance their offerings and business strategies (Estrin et al., 2018). The key aspect of crowdfunding is its ability to engage a wide audience to support ventures, thereby promoting innovation and entrepreneurship.

The advent of digital innovation has elevated crowdfunding to new levels, broadening its impact across various sectors. Crowdfunding has emerged as a viable alternative to traditional

funding sources, particularly for high-risk projects that may struggle to secure support through conventional means (Schucht et al., 2020). By harnessing the power of social media and online platforms, crowdfunding has revolutionized fundraising, offering an interactive way for individuals to contribute to the projects they believe in (Estrin et al., 2018). This shift towards digital crowdfunding has democratized access to capital and enhanced collaboration and innovation in the entrepreneurial ecosystem.

Several key players and platforms are at the forefront of driving digital innovation and crowdfunding in the Asia-Pacific region. First, platforms such as Alibaba's Ant Financial and Tencent's WeChat Pay have revolutionized digital payments in China (CGAP, 2019). At the same time, JD Finance has become one of the significant players in equity crowdfunding in China (JD. Com, 2015). Second, in India, startups like Milaap and Ketto are leading the way in equity and social crowdfunding, respectively (Anupam, 2020). Third, platforms such as Funded-ByMe (Malaysia) and FundedHere (Singapore) are important equity and debt crowdfunding platforms that support SMEs and startups in Southeast Asia (Fong, 2023; Volopay, 2023).

Moreover, the regulatory environment in the Asia-Pacific region is evolving to support crowdfunding growth while ensuring investor protection. Malaysia and Singapore have introduced specific regulations to govern crowdfunding activities, creating a safer environment for investors and fundraisers. These regulatory frameworks are critical for building trust and credibility on crowdfunding platforms and encouraging participation from a broader population segment. However, challenges remain, including the need for enhanced digital infrastructure, improved financial literacy, and stronger regulatory frameworks to mitigate the risks associated with crowdfunding, such as fraud and project failure. Addressing these challenges is essential for sustaining crowdfunding growth and harnessing its potential to drive digital innovation in the region.

Furthermore, Digital innovation in Asia and the Pacific encompasses a broad spectrum of technologies, including

mobile internet, blockchain, artificial intelligence (AI), and the Internet of Things (IoT). However, when there is an opportunity, there is a challenge as well, since rising technology can also bring disruptive effects (SZAKOS, 2023). These technologies have driven significant changes across various sectors, from fintech and e-commerce to health-care and smart cities. Crowdfunding platforms have become critical in funding these innovations, allowing entrepreneurs to bypass traditional financial barriers and access a global pool of investors. Crowdfunding has emerged as a versatile and innovative financing mechanism that significantly impacts sustainable development by facilitating funding projects that comply with Sustainable Development Goals (SDGs).

Models for crowdfunding

Various crowdfunding models cater to different projects and stakeholders, each with unique characteristics that influence their suitability and effectiveness in supporting sustainable development initiatives (Ghobakhloo, 2021).

Donation-based Crowdfunding is primarily used for social, environmental, and humanitarian projects where funders donate funds without expecting any financial return. This model is particularly suited for initiatives that directly contribute to the SDGs, such as poverty alleviation (SDG 1), clean water and sanitation (SDG 6), and climate action (SDG 13). Projects leveraging donation-based crowdfunding often emphasize social impact and emotional appeal to attract funders. Reward-based Crowdfunding offers funders tangible or intangible rewards in exchange for their contributions. This model is effective for sustainable development projects offering products, services, or experiences, complying with goals such as responsible consumption and production (SDG 12) and sustainable cities and communities (SDG 11). Reward-based crowdfunding allows innovators to validate their ideas and build a customer base while contributing to sustainability.

Equity-based Crowdfunding involves exchanging equity shares of a startup or business venture for capital (Riswandi, 2023). It is suitable for sustainable development projects with a

clear business model and potential financial returns, such as renewable energy initiatives (contributing to SDG 7) and sustainable industrialization (SDG 9). This model complies with investors' financial incentives and the long-term success of projects that contribute to the SDGs. Debt-based Crowdfunding, or peer-to-peer (P2P) lending, allows individuals to lend money to project owners or businesses who repay the loan with interest. This model can support small and medium enterprises (SMEs) in developing countries in areas like sustainable agriculture (SDG 2) and affordable and clean energy (SDG 7), where traditional financing is limited.

Crowdfunding has the potential to directly affect several SDGs by providing much-needed capital for sustainable development projects. For example, renewable energy projects funded through equity-based or debt-based crowdfunding contribute to achieving SDG 7 (Affordable and Clean Energy) by increasing the share of renewable energy in the global energy mix. Similarly, donation-based crowdfunding campaigns for clean water projects directly support SDG 6 (Clean Water and Sanitation), addressing critical infrastructure needs in underserved communities. Hence, the government must encourage crowdfunding growth by implementing integrity policies to look after the stability of the internal market and facilitate the creation of competitive market conduciveness (Riswandi, 2023).

Case studies

1. "Solar Home" Project, Myanmar

One notable example is the "Solar-Home" project in Myanmar, which utilized a pay-as-you-go financing model funded through crowdfunding (Petrova, 2018). This initiative aims to provide affordable solar home systems to off-grid households, significantly affecting energy access in rural areas. The success of SolarHome can be attributed to its innovative business model, which complies with the local context and needs, demonstrating the critical role of market understanding in

crowdfunding success. The business model of SolarHome is based on a pay-as-you-go scheme. This model allows households to pay for their solar home systems in instalments, making them financially viable for families that may not afford the upfront costs of solar installations. The pay-as-you-go scheme is enabled by technological advancements that allow for the remote control and monitoring of solar units, ensuring that payments are made before the service is provided. This mitigates financial risk for project operators and investors, thereby encouraging more significant investment in such initiatives. Crowdfunding not only garners the necessary capital for project implementation but also enhances public awareness and engagement in renewable energy solutions, as well as reflects a deep understanding of the market dynamics and financial capabilities of the target demographic.

2. Milaap Platform, India

The "Milaap" platform has facilitated numerous successful crowdfunding campaigns focused on healthcare, education, and women's empowerment in India (FinDev Gateway, 2013). A stand-out project funded by Milaap was the setup of microgrid solar installations in several off-grid villages, showcasing the power of crowdfunding in mobilizing resources for sustainable energy solutions. The identified success factors include a strong narrative that resonates with a broad audience and the effective use of digital marketing strategies to reach potential funders. Strategies such as employing emotionally appealing visuals, showcasing digital marketing expertise, and providing regular updates play a pivotal role in the triumph of crowdfunding initiatives (Kubheka, 2020). The digital landscape offers crowdfunding platforms the opportunity to reach a wider audience and engage with funders at a more personal level, thus enhancing the visibility and impact of projects. A strong narrative that resonates with a broad audience can significantly amplify interest in and support for a cause (Macht and Weatherston 2014). Besides, digital marketing tools offer the advantage of targeted advertising, where campaigns can reach individuals based on their interests, behaviors, and online activi-

ties, making the outreach efforts more efficient and effective (Ordanani et al., 2011). Furthermore, the digital nature of these campaigns enables the collection and analysis of data on funder behavior and preferences, which can inform the optimization of future campaigns for better performance (Belleflamme et al., 2014). Hence, underlying digital technologies allow businesses to improve inter-functional collaboration and integrate better with internal and external stakeholders (Ghobakhloo, 2021).

3. EcoMatcher Initiative, Philippines

Another case is the "EcoMatcher" initiative, which utilizes crowdfunding to finance tree-planting activities in various countries, including Indonesia and the Philippines. (EcoMatcher, 2024). This project successfully capitalized on the growing global concern for climate change, offering funders the opportunity to contribute directly to reforestation efforts. The initiative's success can be attributed to its clear and measurable impact, which gives contributors a tangible sense of the environmental benefits of their investment.

4. Hamri Bahini, Nepal

In Nepal, the "Hamri Bahini—The Green Angels" social enterprise used crowdfunding to expand its environmentally sustainable waste management services (Emotive, 2023). This project addressed urban waste issues and empowered marginalised women by providing them with employment opportunities. The key success factors included a compelling social and environmental mission, strong community involvement, and effective storytelling, which highlighted the dual impact of the initiative on both the environment and women's empowerment.

Examining these case studies reveals several key factors contributing to the success of crowdfunding campaigns for sustainable development projects in the Asia-Pacific region. Projects that actively engage with the community and stakeholders tend to build trust and credibility, which are essential for attracting crowdfunding support. In addition, campaigns that maintain high

levels of transparency regarding their goals, progress, and use of funds are more likely to gain and retain funders' trust (Riswandi, 2023).

Furthermore, projects that offer clear and measurable environmental, social, and economic impacts are more likely to attract funders. Demonstrating how each contribution makes a difference engages potential supporters on a personal level. Additionally, initiatives that involve the community and relevant stakeholders in the project planning and execution phases benefit from deeper engagement and support. This involvement increases the sense of ownership between the funders and beneficiaries, enhancing the project's credibility and appeal. Successful projects often exhibit high adaptability and respond to challenges and feedback in real time. This flexibility allows projects to overcome unforeseen obstacles and maintain momentum toward their crowdfunding goals. Moreover, effective use of digital marketing tools, social media, and crowdfunding platforms can amplify a project's reach and attract a wider pool of potential funders. Tailoring messages to different platforms and audiences can enhance engagement and support.

Therefore, exploring successful crowdfunding campaigns for sustainable development in the Asia-Pacific region highlights the significant potential of this financing mechanism. The success factors identified, from precise impact measurements and community involvement to strategic communication and adaptability, offer valuable insights for future initiatives. As the digital economy continues to grow and evolve, crowdfunding becomes a powerful tool for mobilizing resources and supporting sustainable development projects, thereby increasing the region's sustainable, equitable, and prosperous future. Conversely, the factors contributing to the failure of crowdfunding campaigns often include a lack of clear objectives, poor communication strategies, failure to engage the target audience, and unrealistic goals or rewards. Moreover, projects that overlook the importance of the local context and stakeholder involvement may struggle to achieve their crowdfunding goals.

Challenges and opportunities

The expanding fields of crowdfunding and digital innovation present a complex landscape of challenges and opportunities, particularly in the sustainable development and incorporation of Islamic financial principles (Pratono, 2020). These dynamics are particularly pronounced in regions that strive to balance rapid technological advancement with equitable and sustainable growth. Understanding these challenges and opportunities is crucial for policymakers, entrepreneurs, and investors aiming to harness crowdfunding and digital innovation to achieve positive social and environmental outcomes.

One of the challenges for crowdfunding and digital innovation is navigating diverse and often stringent regulatory environments across jurisdictions (Valiante, 2022). Regulatory frameworks can enable or inhibit the growth of crowdfunding platforms and digital ventures, particularly those aimed at cross-border operations. In some cases, the lack of specific crowdfunding regulations can create uncertainty for platforms and investors, thereby affecting overall market confidence. Despite the high penetration rate of mobile and Internet technologies in many regions, disparities in market readiness and access to technology can limit the effectiveness of crowdfunding and digital innovation projects. In rural or underprivileged areas, limited digital literacy and access to Internet infrastructure can restrict the participation of a broader audience in crowdfunding campaigns, thereby affecting the fundraising process for projects aimed at sustainable development. The success of crowdfunding and digital initiatives depends on their cultural and social acceptance. In some regions, skepticism may exist towards online financial transactions or a preference for traditional financing methods, posing challenges for adopting crowdfunding models, especially those less familiar, such as equity-based or debt-based crowdfunding.

Despite these challenges, crowdfunding and digital innovation offer significant opportunities for promoting

sustainable development (Chi Wei Su, 2023). Crowdfunding platforms can mobilize resources from a global pool of funders, providing essential funding for projects that may not qualify for traditional financing. This democratization of finance can accelerate the implementation of projects conforming to the SDGs, from renewable energy initiatives to social enterprises. Crowdfunding not only raises funds but also serves as a powerful tool for market validation and community engagement. By involving the community in the funding process, project initiators can gain valuable insights and increase the sense of ownership among funders, thereby increasing a project's chances of success and sustainability. Digital innovation, supported by crowdfunding, can drive entrepreneurship and the development of new technologies and business models (Chenglei Xu, 2023). This is particularly important for addressing complex sustainability challenges and enabling innovative solutions that can be scaled up and replicated in various contexts.

Hence, while crowdfunding and digital innovation face several challenges, including regulatory hurdles, market readiness, and cultural barriers, they also present unprecedented opportunities to drive sustainable development. Integrating Islamic finance principles further enhances these efforts by offering ethical and socially responsible investment opportunities that uphold global sustainability goals. Addressing these challenges and leveraging opportunities will require concerted efforts from governments, industry players, and global communities to create an enabling environment that increases innovation, inclusivity, and sustainability.

Policy recommendations

In leveraging crowdfunding and digital innovation for sustainable development, policymakers play a crucial role in creating a conducive environment that nurtures these activities while ensuring investor protection and project accountability (Chenglei Xu, 2023). The convergence of crowdfunding, digital

innovation, and sustainable development presents unique opportunities and challenges that require thoughtful regulatory and policy responses. International cooperation and partnership models can amplify the impact of such efforts by promoting global best practices and shared learning.

Policymakers should focus on establishing clear, transparent, and flexible regulatory frameworks for crowdfunding and digital innovation. These regulations should protect investors from fraud and ensure the integrity of crowdfunding platforms while increasing an environment that encourages innovation and supports the growth of startups and SMEs that comply with development goals. Tailored regulations can also address the specificities of different crowdfunding models—donation-based, reward-based, equity-based, and debt-based—each of which may require different mechanisms of oversight. To maximize the reach and effectiveness of crowdfunding and digital innovations, governments should invest in improving digital infrastructure, particularly in underserved areas. This includes expanding Internet access, enhancing cybersecurity measures, and promoting digital literacy among the population. Such efforts can democratize access to crowdfunding platforms and digital marketplaces, thereby widening the scope of sustainable development projects.

Policies aimed at increasing financial inclusion can significantly benefit crowdfunding ecosystems. By simplifying the process of opening bank accounts, enhancing mobile banking services, and supporting fintech innovations that offer alternative financial services, governments can ensure that a broader population participates in crowdfunding both as contributors and beneficiaries. Encouraging partnerships between public institutions, private sector entities, and crowdfunding platforms can lead to the development and implementation of sustainable projects on a larger scale. In addition, it can leverage the strengths of each sector by combining public oversight and resources with the agility, innovation, and funding capabilities of the private sector and crowdfunding communities.

Although there are suggestions for international cooperation and partnership models, crowdfunding platforms' international networks or coalitions can facilitate the exchange of best practices, regulatory experiences, and success stories. These networks can also work towards harmonizing regulatory standards across borders, making it easier for projects to attract international funding and for platforms to operate in multiple jurisdictions. International frameworks that address legal and tax implications for funders can be developed to encourage cross-border investments in crowdfunding projects, especially those targeting the development goals. Such frameworks can mitigate risk for investors and make them more attractive to funding projects in other countries, thereby increasing the pool of available capital for sustainable initiatives.

International development agencies and financial institutions can play a pivotal role by partnering with crowdfunding platforms to match the funds raised for projects that adhere to specific SDGs. These partnerships can provide additional funding and lend credibility to projects, thereby attracting more funders and increasing their overall impact. International cooperation can also promote ethical and impact investments. By developing shared standards and certifications for ethical and socially responsible projects, stakeholders can increase the global market for investments that support sustainable development.

By implementing these policy recommendations and increasing international cooperation, governments and international bodies can enhance the environment for crowdfunding and digital innovation, driving progress towards sustainable development goals. These efforts require a multi-stakeholder approach involving governments, industry players, international organizations, and civil society to create synergies that maximize the benefits of crowdfunding and digital innovations for global sustainable development.

Future directions

The digital finance and innovation landscape is rapidly evolving, with emerging trends and technologies poised to significantly impact sustainable development efforts in the Asia and Pacific regions. It has become a new driver of economic development (Romdhane, 2024). These advancements offer new opportunities to address longstanding challenges related to financial inclusion, environmental sustainability, and economic growth. As these technologies continue to develop, they also present potential areas for future research, aiming to fully understand their implications and harness their potential for positive impacts.

Blockchain and Distributed Ledger Technology (DLT) are revolutionizing how financial transactions and asset management are conducted, offering unprecedented transparency, security, and efficiency. In the context of sustainable development, these technologies can facilitate more effective tracking and verification of sustainable practices and outcomes. For instance, blockchain can be used to verify the authenticity of products in supply chains, thereby ensuring that they meet sustainability standards. In addition, DLT can support innovative financing mechanisms, such as the tokenization of assets, to mobilize funds for sustainable development projects. AI and big data analytics transform decision-making processes by providing deeper insights into complex issues. In sustainable development, AI can optimize resource allocation, enhance energy efficiency, and predict environmental trends, thereby contributing to informed policy and investment decisions. Big data analytics can also improve credit risk assessment for underserved populations, expanding access to finance for smallholder farmers and SMEs in sustainable sectors.

The rise of digital currencies and advanced payment systems is reshaping the financial landscape, potentially enhancing financial inclusion and transaction efficiency. Central Bank Digital Currencies (CBDCs) and mobile payment solutions can offer secure and accessible financial services, particularly in rural and underserved ar-

eas, support economic participation, and pursue sustainable development goals. Internet of Things (IoT) technologies connect the physical and digital worlds, enabling real-time monitoring and management of resources and environments. In sustainable development, IoT applications can support smart agriculture, water management, and energy systems, contributing to more efficient use of natural resources, reducing environmental footprints, and reshaping transportation operations (Tondro, 2023).

As digital finance and innovation tools are increasingly deployed to support sustainable development, research on effective impact measurement and verification methods is needed. This includes exploring how blockchain and AI can enhance the reliability and transparency of impact reporting for sustainability projects and investigating how digital finance innovations can be designed and implemented to promote financial inclusion and support the economic empowerment of marginalised communities (Charles, 2023). This research area explores the roles of mobile banking, digital currencies, and peer-to-peer lending platforms in providing accessible financial services. With the rapid adoption of emerging technologies, there is a critical need for research on developing regulatory and ethical frameworks that ensure that these innovations are used responsibly and equitably. This includes examining the implications of AI and big data for privacy and data protection and the governance of blockchain systems, and exploring the potential for cross-sectoral synergies between digital finance, sustainable development, and other areas such as healthcare, education, and disaster risk reduction.

Conclusion

This study explored the complex landscape of crowdfunding, digital innovation, and Islamic finance, elucidating their significant contributions and potential to drive sustainable development in Asia and the Pacific. This exploration has revealed key findings on how these financial and technological innovations can impact the SDGs and the challenges and opportunities they

present. Crowdfunding has emerged as a mechanism for mobilizing resources for sustainable development projects, enabling access to capital for initiatives that may otherwise struggle to secure funding through the traditional financial system. Digital innovation through technologies such as blockchain, AI, and IoT has the potential to revolutionize the efficiency, transparency, and impact of projects targeting SDGs. These technologies offer novel solutions to longstanding challenges, from enhancing financial inclusion to optimizing resource use and improving decision-making processes to support sustainability objectives.

The integration of crowdfunding and digital innovation presents a unique opportunity to address the SDG financing gaps in Asia and the Pacific. These mechanisms can catalyze the implementation of sustainable projects by providing innovative funding solutions, enhancing project accountability, and increasing community engagement. Moreover, emphasis on ethical and sustainable investments can attract a wider pool of investors interested in contributing to positive social and environmental outcomes. Crowdfunding and digital innovation hold considerable promise for achieving development goals by democratizing access to capital and leveraging technology to solve complex sustainability challenges. However, realizing this potential requires supportive regulatory frameworks, digital infrastructure, literacy investments, and initiatives to promote financial inclusion. Policymakers, entrepreneurs, and investors must collaborate to create an ecosystem that nurtures these innovations and maximizes their impact on sustainable development. The challenge lies in integrating crowdfunding and digital innovation platforms to ensure that these financial models are accessible and attractive to various investors and projects. Future research and policy development should focus on harnessing the synergies between crowdfunding and digital innovation and exploring innovative models that can finance sustainable development projects effectively and ethically. Hence, the integration of crowdfunding and digital innovation offers a pathway to mobilize resources, engage communities, and drive inno-

vation to pursue SDGs for advancing sustainable development in Asia and the Pacific. The. As the region continues to face environmental, social, and economic challenges, leveraging these tools in a coordinated and strategic manner is crucial for building a sustainable, inclusive, and prosperous future.

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Tech Events

06 – 08 August, 2024

Asia Blockchain Summit

Taipei, Taiwan Province of China

<https://abs.io/>

28 – 29 August, 2024

Web 2024

Tokyo, Japan

<https://webx-asia.com/>

01 – 07 September, 2024

Korea Block Chain Week

Seoul, the Republic of Korea

Contact:

Tel: +82 2 6965 0013

<https://koreablockchainweek.com/>

24 - 27 September, 2024

The International Conference on Intelligent Data Science Technologies and Applications (IDSTA2024)

Dubrovnik, Croatia

<https://idsta-conference.org/2024/>

25 – 26 September, 2024

TECHSPO Delhi

New Delhi, India

<https://techspodelhincr.in/>

29 September, 2023

3rd Annual APAC Data 2030 Summit

Singapore

<https://apac.data2030summit.com/>

01 – 02 October, 2024

AI & Big Data Expo World Series

Contact:

Email: ai@techexevent.com

Tel: +44 (0)117 980 9023

<https://www.ai-expo.net/>

24 – 25 October, 2024

Third International Conference on Intelligent Systems

Hanoi, Viet Nam

Contact:

University of Transport Technology

Email: intelligentsystem.icis@gmail.com

<https://intelligentsystem.in/>

01 – 02 October, 2024

Digital Transformation Week Europe

Amsterdam, The Netherlands

<https://www.digitaltransformation-week.com/europe/>

19 – 21 October, 2023

Asia Pacific Innovation Conference

Ahmedabad, India

Contact:

Centre for Technology Innovation and Economic Research (CTIER) and Ahmedabad University

Email: info@ahduni.edu.in

<https://ahduni.edu.in/all-events/asia-pacific-innovation-conference-apic-2023/>

30 Oct - 01 Nov, 2024

AIoT Korea Exhibition 2024

Seoul, Republic of Korea

Contact:

Email: aiot@kiot.or.kr

<http://iotkorea.or.kr/2023/kor/>

20 – 22 November, 2024

8th AI Expo Tokyo

Tokyo, Japan

Contact:

Tel: +81-3-6739-4131

Email: nextech-eng.jp@rxglobal.com

<https://www.nextech-week.jp/>

13 December, 2024

International Conference on Big Data, IoT, Cyber Security and Information Technology (ICBDICSIT)

Dubai, United Arab Emirates

Institute of Research and Journals (IRAJ)

Contact:

Email: papers.iraj@gmail.com

<https://iraj.in/Conference/14570/ICBDICSIT/>



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