Strengthening innovation-driven inclusive and sustainable development

Asia-Pacific Tech Monitor

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Regional cooperation for innovation and technology transfer – Emerging strategies, models and collaborative networks

UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific
Asian and Pacific Centre for Transfer of Technology (APCTT)

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

The Economic and Social Commission for Asia and the Pacific (ESCAP) serves as the United Nations' regional hub promoting cooperation among countries to achieve inclusive and sustainable development. The largest regional intergovernmental platform with 53 Member States and 9 associate members, ESCAP has emerged as a strong regional think-tank offering countries sound analytical products that shed insight into the evolving economic, social and environmental dynamics of the region. The Commission's strategic focus is to deliver on the 2030 Agenda for Sustainable Development, which is reinforced and deepened by promoting regional cooperation and integration to advance responses to shared vulnerabilities, connectivity, financial cooperation and market integration. ESCAP's research and analysis coupled with its policy advisory services, capacity building and technical assistance to governments aims to support countries' sustainable and inclusive development ambitions.

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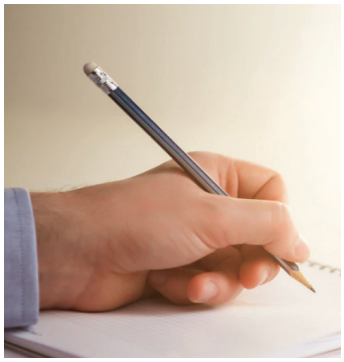

Introductory note

Innovation and technologies are key to achieving sustainable development goals (SDGs). However, the availability, access, and successful adoption of innovations and technologies remain a challenge, particularly for many developing and least-developed countries. Despite the technological advances in recent decades, a large share of the population, especially in low-income countries, still struggles to progress on development parameters such as health and education.

Strengthened cross-border collaborations and regional cooperation can facilitate faster development, transfer, and adoption of innovative technologies and applications to foster sustainable development across Asia and the Pacific. There are different mechanisms that can contribute toward this objective. Co-innovation, the private sector's participation, and public-private partnerships involving multiple stakeholders can promote innovation and strengthen regional technology cooperation among nations.

Knowledge sharing through collaborative networks and South-South cooperation is another way to enhance cooperation and adopt good examples from the region on enabling policies and the adoption of technologies. Collaborative efforts to harmonize intellectual property policies and create an enabling environment for cross-border technology transfer can help achieve this objective and accelerate the achievement of SDGs.

Regional cooperation brings economic development and environmental and social benefits but faces regulatory, financial, political, and technological challenges. APCTT-ESCAP has been playing a key role in overcoming some of these challenges by providing platforms and bringing together multiple stakeholders for policy dialogues, exchange of emerging knowledge, strategies, and good practices to facilitate evidence-based policy formulation and strengthening of capacities for sustainable development in the Asia-Pacific region.

This issue of the Asia-Pacific Tech Monitor discusses emerging strategies, models, and collaborative networks to foster regional cooperation for innovation and technology in the Asia-Pacific countries. It presents a case study on Technology Transfer and Innovation for electrical energy storage technology and strategies on developing locally rooted ecosystems while contributing to global supply networks for the manufacturing sector in Southeast Asia.

Preeti Soni
Head, APCTT-ESCAP

ASIA-PACIFIC

Artificial Intelligence (AI) Solutions

According to International Data Corporation's (IDC) latest Worldwide Artificial Intelligence Spending Guide, Asia/Pacific's* expenditure on artificial intelligence (AI) systems (including hardware, software, and services) will increase from $20.6 billion in 2022 to around $46.6 billion in 2026. AI solutions have become an essential part of process improvement and business decision-making, assisting organizations in keeping up with market viability. IDC forecasts a compound annual growth rate (CAGR) of 23.7 percent for 2021-2026.

"Pre-trained natural language and computer vision models have contributed largely to the 1st wave of adoptions. It's time for more organizations to tap into their own data asset and start managing the "data to intelligence" lifecycle. This will become one of the differentiating capabilities for companies to compete in the digital-first era," says Jessie Danqing Cai, Associate Research Director, Artificial Intelligence, IDC Asia/Pacific.

Dependence on online services and their usage and customer assistance enabled by AI have improved rankings of professional services. Banking will keep investing in AI solutions as market risks and threats increase; AI-enabled apps that boost threat intelligence and fraud analysis will help reduce the risk. As a result of the current economic volatility and rising resource scarcity, discrete manufacturing will be the next major industry to invest in AI solutions to maintain production quality and minimize errors. State/local and federal/central government is the next biggest spender on AI solutions, focusing on public safety and emergency response, defense, terrorism, investigation, and government intelligence systems.

By 2026, spending on the top 5 use cases will have doubled, rising from $8.3 billion to $18.5 billion. With the present industrial digitalization, AI adoption across industries has become necessary for a competitive advantage. For example, augmented customer service agents reduce the time and resources required to resolve customer issues. Smart business innovation and automation optimize and streamline complex business tasks, enabling better decisions by incorporating more data into the decision-making process. Sales process recommendations and enhancements will aid in the smooth flow of the sales process and IT optimization to automate time-consuming software maintenance tasks. Augmented threat intelligence and prevention systems help identify threats for the digital business setup and take preventive measures to avoid critical data threats.

Hardware will be the leading technology, accounting for more than 54.2% of AI spending; the most significant investment areas will be servers, accounting for more than 86% of total expenditure, while the rest will go toward storage. Software is the second leading technology, with 29% of AI spending. AI platforms and applications account for 52% of total software spending. The rest of the AI spending goes to services technology, 77% of the total AI spending in services goes toward IT services, and the rest is under business services.

China is the leading country in AI spending in Asia/Pacific*, expected to reach nearly $26.6 billion by 2026. Enterprises' demand for AI solutions has increased drastically. Digital transformation and policies are one of the factors for the rise in AI-enabled industries.

Australia is the second leading country in AI spending, expected to reach $5.7 billion by 2026. The use of AI solutions in enterprises is increasing as it is critical in business decision-making and data process improvement.

India is the next leading and fastest-growing country, with an expected CAGR of 33.5% in AI spending of $3.4 billion. Digital transformation, government initiatives, customer experience, and cloud adoption are some of the factors that influence enterprise adoption of AI solutions.

The Republic of Korea will be the next spender on AI solutions, which is expected to reach $2.9 billion by 2026. The South Korean government is constantly assisting businesses in adopting AI technologies by establishing AI hubs and education and training programs for developing AI skills.

The Worldwide Artificial Intelligence Spending Guide sizes spending for technologies that analyze, organize, access, and provide advisory services based on a range of unstructured information. The Spending Guide quantifies AI opportunities by providing data for 29 use cases across 19 industries in 9 regions and 32 countries. Data is also available for the related hardware, software, and services categories.

**Asia/Pacific excluding Japan*

https://www.idc.com

CHINA

R&D spending intensity built in 2021

China's research and development (R&D) spending intensity, or the expenditure on R&D as a percentage of its gross domestic product, built up to 2.44 percent in 2021, is shown by a yearly statistical bulletin. The rate, jumping from 1.91 percent in 2012, ranks the top among developing countries and is higher than the European Union's average level, said Liu Huifeng, a researcher from the Chinese Academy of Science and Technology for Development.

In 2021, China invested 2.8 trillion yuan (about $405 billion) in R&D, rising 14.6 percent over that of 2020. Among it, over 2 trillion yuan, or nearly 77 percent, was funded by the enterprises, according to the country's R&D bulletin released in 2021. According to Liu, China is expected to spend more than 3 trillion yuan on R&D in 2022. Liu added that China's R&D spending from the corporate sector was the second largest in the world last year.

As per the bulletin, the country's investment in basic research in that year totaled 181.7 billion yuan, a 23.9 percent year-on-year increase. It accounted for 6.5 percent of the overall R&D spending, maintaining a 6-plus percentage growth for three consecutive years. Provincially, the R&D spending in Guangdong,

Jiangsu, Beijing, and Zhejiang stood in the first echelon, exceeding 200 billion yuan each. According to the bulletin, a slew of provinces in central and western China, including Hubei, Hunan, Sichuan, and Henan, rose to the 100-billion-yuan club in R&D spending,.

http://www.china.org.cn

Basic research spending

Basic research accounted for 6.5 percent of China's overall R&D expenditure last year as the country moved closer to its goal of 8 percent by 2025. In all, the country spent 182 billion yuan ($26.4 billion) on basic research in 2021, an increase of nearly 24 percent from the previous year, according to data released by the National Bureau of Statistics. The growth rate was well above the 9.8 percent increase from 2019 to 2020.

In 2020, basic research accounted for 6.01 percent of China's overall R&D expenditure. Basic research aims to understand better the fundamentals of how nature works, such as astronomy and mathematics. It often has no immediate applications but can form the basis of scientific and technological innovation.

https://www.scmp.com

Blockchain patent applications

According to the most recent data released by a Chinese government official, China accounts for 84% of all blockchain applications filed worldwide. China has avoided the bitcoin market. However, the Chinese government has backed the underlying blockchain technology. Over the years, the country has actively encouraged the use of blockchain technology, therefore the high rate of blockchain patents is not surprising.

President Xi Jinping has also been instrumental in advancing the fledgling blockchain technology. In 2019, the President urged citizens, tech businesses, and ecosystem stakeholders to actively participate and develop emerging technology, as it will play a critical role in the future of the next industrial revolution. As previously revealed by Cointelegraph, Chinese companies submitted 4,435 blockchain patents within a year of President Xi Jinping's encouragement of the industry. According to another report, from 2015 to June 2021, China accounted for nearly 60% of the world's blockchain patent applications, followed by the United States and the Republic of Korea.

While China has the most blockchain patent applications, the approval rate is extremely low, with only 19% of total filed applications being approved, according to the South China Morning Post, Cointelegraph states.

https://www.financialexpress.com

INDIA

Programme for development of semiconductors and display manufacturing ecosystem

The Cabinet, chaired by Prime Minister, Shri Narendra Modi, has approved the following modifications in the programme for development of semiconductors and display manufacturing ecosystem in India:

Fiscal support of 50% of Project Cost on pari-passu basis for all technology nodes under the Scheme for Setting of Semiconductor Fabs in India.

Fiscal support of 50% of Project Cost on pari-passu basis under the Scheme for Setting of Display Fabs.

Fiscal support of 50% of Capital Expenditure on pari-passu basis under the Scheme for Setting of compound semiconductors/silicon photonics/sensors fab and semiconductor ATMP/OSAT facilities in India. Additionally, target technologies under the scheme will include discrete semiconductor fabs.

Under the modified programme, a uniform fiscal support of 50% of Project Cost shall be provided across all technology nodes for setting of semiconductor fabs. Given the niche technology and nature of compound semiconductors and advanced packaging, the modified programme shall also provide fiscal support of 50% of capital expenditure in pari-passu mode for setting of compound semiconductors/silicon photonics/sensors/discrete semiconductors fabs and ATMP/OSAT.

The programme has attracted many global semiconductor players for to set up fabs in India. The modified programme will expedite investments in semiconductor and display manufacturing in India. On the basis of discussion with potential investors, it is expected that work on setting of the first semiconductor facility will commence soon.

An Advisory Committee comprising global experts from industry and academia was constituted to advise India Semiconductor Mission—the nodal agency for the programme for the development of semiconductors and display manufacturing ecosystem in India. The Advisory Committee has unanimously recommended uniform support for all technology nodes of silicon semiconductor fabs/silicon photonics/sensors/discrete semiconductor fabs and ATMP/OSAT, which the government has accepted. The technology nodes of 45 nm and above have high demand, inter alia driven by automotive, power, and telecom applications. Moreover, this segment constitutes around 50% of the total semiconductor market.

https://pib.gov.in

R&D services exports

The fourth edition of SDG Pulse, the annual statistical publication of the United Nations Conference on Trade and Development (UNCTAD) states that India is the fastest-growing R&D services export hub globally. The country is also a leading R&D investor among developing countries if China, the world's second-largest investor in R&D after the United States, is excluded from the list.

SDG Pulse gives an update on developments relating to the UN's 2030 Agenda for Sustainable Development and the Sustainable Development Goals (SDGs). R&D service export statistics are covered under the ninth SDG, which tracks sustainable industrialization and higher technologies. The SDG Pulse data shows that India's annual average growth of R&D services exports during 2015-2020 was 32.2%, ahead of the second fastest-growing R&D services exporter, Ireland, which grew 25.7% during the same five-year period.

In absolute value terms, with $5 billion worth of exports in 2020, India's position was among the top 10, though nowhere close to the U.S., Germany, or China—the leaders in global R&D exports. While the U.S. exported $45 billion worth of R&D services in 2020, Germany exported $25 billion worth of services. The SDG Pulse data did not have the Chinese figures for the comparable year though it mentioned the country remains a leading player based on its past years' performance.

According to the report, innovation is increasingly traded internationally and global R&D services exports expanded by an estimated 5% annually between 2015 and 2020, outpacing the average 2% growth of total trade in services. "In 2020, countries exported about $172 billion worth of R&D services. The top-ten R&D exporters accounted for 77% of the total; the top three held 49%. Seven out of ten leading R&D services exporters also belonged to the top-ten R&D services importers. They were also part of the world-leading recipients of charges for the use of intellectual property. Among developing economies, prominent exporters of R&D services include China, India, Singapore, Brazil, Turkey, and Malaysia," the report says.

In the case of R&D investments, SDG Pulse points out that despite the growth of world R&D investment in absolute terms, global R&D intensity remained at 1.7% of GDP from 2013 to 2018. "Israel (4.9 %) and the Republic of Korea (4.5 %) were the most prominent R&D investors relative to GDP, followed by Switzerland (3.4 %) and Sweden (3.3 %). The United States of America invested 2.8 % of its GDP in innovation, and China 2.1 %," it says. In PPP-adjusted value terms, India's investment of $59 billion—though 0.7% of its GDP—was the highest among developing countries excluding China.

The report also quoted WIPO's Global Innovation Index to state that while Switzerland, Sweden, and the United States remained the top performers in innovation in 2020, Singapore, China, and the United Arab Emirates ranked the highest, followed by Malaysia, Turkey, Thailand, Viet nam, and India ranked highest among the developing economies, the latter five being described as progressing fast or above expectations based on their income level.

https://www.fortuneindia.com

INDONESIA

Personal data regulations approved

The Bill for the Protection of Personal Data (PDP) in Indonesia has been adopted by the House of Representatives and the Government. The House will send it to the President for ratification and publication in the State Gazette. The Minister of Communication and Information, Johnny G. Plate, declared, on behalf of the President of the Republic of Indonesia, Joko Widodo, that Indonesia is the fifth country in ASEAN to have a comprehensive legal framework for personal data protection. Minister Johnny underlined that the establishment of the PDP Law will ensure citizens' rights in accordance with the mandate of the Republic of Indonesia's 1945 Constitution.

Ratification of the PDP Bill is a piece of practical evidence that the Constitution's mandate has been realized. The PDP Bill will increase the government's role and authority in enforcing and regulating the compliance and obligations of all parties who process personal data, both public and private.

According to Minister Johnny, the PDP Law is a form of the state's presence in preserving citizens' fundamental rights in the digital sphere from a state and government perspective. He underlined that the PDP Law would provide a more comprehensive, robust, and forward-thinking legislative framework for personal data protection. He emphasized that, from the perspective of the law, the PDP Bill also ensures equality and balances the rights of personal data subjects with the responsibility of the Personal Data Controller.

Minister Johnny claimed that ratifying the PDP Law would increase the trust and acknowledgment of Indonesia's leadership in global data governance. According to him, Indonesia would become the sixth ASEAN country to have a complete Personal Data Protection law framework. This is consistent with Indonesia's efforts in the G20, where the G20 Digital Economy Working Group launched the adoption of three principles in data-free flow with trust and cross-border data flows, including lawfulness, fairness, and transparency.

Minister Johnny praised members of the Indonesian House of Representatives for their efforts in ratifying the PDP Law. The judgment on the PDP Bill is significant and has been anxiously anticipated by many parties. State institutions, law enforcement, the commercial sector, the digital ecosystem, platforms, social media, and the Indonesian people all play an important role.

The PDP Law will consist of more than 70 articles organized into more or less 15 chapters. These articles and chapters will discuss in-depth data ownership rights and data usage limitations as well as the acquisition, storage, processing, and transfer of personal data of Indonesian users. Because Indonesia is an integral part of the global economy and attracts millions of tourists each year, businesses must immediately adjust their operations to comply with the PDP Law.

The bill applies to companies within and beyond the territory of Indonesia whose actions have legal implications within the territory of Indonesia; affect Indonesian citizens both within and outside the territory of Indonesia. In addition, the PDP Law will have repercussions for local businesses in the nation as well as global corporations that do business with Indonesian consumers. It will also apply to all registered companies conducting business with Indonesian citizens, regardless of where they are registered. Thus, whether a business is public or private, domestic, or foreign, the PDP Law will automatically apply if it handles the personal information of Indonesian residents. The new PDP Law is anticipated to apply to all industries, introducing extensive requirements on electronic and non-electronic personal data protection.

https://opengovasia.com

Pharmacy, medical devices dictionary to standardize data

The Pharmacy and Medical Devices Dictionary (KFA) was formally introduced to participants of the recently held National Forum for the Independence and Resilience of the Pharmaceutical and Medical Devices Industry led by the Indonesian Ministry of Health (Kemenkes) after passing through the development and data input processes since the end of 2021.

KFA was developed by the Directorate General of Pharmacy and Medical Devices in collaboration with the Centre for Data and Information – Digital Transformation Office (Pusdatin-DTO) to standardize data on pharmaceutical products and medical devices for the pharmaceutical industry, the medical device industry, government agencies, and health care facilities on a national scale.

"The existence of this KFA is expected to be a reference solution for pharmaceutical dictionaries and medical devices so that more accurate and precise analysis of pharmaceutical data and medical devices can be carried out in order to meet the needs and availability of pharmaceutical products and raw materials or medical devices, especially in conditions of disease outbreaks or natural disasters," says Setiaji, Chief of Digital Transformation Office, Ministry of Health.

Because there were no data standards during the early stages of the Covid-19 epidemic, it was challenging to integrate data on the needs of the product supply chain. This was owing to the shortage of medications and medical devices that resulted from a considerable spike in demand for a certain period. As a result, the nation requires a platform to combine and standardize different data on medications, drug raw materials, and medical devices.

KFA is an innovation that provides information on pharmaceutical items and medical devices in the form of a web browser tag as the KFA Browser. Manufacturers, distributors, and the public can now use the KFA Browser to search for standardized reference pharmaceuticals and medical equipment, which can then be accessed via a website.

Every pharmaceutical product and medical device registered in the KFA Browser will have a single unique code that works as an identifier to distinguish it from others. Visitors to the KFA Browser site can access product information data and its hierarchy using this code.

Around 4,569 product data have been successfully entered into KFA Browser to date. The figure will continue to grow in the future until it meets the aim of 133,101 total product data submitted and shown in the KFA Browser by the end of this year. In the future, KFA Browser will be linked to SATUSEHAT, a platform for facilitating the exchange of health data and information between hospital systems, laboratories, pharmacies, and independent clinics.

Meanwhile, the Ministry of Health recently announced the Biomedical & Genome Science Initiative (BGSi) to provide precision medical services to the people. BGSi is the first national initiative programme established by Health Minister Budi Gunadi Sadikin, to develop more appropriate community treatment. The process, known as whole genome sequencing, is based on the technology of gathering genetic information (genome) from humans and diseases such as viruses and bacteria (WGS).

According to the Minister of Health, the development of the WGS is in line with the transformation of biotechnology in biosurveillance activities and health services aimed at enhancing disease detection and better treatment. Previously, the WGS approach was adopted and played a key role in COVID-19 prevention in Indonesia.

https://opengovasia.com

ISLAMIC REPUBLIC OF IRAN

Nanotechnology patents

IRNA reported that Iran ranked 24th in 2021 for its patents registered in the United States Patent and Trademark Office (USPTO). According to the national nanotechnology development headquarters, Iran patented 307 innovations by the end of 2021 at registration offices in the United States and Europe. The patents related to nanotechnology at USPTO were 21 in 2021, while 34 other innovations were also registered in the office.

A comprehensive report on the development of the nanotechnology sector reveals that the country exported $553 million worth of nanotechnology products in the Iranian calendar year 1399 (March 2020-March 2021).

According to the report, 12,199 articles related to nanotechnology were indexed by Iranian researchers in the Web of Science (WoS) in 2021, equaling 41.5 percent of total nanotechnology articles published that year. These figures put Iran at fourth place in the world compared to the year 2000, in which Iran had published just eight articles in the field of nanotechnology, ranking the country 58th in the world. The ratio of nano-articles to the total number of articles published in Iran is the highest in the world, highlighting the amount of attention and priority given to nano-sciences in the country.

According to StatNano, nearly 202,000 nano-articles were issued in Journal Citation Reports (JCR) indexed journals, accounting for approximately 8.2 percent of the total articles indexed in WoS in 2021. Alternatively stated, about 8 percent of all scientific publications across the globe are in the field of nanotechnology. In terms of the ratio of nano-articles to the total number of articles, Iran still possesses the highest share in this index with 18.7 percent of the total articles falling in the category of nanotechnology.

Iran ranked 43rd among the 100 most vibrant clusters of science and technology (S&T) worldwide for the third consecutive year, according to the Global Innovation Index (GII) 2020 report. The country experienced a three-level improvement compared to 2019.

Nanotechnology's trend of development is growing in Iran, as the number of nano-products and equipment developed in the

Iranian calendar year, which ended March 20, 2021, increased to 750, compared with 647 a year before. Some 223 product manufacturing companies and 59 equipment manufacturing companies are active in the field of nanotechnology, and by the end of last year, which developed a total of 750 products and equipment. At the start of a national plan to develop the nanotechnology sector 15 years ago, more than 5,283 billion rials (about $19 million) were allocated to nanotechnology projects.

Iran's nanotechnology products are generally classified into three groups of goods, services, and equipment, and the service sector has grown by nearly 130 percent over the past year (March 2020-March 2021). Reports show that the largest share of the Iranian nano market, equivalent to 96 percent, belongs to goods. The service sector has grown by about 130 percent last year, from 443 billion rials (nearly $1.6 million) to 1 trillion rials.

https://www.tehrantimes.com

PHILIPPINES

Virus R&D funding

Funding for virus research has been raised by 58.14% to P419.3 million to support the establishment of the Virology and Vaccine Institute of the Philippines, the Department of Budget and Management (DBM) said. "We need to be proactive and fund a Virology Institute composed of highly-trained experts who will conduct studies on emerging virus strains as quickly as possible and prepare us in case of health emergencies," Budget Secretary Amenah F. Pangandaman said in a statement.

In his first State of the Nation Address last July, President Ferdinand R. Marcos, Jr., cited the creation of the institute as a legislative priority. Speaking in his budget message, Mr. Marcos said that the coronavirus disease 2019 (COVID-19) pandemic highlighted "the need for faster identification of and response to outbreaks."

"At present, the Department of Science and Technology's (DoST) Industrial Technology Development Institute (ITDI) and the Research Institute for Tropical Medicine (RITM)" have taken the lead on virus-related medical and scientific research, the DBM said. Specifically, these research projects include the identification of viruses in the Philippines with pandemic potential, tests on combination therapy for drug-resistant bacteria, the development of diagnostics for food- and waterborne bacterial pathogens, and an on-site detection method for African swine fever.

The 2022 General Appropriations Act also sets aside P360.5 million to establish the institute, including its operations to a second year, and P356.2 million to acquire scientific and laboratory equipment and vehicles.

https://www.bworldonline.com

Technology startups

The Philippines now hosts over 50 technology startups that are expected to help develop the country's AI ecosystem, which if further developed, has the opportunity to contribute $92 billion or 12 percent of the country's economy by 2030. This was revealed by Trade and Industry Undersecretary Rafaelita Aldaba at the Italy-Philippines Business Forum as DTI urged Italian businessmen to consider the business opportunities in the country and improve trade and business relationships between the two trading partners.

In terms of investments, Aldaba said that the past three years have seen a slowdown in investment inflows from Italy. So far this year, Italian investments in the Philippines stood at $380,000 only compared to about $3 million pre-pandemic. There are also 13 Italian firms registered with the Philippine Economic Zone Authority with total investments of P700 million. In terms of trade, Philippines exports to Italy recently grew by 14.36 percent from more than $203 million in 2020 to more than $232 million in 2021.

One of the DTI's flagship initiatives that would drive digital transformation is the establishment of an Industry 4.0 Pilot Factory, which will host pilot, demonstration, and learning laboratories for Industry 4.0 technologies, such as robotics, intelligent manufacturing systems, and cyber-physical systems. It will serve as a technology platform for various stakeholders and a training and research hub where industries can have hands-on experience with Industry 4.0 applications.

The proposed facilities that the Industry 4.0 Pilot Factory will house a demo and digital experience center where technology providers can showcase use-cases of their products, learning and co-working spaces where trainings and collaborative discussions can be conducted, an application and design hub where in-house applied R&D can be executed, exhibition centers for the conduct of events, and a prototyping sandbox where researchers and companies including subject-matter experts (SMEs) can develop proofs of concepts. To complement the Industry 4.0 Pilot Factory, DTI said it will also establish the Center for AI Research (CAIR) under the National AI Roadmap with the goal of making the Philippines an AI center of excellence.

To support the development of a robust startup ecosystem, which is composed of young, energetic, and tech-savvy population, the government is also implementing various incubation and acceleration programs, as well as funding, and market access programs to support innovative startups in all stages of development with the goal of growing homegrown tech giants.

Together with other government agencies, the DTI is also implementing the Philippine Skills Framework (PSF), which seeks to develop a common language that employers, workers, and training institutions share in order to address skills mismatch. To date, three industry-specific PSFs have been launched: supply chain and logistics, game development, and digital arts and animation. Two cross-sectoral PSFs on business development and human capital development have also been formulated.

In order to diffuse innovation in all parts of the country, the DTI is also establishing Regional Inclusive Innovation Centers (RIICs), which serve as platforms to connect stakeholders in the regions to

collaborate and advance innovation and entrepreneurship to drive regional industrialization.

https://mb.com.ph

Rules and regulations for patents, utility models, and industrial designs 2022

The Intellectual Property Office of the Philippines (IPOPHL) has announced a Revised Implementing Rules and Regulations (IRR) for Patents, Utility Models, and Industrial Designs that came into force on 20 September 2022.

Some notable key changes to the IRR are as follows:

- A general or specific power of attorney is now required at the time of filing. Failure to submit a power of attorney at the time of filing may result in the application being deemed incomplete.
- Notarization is no longer required for general powers of attorney and e-signatures are now acceptable.
- A summary of the invention section is now a required part of the description and lack of a summary of the invention section may result in the application being deemed incomplete.
- An application that is deemed incomplete will not be accorded a filing date. The filing date will be accorded as the date when all the requirements for a complete application have been met.
- Excess claim fees must be paid in full at the time of filing and multiple dependent claims, as well as claims directed to genus, species, and Markush type claims will be subject to claim fees.
- A one-month grace period from the notice of deficit in payment is available to pay any deficit claim fees, and failure to pay the deficit claim fees in full within the grace period will result in deletion of the unpaid claims.
- Voluntary divisional applications can now be filed within four months from the date of grant or withdrawal of the parent or earlier divisional application.
- When a requirement to divide due to a lack of unity objection is made final, it is now possible to appeal the requirement and request that the four-month period to file mandatory divisional applications starts only after the appeal is resolved.
- The deadline to file a mandatory divisional application from an original parent application is four months from the date the requirement to divide is made final, or four months from the date of the decision of the appeal.
- In the case of a mandatory divisional application based on an earlier divisional application, the deadline to file is four months from the date the requirement to divide is made final, or four months from the date of election.
- A two-month extension is available to file mandatory divisional applications.
- There is now only one two-month extension available for responding to office actions, instead of two.
- It is now possible to request for accelerated examination after the application is published and the request for examination has been filed.
- The period for filing an appeal against the refusal of an application has been shortened to two months from the mailing date of the notice of final refusal instead of four months.
- The period for filing a petition to revive a withdrawn application has been shortened to three months from the mailing date of the notice instead of four months.

https://www.mondaq.com

REPUBLIC OF KOREA

R&D digitalization

The Republic of Korea will spend 200 billion won ($144 million) on digital integration strategy projects over the next five years to shorten the time researchers take to solve complex problem surrounding new technologies by decades, states the Ministry of Science. According to the ministry, the government will use the financial support for projects that integrate AI, Digital Twin and Big Data, into developing diagnoses of diseases such as intractable cancer and dementia, nine new materials, and prediction models of changes in space.

The ministry plans to increase the number of smart laboratories such as AI robot material labs and bio foundry facilities. The government will look to strengthen support for advancing the infrastructure of collecting, sharing, and utilizing research data by setting up and operating a quality checking center for research data. The ministry will develop over 40 data analysis models for various research purposes including designing antibodies and diagnosing diseases through reviewing protein data as well as predicting synthesis probabilities based on material data. In order to secure core research personnel, the ministry will expand data science education for 1,000 postgraduate and doctorate students by 2028. The ministry will also provide AI education for some 8,000 researchers at government-funded research institutes through 2027.

https://www.koreaherald.com

Digital competitiveness

"We will bring up our global (artificial intelligence) competitiveness to No. 3 in the world and double the data market size to 50 trillion won ($34.7 billion) or bigger," said President Yoon Suk-yeol as he chaired the eighth pangovernmental meeting on economy and people's livelihood at the Kimdaejung Convention Center in Gwangju. The Republic of Korea's AI competitiveness is ranked sixth in the world, Yoon said, referencing Stanford's AI Index Report from 2021.

The announcement of the blueprint followed Yoon's consecutive speeches on the importance of combined efforts to decrease the digital gap across the world at the United Nations General Assembly and the role of digital technologies in expanding freedom for all at the Digital Vision Forum held by New York University in New York.

Under the blueprint, the Ministry of Science and information and

communication technology (ICT) set out five main strategies and 19 objectives. The strategies focus on securing world-leading digital abilities, expanding the digital economy, creating a digitally inclusive society, establishing a digital platform government, and innovating digital culture. The government will intensively invest in research and development for AI semiconductors, 5G and 6G networks, quantum, metaverse, and cybersecurity, the ministry said.

The Republic of Korea has allocated 1.02 trillion won for securing core technologies of AI semiconductors and 302 billion won for developing next-generation AI technologies by 2026. The plan includes fostering over 2,000 software service companies by 2027. According to the ministry, the government will aim to complete setting up the infrastructure for a nationwide 5G network by 2024 and secure the standard patent for 6G technology while pushing for a trial service of the world's first pre-6G network in 2026. The ministry expects the country to increase its competency in digital technology, industry, and talent under the blueprint to earn it a No. 3 spot on the Swiss International Institute for Management Development's (IMD) annual world digital competitiveness rankings in 2027.

According to the IMD's world digital competitiveness rankings, the Republic of Korea ranked eighth among the 63 countries assessed by the IMD. The Republic of Korea climbed four spots from the previous year's rankings. Of the countries with a population of 20 million or more, the Republic of Korea took the No. 2 spot, only behind the US. The IMD rated Seoul's adaptability to new technology as the world's best and the country's business agility as the second best among the 63 evaluated countries.

https://www.koreaherald.com

International standards about microgrid

A research team of Electronics and Telecommunications Research Institute (ETRI) has developed international standards for microgrid technology that maximizes energy usage efficiency through the convergence of electrical technology and ICT. The establishment of a stable and efficient energy utilization system is expected to serve as a solid foundation for the realization of carbon net zero.

ETRI said that two international standards for energy storage system (ESS) and demand response (DR), which are the key elements of the microgrid system, have been approved by the Technical Committee of the Electrical Energy Storage System (TC120), Industrial Process Measurement, Control and Automation (TC65) of the International Electrotechnical Commission (IEC).

The international standards for microgrid developed and established by ETRI this time are two items; the requirements and use cases for using ESS in power peak management and emergency power support, and the framework of demand response (DR)-based energy management system for industrial facilities such as factories.

Among the essential elements of the microgrid, the energy storage system stores the produced energy and then discharges the energy when electricity is not generated in the renewable energy sources or the amount of energy demand exceeds the pre-defined threshold to maintain a stable operation of microgird power systems. This prevents the waste of excess energy and enables the stable and efficient energy use.

The research team analyzed the structure of an emergency power support system based on the conventional diesel generator and developed the requirements and guidelines for applying ESS to the emergency power support system. The requirements and guidelines were presented in the approved international standard. The wider deployment of emergency power support system based on ESS is expected to significantly reduce carbon emissions compared to the conventional system. Moreover, it is the first approved IEC international standard for ESS developed by Korean experts in TC120.

https://www.eurekalert.org

SRI LANKA

National Instrument Database launched

The National Science Foundation (NSF) is the premier national institution delegated to promote science, technology, and innovation for socioeconomic development of the country. In keeping with its mandate and in order to advance a digital economy in Sri Lanka, the NSF recently embarked upon several novel initiatives. They included, among others, establishment of a global digital platform (GDP) to harness Sri Lankan expatriate scientists, technologists, entrepreneurs, and professionals for national development; construction of a National Instrument Database (NID) to promote R&D, industrial growth and exports; and taking steps for establishing a national digital library to provide academics and scientists with increased user-friendly access to scientific journals and databases in a cost-effective manner.

Sri Lanka has over 20 state-owned higher education institutions, a comparable number of R&D institutions, and several public-sector institutions, such as Sri Lanka Atomic Energy Board, Sri Lanka Standard Institute, and Board of Investment, which collectively possess an immense instrument base including high-end equipment, most of which has been purchased using public funds. Much of this equipment is meant to be used on a 24×7 basis, as is done in many parts of the world. However, due to compartmentalization and fragmentation of institutions, the "possessive attitude" of many scientists, the lack of a sharing culture, and the absence of an institutional policy and mechanism for providing analytical and testing services to external institutions and persons, many expensive items of advanced equipment and instruments purchased operate far below their capacity.

This database will contain information on the type of equipment, its model, year of manufacture, analytical and testing capabilities, location by means of a Google map, the turn-around time for sample analysis, cost of analysis, contact details, etc.

It is constructed in a user-friendly manner so that even a non-technical person can easily access it by indicating either the test required, for example aflatoxin, *Escherichia coli* (*E. coli*) bacteria, or heavy metal, or the name of equipment needed. This will enable the finder to find out the closest place available for sample analysis in a cost-effective and time-efficient manner. For instance, an industry, an SME, or a farmer in Mullaitivu may not need to send samples to Colombo for analysis but could get that done at the University of Jaffna or the University of Vavuniya, thereby avoiding a lot of hassle as well.

The NID will have information on analytical and testing facilities and parameters relevant to a wide range of samples, including ones of soil, water, air, food and beverage products, industrial pollution, food contamination, food safety, food hygiene, and material.

The NID, with its diverse and wide instrument base, will pave the way for establishing the required compliance infrastructure and capabilities in Sri Lanka. These will, among other things, promote exports, thereby enhancing foreign exchange reserves. This facility can also be used to monitor the quality of imported food and feed to the country, which is of prime importance given the spate of unhealthy and harmful imports to the country in the recent past. The import of large quantities of coconut oil contaminated with aflatoxin and fertilizers contaminated with heavy metal are two poignant examples.

This will ensure that edible products, both exported and imported, will be free of biological (e.g., salmonella, *E. coli* bacteria, etc.), chemical (e.g., pesticide residue, food additives, adulterants, etc.) and physical (e.g., glass, pieces of metal, plastic, or wood, etc.) hazards. This will protect public health, ensure the safety of consumers, and build the confidence of importers of Sri Lankan products, which will contribute to increasing forex reserves through improved exports and tourism.

Further, the NSF will work closely with institutions such as Sri Lanka Standards Institution (SLSI), Sri Lanka Accreditation Board (SLAB), and Measurement Units Standards and Services Department (MUSSD) to have a few selected laboratories accredited initially as per ISO/IEC 17025 standard in line with the high priority needs of the country concerning the key exports and imports. This will obviate any chance of shipments from Sri Lanka being returned due to non-compliance. This failure of compliance has, in the recent past, had a negative impact on Sri Lankan exports in a fiercely competitive globalized environment, and resulted in the payment of heavy demurrage to ships on account of the long turn-around time taken for quality testing.

In addition, the NID will provide more accessible and affordable opportunities for sample analyses resulting in improved cost-effectiveness and reduced turnaround time. This will thereby enhance the research culture, research accomplishments, and the output of postgraduates in higher education institutions in the country.

https://www.ft.lk

THAILAND

New patent e-filing system

In Thai Intellectual Property Law, patents are classified as the highest proprietary rights that give the owner the legal right to prevent others from manufacturing, distributing, using, or selling an invention for a certain period of time in a particular jurisdiction. Digital documents, as the permitted form of submission, improve the aforementioned safeguard by effectively providing enhanced access to the protection under Thai Intellectual Property Law.

Patent e-Document system

The Thai Department of Intellectual Property (DIP) has implemented the Patent e-Document system for use with the filing of patent and petty patent applications, effective from January 1, 2022. This aims to facilitate the filing of patent applications or amendments, promote environmental awareness (through paperless processes), and to expedite the registration process by allowing the advance submission of electronic files through the Patent e-Document system, but with certain criteria as follows:

1) This feature is only applicable to patent applications and petty patent applications as well as requests to amend patent and petty patent applications.

2) An e-Signature can be used in any document in accordance with the provisions under Section 9 of the Electronic Transactions Act B.E. 2544 (2001) as amended by the Electronic Transactions Act (3rd Edition) B.E. 2562 (2019). A scanned signature or signature signed electronically on electronic devices, for example using a stylus, are admissible.

3) This request to obtain a patent by way of the e-Document system will be considered as a patent application or petty patent application, or a request to amend a patent application or petty patent application once the user provides a reference number to an official of the DIP and pays the applicable fees as stipulated by law for each criterion.

4) The DIP will collect and maintain the files submitted into the system by the users with strict security measures for seven days following the date of issuance of the reference number. It will then be immediately erased from the system.

5) The applications filed through said e-Document system shall be examined in accordance with the current process stipulated by patent law and regulations.

The new e-Filing system

The DIP has implemented a new e-Filing system, effective from June 1, 2022, to support the operation of government officials as per the Licensing Facilitation Act B.E. 2558 (2015) and the "e-Payment Portal of Government" via the Comptroller General's Department under the Ministry of Finance.

With this new system, all patent applicants, including petty patents, designs, and any other types of applications or requests, can be filed via the e-Filing system; in such regard, they shall be deemed as being submitted instantly under the Patent Act B.E. 2522 (1979), without making reference

to the assigned number, but payment of the fees is required. However, the applicants will be required to follow-up on the application status and notification of orders, as well as rulings of the officials, the Director-General or the Board of Patents via e-Filing only.

Key points of e-Filing to be aware of

1) Once submitted, all information, even if it is inaccurate and/or incomplete, shall be deemed acknowledged and accepted by the applicant. Such inaccurate and/or incomplete information will be reflected in the memorandum of application.

2) Applicants must submit documents or evidence in accordance with the memorandum of application via the e-Filing system within 90 days following the date of application. Failure to proceed within such time period will be deemed as the applicant's intention not to proceed.

3) Any supporting evidence that cannot be converted into electronic data must be submitted to the officials at the DIP, Ministry of Commerce, or via registered mail within the prescribed period as stipulated by the Patent Act B.E. 2522 (1979).

4) The Applicants may be contacted to submit additional statements or to submit additional documents or items in support [Section 27 of the Patent Act B.E. 2522 (1979)] or by the Board of Patents [Section 73 of the Patent Act B.E. 2522 (1979)].

e-Payment

The payment of application fee and any other types of governmental fees must be made by no later than 11:00 pm on the day directly following the filing date via the e-Payment Portal system of the Thai Government. Failure to comply will be deemed as the applicant's intention to abandon the filed application or the filed request.

https://www.lexology.com

VIET NAM

New technology exchanges

Three national technology exchanges will be formed in the near future, facilitating connections with regional and global exchanges, as stated by Huynh Thanh Dat, Minister of Science and Technology. Speaking at a conference on developing an efficient, modern, and integrated science and technology market, Dat said, the exchanges will connect supply and demand, commercialize research products, and support organizations and individuals to display, demonstrate, exhibit, and promote transactions of scientific and technological products. The minister said it was necessary to build a shared database and portal on the science and technology market, invest in the development and application of tools for analysis, statistics, technology transactions, data processing, management, and connection of shared databases, digitization, and data integration.

"It was also necessary to establish a network and build a database of foreign and overseas Vietnamese talents who can contribute to the innovation and development of the Vietnamese science and technology market," Dat said. He said businesses will be supported to assess technology needs, create capacity and exploit intellectual property resources, analyze technology trends, and promote the use of technology to increase labor productivity.

Viet nam will move toward synchronizing the science and technology market with the commodity, labor, and financial markets. Enterprises will be supported to master technical standards and regulations and to protect and use intellectual property in negotiation, transaction, and purchase. The legal environment will be completed to promote international cooperation, especially technology transfer in priority sectors.

https://e.vnexpress.net

ASIA-PACIFIC

AUSTRALIA

The 3D printing process offers energy storage design options

University of New South Wales (UNSW) engineers have developed a process to print solid-state polymer electrolytes into any shape desired for use in energy storage. The research team from the School of Chemical Engineering led by Professor Cyrille Boyer, including Dr. Nathaniel Corrigan and Kenny Lee, states that the 3D printing process of such material could be particularly useful in future medical devices where small, intricately designed energy storage offers a number of benefits.

Solid-state electrolytes are a key component in solid-state batteries, although traditionally, they have suffered from poor performance due to low ionic conductivities or poor mechanical properties. However, in a paper published in Advanced Materials, the team from UNSW reports that their 3D printed solid polymer electrolyte (SPE) offers high conductivity as well as robust strength. This means the solid-state electrolytes can potentially be used as the actual structure of a device, creating a range of conceivable design opportunities, particularly for future medical products.

Although the SPE developed by the UNSW team is regarded as a high-performance material, the researchers say it can be manufactured using inexpensive and commercially available 3D printers rather than sophisticated engineering equipment.

The SPE described in the paper is composed of nanoscale ion-conducting channels embedded in a rigid crosslinked polymer matrix. It is produced via a process known as polymerization-induced microphase separation (PIMS). The researchers used 3D printing to have an intricate map of Australia, which was later tested as an energy storage device to demonstrate the material's versatility.

"One of the other benefits of this SPE in energy storage devices is the fact it increases the cycling stability - that is the number of charging and discharging cycles until its capacity is reduced to a certain .amount," says Dr. Corrigan. "In our paper, we show that this material is very stable and has the ability to charge and discharge over thousands of cycles. After 3000 cycles there was only roughly a 10 percent drop."

Researchers claim that 3D printing also reduces wastage compared to other traditional forms of manufacturing and reduces costs since the same machine can be used to produce a variety of differently shaped materials. In the future, they say product designers could use their SPE to create items with a much higher energy storage density.

https://www.printedelectronicsworld.com

CHINA

Machine learning to predict municipal solid waste generation

Machine prediction models with high accuracy, which can obtain new complex data and mine them in depth, are increasingly used to create short-, medium-, and long-term predictions for municipal solid waste (MSW) generation. Among them, algorithms such as artificial neural network (ANN), support vector machine (SVM), and gradient boost regression tree (GBRT) have been employed to forecast MSW generation. However, the lack of a high-accuracy model based on large-scale data collection and a wide range of influence variables limits the broad applicability of the model.

To meet the needs of the large-scale comprehensive treatment and realize the short-term MSW generation prediction, Professor Weijing Lu from Tinghua University and team members have worked jointly and used a wide range of data (countrywide, city-based) from 130 cities across China, and multilevel feature variables (e.g., socioeconomic factors, natural conditions, and internal conditions) to establish a machine learning multicity model of MSW generation with high accuracy. Their work analyzed and explored the waste management models of two typical large cities (Beijing and Shenzhen) in China. This study, titled "Development of machine learning multicity model for municipal solid waste generation prediction,» was published online in *Frontiers of Environmental Science & Engineering*.

This study constructed a database of MSW generation and feature variables covering 130 cities across China. Based on the database, an advanced machine learning (GBRT) algorithm was adopted to build the waste generation prediction model (WGMod). In the model development process, the main influencing factors on MSW generation were identified by weighted analysis. The selected key influencing factors were annual precipitation, population density, and annual mean temperature with weights of 13%, 11%, and 10%, respectively.

The WGMod showed good performance with $R^2 = 0.939$. Model prediction on MSW generation in Beijing and Shenzhen indicates that waste generation in Beijing would increase gradually in the next 3-5 years, while in Shenzhen it would grow rapidly in the next 3 years. The difference between the two is predominately driven by the different trends of population growth.

This study established a database of MSW generation and feature variables with 1012 data sets covering 130 cities across China. The developed WGMod performs reasonably well and is very suitable for predicting MSW generation in China. This study provided scientific methods and a basic data for multicity model development for MSW generation.

https://techxplore.com

3D printing sodium-ion micro batteries

Chinese researchers have developed a prototype of planar and flexible 3D printed sodium-ion micro batteries (NIMBs) with ultra-high areal capacity and boosted rate capability, according to a research article recently published in the journal Advanced Materials. Planar NIMBs

are a promising new micro-power source because of their rich sodium resources, low cost, and fast sodium ion transmission. But they are hindered by low areal capacity owing to the thin microelectrodes.

The researchers from the Dalian Institute of Chemical Physics of the Chinese Academy of Sciences developed 3D printable inks with appropriate viscosities and high conductivity. The material allows the multilayer printing of NIMB microelectrodes to reach a very high thickness of about 1,200 micrometers while maintaining effective ion and electron-transfer pathways.

The 3D-printed NIMBs deliver a superior areal capacity of 4.5 mAh per square centimeter at a low current density of 2 mA per square centimeter, outperforming the state-of-the-art printed micro batteries, said the research article.

The new NIMBs show enhanced rate capability with 3.6 mAh per square centimeter at a high current density of 40 mA per square centimeter and robust long-term cycle life of up to 6,000 cycles.

Furthermore, the planar NIMB microelectrodes exhibit decent mechanical flexibility under various bending conditions.

http://english.news.cn

Robotic fish to "eat" microplastics

Chinese scientists have developed a robotic fish that can remove microplastic particles from water environments. Researchers working on the project say the robots could help clean up plastic pollution in oceans around the world. The robotic swimmers are about 1.3 centimeters long. They are made of a soft chemical compound. The robots are designed to absorb microplastics while moving through the water.

The project was launched by a team at Sichuan University in southwestern China. The researchers said the robots have already performed well in shallow water, and they plan to carry out more tests in deeper waters. The scientists reported their findings in a new study in *Nano Letters*. The publication comes from the American Chemical Society, a non-profit organization supported by the U.S. Congress.

The robotic fish was built to target microplastic particles smaller than 5 millimeters. Studies have confirmed that microplastic pollution has been discovered in many natural environments. The material comes from the breakdown of manufactured plastic products and industrial waste. The team said that the robots can be controlled by light. Turning "a near-infrared light laser" on and off causes the fish's tail to move back and forth, the American Chemical Society said. The robotic fish can swim up to 2.76 body lengths per second. The researchers said this is faster than most similar soft robots.

Wang Yuyan was a member of Sichuan University's research team. She told the Reuters news agency that the small, lightweight robot is currently being used to collect microplastics for research purposes. But Wang added that the team plans to expand that use so the robot fish can remove larger amounts of microplastic waste from deep ocean areas.

The researchers said that the fish can take in different kinds of microplastics and even repair itself when damaged. And if a robot fish is accidentally eaten by a real fish, it could safely digest the material, the team added. Wang said similar robots could be developed to be placed inside the human body to remove unwanted materials or diseases.

https://learningenglish.voanews.com

INDIA

Indigenous metal 3D Printer

Indian Institute of Technology (IIT) Jodhpur researchers have indigenously developed a metal 3D printer based on the Direct Energy Deposition (DED) technology. All the components of this metal 3D printer, except the laser and robot systems, are designed and manufactured in India. The project›s main objective is to reduce the cost of metal 3D printers and attract a broader range of users.

Despite the fact that metal 3D printing technology started a few years after the launch of polymer 3D printing, it is yet to experience the tremendous growth that the polymer 3D industry has achieved, especially in India. The high price of the product and the more expensive proprietary metal powders imported from abroad are some of the reasons for the limited growth of metal 3D printers.

The printer developed is suitable for repairing and adding additional material to existing components. Hence, it is ideal for printing fully functional parts for a range of industries, like aerospace, defense, automotive, oil and gas, and general engineering, to name a few. This machine can print 3D parts with metal powders made in India. In addition, India's first state-of-the-art variable spot size laser optics, without compromising on laser beam homogeneity for laser cladding and additive manufacturing process, is available in this machine. The team at IIT Jodhpur has developed this machine's tool path planning software and coaxial nozzle. It also has in-situ monitoring technologies that constantly monitor the melt pool temperature and clad thickness during the additive manufacturing process.

The research team from IIT Jodhpur involved in this project are Ravi K.R., Associate Professor, Department of Metallurgical and Materials Engineering; V. Narayanan, Associate Professor, Department of Physics; Abir Bhattacharyya, Assistant Professor, Department of Metallurgical and Materials Engineering; Sumit Kalra, Assistant Professor, Department of Computer Science and Engineering; Rahul Chhibber, Associate Professor, Department of Mechanical Engineering, and Hardik Kothadia, Assistant Professor, Department of Mechanical Engineering.

Regarding this indigenously developed 3D printer, Ravi K said, «The small success of this research has given great hope to our team to undertake new endeavours. Moreover, it will further strengthen the trust placed on our team and organization by the funding agencies and industry that are assisting our current research and will be assisting us in the future.»

He added, "Our study results show that if all the parts needed to make a metal printing machine could be manufactured indigenously, the cost of a metal 3D printing machine could be reduced by two to three times. Moreover, such an initiative would further strengthen the policy decisions of the Government of India under the 'Atmanirbhar Bharat' initiative."

The project has been funded by the Technology Development and Transfer (TDT) Division, Department of Science and Technology (DST). Other academic and industrial collaborating partners are PSG College of Technology, Coimbatore; PSG Industrial Institute, Coimbatore; and VectraForm Engineering Solutions, Coimbatore.

Metal 3D printing technology, which has been slowly advancing over the past three decades, is poised to grow rapidly over the next decade due to the astounding progress that has taken place recently in sensors, artificial intelligence (AI), and machine learning (ML) technologies. The future scope of this research will be to transform the current metal 3D printing machine into a "smart metal 3D printer" by creating the infrastructure, expertise, team, etc., needed to participate in this race.

https://www.telegraphindia.com

AI tool for personalized cancer diagnosis

Researchers at IIT Madras have developed an AI-based tool, "PIVOT" that can predict cancer-causing genes in an individual. The tool is designed to help devise personalized cancer treatment strategies. Their work has been published in a reputed peer-reviewed journal, *Frontiers in Genetics*.

PIVOT, an AI tool, is designed to predict genes that are responsible for causing cancer in an individual. The prediction is based on a model that uses information on mutations, expression of genes, and copy number variation in genes and perturbations in the biological network due to an altered gene expression.

Dr. Karthik Raman, a core member of the Robert Bosch Centre for Data Science and Artificial Intelligence (RBCDSAI), and Malvika Sudhakar, a research scholar, at IIT Madras, explained that "in this tool, we are trying to use the available wealth of genomic sequences, we understand what are the mutations triggering this disease in terms of Driver versus passenger mutations."

"With PIVOT, we try to understand mutations that occur in a personalised manner. We have looked further into the Driver genes, wherein the tool can classify genes as tumour suppressor genes, oncogenes or neutral genes. The tool was able to successfully predict both the existing oncogenes and tumour-suppressor genes like TP53, PIK3CA etc. and new cancer-related genes such as PRKCA, SOX9 and PSMD4. The model learns from the data of known driver genes of the patient and then protects it from any unknown mutations you throw at it," says Ms. Malvika Sudhakar, a researcher on the team.

PIVOT is an AI that will collect and study data to identify personalized cancer genes. This would amass a large number of individual data, Dr. Karthik explains if that could be a potential challenge.

https://newsonair.com

Intelligence system and health monitoring solution for EVs

A new complete vehicle intelligence system and health monitoring solution for electric vehicles (EVs) can ensure safe and high EV performance, which will occupy a major part of the next-generation transportation system. The system can help in estimating the accurate state of health and state of charge of the battery pack, help fleet operators in their control, and facilitate seamless communication. The unavailability of such vehicle intelligence modules for the different components of EVs serves as a roadblock in their efficiency.

Delhi-based Vecmocon Technologies developed the vehicle intelligence system with critical battery data collection and monitoring, such as cell voltages, temperature, and the current health of the battery. Vecmocon, incubated at FITT-IIT Delhi, with seed support from the Department of Science and Technology, also provides solutions for intelligent vehicles, including keyless entry, preventive and predictive maintenance, user-adaptive algorithms, remote diagnostics, fleet management, and so on. It can cater to the entire ecosystem of EVs, such as motor power controllers, battery management systems, vehicle intelligence modules, cloud connectivity, etc., with specialized components for high-performance vehicles.

The patented technology at Technology Readiness Level 9 costs around 20-22k for the entire kit (battery management system - 4-5K, vehicle intelligence module - 6-8K, fast chargers - 4-5K, instrument cluster - 2-3K, motor controller - 4-5K) and is being used by more than 15 EV manufacturers as well as original equipment manufacturers (OEMs).

"While others are focused on 2 wheelers, 3 wheelers as a product in the Market, we at Vecmocon are building the ecosystem for electric vehicles to happen in India at a very faster pace. We design and develop core components for electric vehicles like Battery Management System, Motor Controller, Vehicle Intelligence Module, Chargers, and the whole of the cloud architecture for Data Analysis, Machine Learning, and Artificial Intelligence," said Peeyush Asati, one of the founders of the company.

Adarshkumar Balaraman, the other founder, acknowledged DST's support during the company's initial stages.

Vecmocon provides battery packs with all thermal and structural considerations, battery management systems, and machine learning (ML) algorithms for battery management design of computationally in-expensive system-local ML algorithms, which run on ₹100 microcontrollers. It has generated a revenue of ₹5 crore so far.

https://pib.gov.in

Wireless powering and communication technology for IoT applications

Researchers at the Indian Institute of Technology, Mandi, are working toward

developing efficient remote powering and communication technology for futuristic Internet of Things applications. The findings of this study were published in the *Wireless Networks*.

The study was led by Dr. Siddhartha Sarma, Assistant Professor, School of Computing and Electrical Engineering, IIT Mandi, and co-authored by his student Mr. Shivam Gujral, Ph.D. Scholar, School of Computing and Electrical Engineering, IIT Mandi. The Internet of Things (IoT) is a collection of objects (things) that can exchange data with each other through the Internet. IoT devices range from ordinary household appliances in a "smart" home to sophisticated industrial and scientific tools.

These smart things are equipped with sensors, chips, and software that must be powered and stay in communication with other devices at all times. Simplistic power sources such as batteries may be unsuitable for such applications because of the constancy of power required, and because some of these "things" may be embedded or hidden, which makes changing batteries difficult. There is thus worldwide research in combining remote communication technology with remote powering options.

Highlighting his research, Mr. Shivam Gujral, Ph.D. Scholar, School of Computing and Electrical Engineering, IIT Mandi, said, "We have developed a cooperative model, in which, backscatter communication and radiofrequency energy harvesting (RF-EH) devices act together to optimally allocate the resources such as time and antenna weights."

The team performed research on two such powering options—radiofrequency energy harvesting (RF-EH) and backscatter communication. In RF-EH, energy is transmitted by a dedicated transmitter to the IoT device through radio waves, the same kind of waves that are used in mobile phones for communication. In backscatter communication, as before, power is transmitted via radio waves, but with/without the need for a dedicated transmitter. Instead, RF signals available in the vicinity, such as WiFi, cell phone signals, etc., are harnessed through reflection and backscatter to power the IoT objects.

The RF-EH and backscatter devices have their own strengths and drawbacks. For example, while the latter is associated with considerable energy savings compared to the former, it suffers from reduced data rate and a shorter transmission range.

The IIT Mandi team has leveraged the complementary nature of these two technologies and judiciously combined them to achieve the desired quality of service (QoS) and efficiency using the power allotted to the system. Going into the technical aspects of this work, Dr. Siddhartha Sarma, Assistant Professor, IIT Mandi, mentioned, "We used a dedicated power transmitter for the two devices, in which the backscatter device transferred information through a monostatic configuration and the RFEH device through the HTT protocol. The team used extensive numerical simulations to establish the superiority of the proposed cooperative scheme over existing schemes. In these simulations, key parameters were varied to analyze the performance of the model."

Researchers plan to implement the joint radiofrequency energy harvesting backscatter communication system in real-time to analyze system performance. This would include working on the hardware aspects of the two complementary technologies. The potential of the proposed system is vast and includes, in addition to IoT devices, applications such as battery-free wireless cameras, wireless monitors, sensors, skin-attachable sensing platforms, contact lenses, machine-to-machine communication, and human-to-machine interactions.

https://www.iitmandi.ac.in

JAPAN

3D printed electrodes for batteries

Researchers from the Tohoku University in Sendai, Japan, recently announced the discovery of a new procedure in which high-performance carbon micro-lattice electrodes could be 3D printed for batteries. The newly introduced method that was published as a research article in the science journal, *Small,* could soon become an alternative way to produce cheaper and better-performing batteries. The effort may also be able to make the production and use of batteries less harmful to the environment.

By 3D printing carbon micro lattice electrodes for new, high-performance, low-cost batteries, Tohoku University materials scientist Akira Kudo and his colleagues recently introduced a procedure that might be the answer to the ongoing problem. The goal of this new approach is to increase the loaded number of active materials that are used to make a battery into a single battery cell by maximizing their potential and capability. This desired increase in loaded materials would reduce the inactive materials. While these inactive materials are responsible for binding multiple cells together, the battery would require thicker electrodes instead, which would restrict ion movement and the electric charge within the battery.

In their new attempt, Akira Kudo and his team used stereolithography (SLA) to create micro lattice structures from resin, which are then shrunk by carbonizing them via a process called pyrolysis. The resulting hard carbon anodes are able to transport energy-generating ions faster and have a finer lattice structure, which increases the anode's performance altogether. Kudo also states that "As 3D printers gain increasing resolution, sodium-ion batteries could eventually outperform lithium-ion ones." Although the new discovery is a major breakthrough for Kudo and his team, the scientists are still working toward their ultimate goal, which is to further develop the process and soon use these finely architected electrodes to make high-performing, cost-effective sodium-ion batteries.

https://www.3dnatives.com

Robot that can peel bananas

Researchers in Japan have developed a robot capable of **peeling** a banana without crushing the fruit inside. While the two-armed machine is only successful

57 percent of the time, banana peeling points to a future where machines could do more sensitive, skillful kinds of work. A video from researchers at the University of Tokyo showed the robot pick up and peel a banana with both hands in about three minutes.

Researchers Heecheol Kim, Yoshiyuki Ohmura, and Yasuo Kuniyoshi trained the robot using a "deep imitation learning" process. In this training, they showed the banana-peeling action hundreds of times to the robot to produce enough data for the robot to learn the actions and copy them. In this case, the banana reached its success rate after more than 13 hours of training.

While the experiment requires more testing, Kuniyoshi believes his method can teach robots to do different simple "human" tasks. He hopes the better-trained robots can help with Japan's labor shortage problems, particularly in food-processing factories that currently depend on human workers.

https://learningenglish.voanews.com

REPUBLIC OF KOREA

AI-based precision medicine technology

A team of researchers at the Pohang University of Science and Technology (POSTECH) has improved the accuracy of predicting patient response to immune checkpoint inhibitors (ICIs) by using network-based machine learning. The research team discovered new network-based biomarkers by analyzing the clinical results of more than 700 patients with three different cancers (melanoma, gastric cancer, and bladder cancer) and the transcriptome data of the patients' cancer tissues. By using the network-based biomarkers, the team successfully developed artificial intelligence (AI) that could predict the response to anticancer treatment.

The team further proved that the treatment response prediction based on the newly discovered biomarkers was superior to that based on conventional anticancer treatment biomarkers, including immunotherapy targets and tumor microenvironment markers. This study helps detect patients who will respond to immunotherapy in advance and establish treatment plans, resulting in customized precision medicine with more patients to benefit from cancer treatments.

https://www.biospectrumasia.com

SINGAPORE

Assistive robot to prevent falls for the elderly

Researchers at Nanyang Technological University, Singapore (NTU Singapore) and Tan Tock Seng Hospital (TTSH) have developed a wearable assistive robot that can detect and prevent a fall before it happens, reducing the user's risk of sustaining injuries.

The development of the robot, which can also be used to aid patients' rehabilitation from their injuries, was catalyzed by the National Robotics Program, a multiagency national program that looks at the end-to-end development of differentiating robotics enablers and solutions in Singapore, from funding R&D to facilitating partnerships for translation and adoption to maximize socioeconomic impact.

Called the Mobile Robotic Balance Assistant or MRBA (pronounced Mister-Bah), the robot uses its inbuilt sensors to instantaneously detect a loss of balance and catches the user with its attached safety harness, which is worn around the user's hips. The device would also help users who have difficulty in walking and balancing to stand up safely from a seated position, and to sit down safely from a standing position. It also uses a depth-sensing camera to observe the user's movements, while its machine learning algorithms estimate the balance state of the user in real time to better predict any future imbalances or falls.

The human balance control system degenerates with age. This is exacerbated by conditions such as neurological diseases and injuries, musculoskeletal problems like ankle sprains, scoliosis, or missing limbs as well as vertigo. This loss of balance control often results in falls, especially in the elderly.

MRBA was co-developed by a team of researchers, engineers, and data specialists at the Rehabilitation Research Institute of Singapore (RRIS), alongside clinicians and researchers at TTSH. RRIS, which is hosted at NTU's Lee Kong Chian School of Medicine, was founded in 2016 by NTU Singapore, the Agency for Science, Technology, and Research (A*STAR), and the National Healthcare Group (NHG).

In clinical trials involving 29 participants, including patients who suffered from stroke, traumatic brain injuries, and spinal cord injuries, the researchers found that MRBA was successful in aiding them with sitting, standing, and walking as well as assisting in tasks like fetching water. No falls were recorded in the trials, which spanned three days per participant.

The technology presents an improved tool to help in the care of Singapore's aging population, reflecting both NTU's and TTSH's commitment to using technology and innovation to respond to the needs and challenges of healthy living and aging, which is one of four humanity's grand challenges that the university seeks to address through its NTU 2025 strategic plan.

Associate Professor Ang Wei Tech, Executive Director of RRIS, who supervised the project's development, says that "MRBA could prove to be an invaluable resource for older adult users, and help promote independent living and aging. The development of the robot was a result of a fruitful collaboration with TTSH, blending our expertise in engineering and machine learning with their strengths in rehabilitation and medicine." Associate Professor Ang is also from NTU's School of Mechanical and Aerospace Engineering.

MRBA comes in three models. The first model caters to users that weigh up to 80 kilograms, while the second assists those who weigh up to 120 kilograms. The third version, the Agile model, supports more dexterous movements. In addition to assisting users in daily living, the robot can also support physiotherapy consultations by assisting those recovering from injuries to carry out key rehabilitation exercises, such as side stepping, balancing on a

rocker board, and standing on one leg. In providing such balance support, users feel more confident in going about their daily activities, including sports, such as bouncing and throwing a basketball, kicking a soccer ball, and even playing badminton.

https://medicalxpress.com

AI-based method to identify cancer mutations

A*STAR scientists have developed a novel AI-based method, named Variant Network (VarNet), that can inspect and identify cancer mutations (variants) in the millions of DNA fragments inside a tumor sample.

Scientists from A*STAR's Genome Institute of Singapore (GIS) have developed a novel AI-based method, named Variant Network (VarNet), that can inspect and identify cancer mutations (variants) in the millions of DNA fragments inside a tumor sample. It will serve as a key compass in steering personalized treatment strategies in the fight against cancer. VarNet can be used in both clinical as well as research settings to analyze mutations to tailor treatment strategies or better understand cancer. The research was published in *Nature Communications* on July 22, 2022.

Cancer is a genetic disease caused by mutations acquired during an individual's lifetime. Identifying these mutations has been a longstanding challenge that must be solved in order to develop personalized treatment strategies—providing the right treatment to the right patient at the right time. This research was developed to address that challenge.

VarNet uses deep learning, an AI approach, to detect cancer mutations without any specialized knowledge of cancer and genomics. VarNet was trained on vast amounts of cancer sequencing data from both Singapore and international databases. When evaluated on real tumor benchmarks, VarNet often exceeds existing mutation identification algorithms in terms of accuracy. The accurate identification of mutations in tumors affects downstream analyses that could have an impact on research outcomes as well as treatment decisions in the clinic.

Dr. Anders Skanderup, Group Leader of the Laboratory of Computational Cancer Genomics and corresponding author of the study said, "We have been working on machine learning methods for some time to improve detection of cancer mutations. During this work, we learned that human experts were often involved in the process to validate selected high confidence cancer mutations. Such human experts make decisions by inspecting images of DNA reads overlapping the potential mutations. However, while a human can only do this for a couple of mutations in a limited amount of time, an AI-approach could potentially perform the same task across the entire 3 billion nucleotides in the human genome. This inspired us to leverage deep learning approaches that learn patterns in images, and develop a pure AI-based method for identifying mutations in cancer."

Kiran Krishnamachari, a PhD candidate and A*STAR Computing and Information Science scholar affiliated with GIS who is the first author of the study, noted that the system learnt to detect mutations from the raw data in a manner that a human expert would do when manually inspecting potential mutations. He remarked, "This gave us the confidence that the system can learn relevant mutational features when trained on vast sequencing datasets, using our weak-supervision strategy that does not require excessive manual labelling."

Professor Patrick Tan, Executive Director of GIS, said, "Identifying cancer mutation is a critical step in developing precision medicine. VarNet demonstrates that deep machine learning can detect cancer mutations with an accuracy often exceeding existing state-of-the-art methods."

https://www.eurekalert.org

EUROPE

Flying 3D printing drones to create and repair buildings

A team led by scientists at Imperial College London and Empa—the Swiss Federal Laboratories of Materials Science and Technology—claims the lab-tested system could be used for manufacturing and building in difficult-to-access or dangerous locations, such as high-rise buildings, or help with post-disaster relief construction. The researchers have trailed the flying, 3D printing robots using "collective building methods inspired by natural builders like bees and wasps who work together to create large, intricate structures."

According to the team, the drones in the Aerial Additive Manufacturing (Aerial-AM) fleet work co-operatively from a "single blueprint, adapting their techniques as they go." Although fully autonomous while flying, they are monitored by a human controller who checks progress and intervenes, if necessary, based on the information provided by the drones.

Aerial-AM uses both a 3D printing and path-planning framework to help the drones adapt to variations in the geometry of the structure as the build progresses. The fleet consists of BuilDrones, which deposit materials during flight, and quality-controlling ScanDrones that continually measure the BuilDrones' output, informing their next manufacturing steps.

To test this concept, the researchers developed four different cementitious mixtures for the drones to build with. Throughout the construction, the drones assessed the printed geometry in real time and adapted their behavior to ensure they met the build specifications. The researchers said the drones achieved a manufacturing accuracy of 5 mm.

The team's proof-of-concept prints included a 2.05 m-high cylinder (72 layers) with a polyurethane-based foam material and a 0.18 m-high cylinder (28 layers) with a custom-designed structural cementitious material.

https://www.architectsjournal.co.uk

SWITZERLAND

Preparing for future COVID variants using AI

Researchers led by Professor Sai Reddy from the Department of Biosystems Science and Engineering at ETH Zurich in

Basel have now developed a way of using artificial intelligence to answer such questions, potentially even in real time immediately after a new variant emerges. The new method takes a comprehensive approach: for each variant in this multitude of potential viral variants, it predicts whether or not it is capable of infecting human cells and if it will be neutralized by antibodies produced by the immune system found in vaccinated and recovered persons. It is highly likely that hidden among all these potential variants is the one that will dominate the next stage of the COVID-19 pandemic.

To establish their method, Reddy and his team used laboratory experiments to generate a large collection of mutated variants of the SARS-CoV-2 spike protein. The scientists did not produce or work with live virus, rather they produced only a part of the spike protein, and therefore there was no danger of a laboratory leak.

The spike protein interacts with the angiotensin-converting enzyme 2 (ACE2) protein in human cells for infection, and antibodies from vaccination, infection, or antibody therapy work by blocking this mechanism. Many of the mutations in SARS-CoV-2 variants occur in this region, which allows the virus to evade the immune system and continue to spread. Although the collection of mutant variants the researchers have examined only comprises a small fraction of the several billion theoretically possible variants, which would be difficult to examine in a laboratory setting, it does contain a million such variants. These carry different mutations or combinations of mutations.

By performing high-throughput experiments and sequencing the DNA from these million variants, the researchers determined how successfully these variants interact with the ACE2 protein and with existing antibody therapies. This indicates how well the individual potential variants could infect human cells and how well they could escape from antibodies.

The researchers used the collected data to train machine learning models, which are able to identify complex patterns and when given only the DNA sequence of a new variant could accurately predict whether it can bind to ACE2 for infection and escape from neutralizing antibodies. The final machine learning models can now be used to make these predictions for tens of billions of theoretically possible variants with single and combinatorial mutations and going far beyond the million that were tested in the laboratory.

The new method will help develop the next generation of antibody therapies. Several of such antibody drugs were developed to treat the original SARS-CoV-2 virus and approved for use in the United States and Europe. Among these, five antibody drugs were removed from clinical use, and many others under clinical development were discontinued because they could no longer neutralize the Omicron variant. To address this challenge, the new method may be applied to identify which antibodies have the broadest activity.

"Machine learning could support antibody drug development by enabling researchers to identify which antibodies have the potential to be most effective against current and future variants," says Reddy. The researchers are already working with biotechnology companies that are developing next-generation COVID-19 antibody therapies.

Additionally, the method developed at ETH Zurich could be applied to support the development of next-generation COVID-19 vaccines. The focus here is to identify virus variants that still bind to the ACE2 protein, and can therefore infect human cells, but cannot be neutralized by the antibodies present in the vaccinated and recovered people. In other words, variants that can escape the human immune response. This was indeed the case with the Omicron variant that escaped from most antibodies, and resulted in many breakthrough infections in vaccinated and previously infected people. Therefore, similar to antibody therapies, it would be a major advantage if vaccines could induce antibodies that provide protection against potential future viral variants.

https://www.eurekalert.org

UK

Machine learning algorithm predicts EV battery life

Researchers have developed a machine learning algorithm that could help reduce charging times and prolong battery life in electric vehicles by predicting how different driving patterns affect battery performance, improving safety and reliability. The researchers from the University of Cambridge, say that their algorithm could help drivers, manufacturers, and businesses get the most out of the batteries that power electric vehicles by suggesting routes and driving patterns that minimize battery degradation and charging times.

The team developed a non-invasive way to probe batteries and get a holistic view of battery health. These results were then fed into a machine learning algorithm that can predict how different driving patterns will affect the future health of the battery.

If developed commercially, the algorithm could be used to recommend routes which get drivers from point to point in the shortest time without degrading the battery, for example, or recommend the fastest way to charge the battery without causing it to degrade. The results are reported in the journal *Nature Communications*.

The health of a battery, whether it's in a smartphone or a car, is far more complex than a single number on a screen. "Battery health, like human health, is a multidimensional thing, and it can degrade in lots of different ways," said first author Penelope Jones, from Cambridge's Cavendish Laboratory. "Most methods of monitoring battery health assume that a battery is always used in the same way. But that's not how we use batteries in real life. If I'm streaming a TV show on my phone, it's going to run down the battery a whole lot faster than if I'm using it for messaging. It's the same with electric cars – how you drive will affect how the battery degrades."

The researchers developed a non-invasive probe that sends high-dimensional electrical pulses into a battery and measures the response, providing a series of "biomarkers" of battery health. This method is

gentle on the battery and does not cause it to degrade any further. The electrical signals from the battery were converted into a description of the battery's state, which was fed into a machine learning algorithm. The algorithm was able to predict how the battery would respond in the next charge-discharge cycle, depending on how quickly the battery was charged and how fast the car would be going the next time it was on the road. Tests with 88 commercial batteries showed that the algorithm did not require any information about the previous usage of the battery to make an accurate prediction.

The experiment focused on lithium cobalt oxide (LCO) cells, which are widely used in rechargeable batteries, but the method is generalizable across the different types of battery chemistries used in electric vehicles today.

The researchers are now working with battery manufacturers to accelerate the development of safer, longer lasting next-generation batteries. They are also exploring how their framework could be used to develop optimal fast charging protocols to reduce electric vehicle charging times without causing degradation. The research was supported by the Winton Programme for the Physics of Sustainability, the Ernest Oppenheimer Fund, the Alan Turing Institute, and the Royal Society.

https://www.eurekalert.org

NORTH AMERICA

CANADA

Machine learning to keep drinking water safe

Waterborne illness is one of the leading causes of infectious disease outbreaks in refugee and internally displaced persons (IDP) settlements, but a team led by York University has developed a new technique to keep drinking safe water using machine learning, and it could be a game changer. The research is published in the journal *PLOS Water*.

"When water is stored in a container in a dwelling it is at high risk of being exposed to contaminants, so it's imperative there is enough free residual chlorine to kill any pathogens," says Ph.D. student Michael De Santi from Lassonde School of Engineering, who is part of York's Dahdaleh Institute for Global Health Research, and who led the research.

Recontamination of previously safe drinking water during its collection, transport, and storage has been a major factor in outbreaks of cholera, hepatitis E, and shigellosis in refugee and IDP settlements in Kenya, Malawi, Sudan, South Sudan, and Uganda.

"A variety of factors can affect chlorine decay in stored water. You can have safe water at that collection point, but once you bring it home and store it, sometimes up to 24 hours, you can lose that residual chlorine, pathogens can thrive and illness can spread,» says Lassonde Adjunct Professor Syed Imran Ali, a Research Fellow at York›s Dahdaleh Institute for Global Health Research, who has firsthand experience working in a settlement in South Sudan.

Using machine learning, the research team—including Associate Professor Usman Khan, also of Lassonde—has developed a new way to predict the probability that enough chlorine will remain until the last glass is consumed. They used an artificial neural network (ANN) along with ensemble forecasting systems (EFS), something that is not typically done. EFS is a probabilistic model commonly used to predict the probability of precipitation in weather forecasts.

"ANN-EFS can generate forecasts at the time of consumption that take a variety of factors into consideration that affect the level of residual chlorine, unlike the typically used models. This new probabilistic modeling is replacing the currently used universal guideline for chlorine use, which has been shown to be ineffective," says Ali.

Factors such as local temperature, how the water is stored and handled from home to home, the type and quality of the water pipes, water quality, and whether a child dipped their hand in the water container can all play a role in how safe the water is to drink.

"However, it's really important that these probabilistic models be trained on data at a specific settlement as each one is as unique as a snowflake," says De Santi. "Two people could collect the same water on the same day, both store it for six hours, and one could still have all the chlorine remaining in the water and the other could have almost none of it left. Another 10 people could have varying ranges of chlorine."

The Safe Water Optimization Tool Project provided the researchers with data on routine water quality monitoring from two refugee camps in Tanzania and Bangladesh. In Bangladesh, the data was collected from 2,130 samples by Médecins Sans Frontières from Camp 1 of the Kutupalong-Balukhali Extension Site, Cox's Bazaar between June and December 2019 when it hosted 83,000 Rohingya refugees from neighboring Myanmar.

Determining how to teach the ANN-EFS to come up with realistic probability forecasts with the smallest possible error required out-of-the-box thinking. "How that error is measured is key as it determines how the model behaves in the context of probabilistic modeling," says De Santi. "Using cost-sensitive learning, a tool that morphs the cost function toward a targeted behavior when using machine learning, we found it could improve probabilistic forecasts and reliability. We are not aware of this being done before in this context."

For example, this model can say that under certain conditions at the tap with a particular amount of free residual chlorine in the water, there is a 90 percent chance that the remaining chlorine in the stored water after 15 hours will be below the safety level for drinking.

https://phys.org

USA

AI-based screening method for drug discovery

Using a technique that models drug and target protein interactions using natural language, researchers achieved up to 97% accuracy in identifying promising drug candidates. Developing life-saving

medicines can take billions of dollars and decades, but the University of Central Florida researchers are aiming to speed up this process with a new artificial intelligence-based drug screening process they've developed.

Using a method that models drug and target protein interactions using natural language processing techniques, the researchers achieved up to 97% accuracy in identifying promising drug candidates. The results were published recently in the journal *Briefings in Bioinformatics*.

The technique represents drug–protein interactions through words for each protein binding site and uses deep learning to extract the features that govern the complex interactions between the two. "With AI becoming more available, this has become something that AI can tackle," says study co-author Ozlem Garibay, an Assistant Professor in UCF's Department of Industrial Engineering and Management Systems. "You can try out so many variations of proteins and drug interactions and find out which are more likely to bind or not."

The model they have developed, known as AttentionSiteDTI, is the first to be interpretable using the language of protein binding sites. The work is important because it will help drug designers identify critical protein binding sites along with their functional properties, which is key to determining if a drug will be effective.

The researchers made the achievement by devising a self-attention mechanism that makes the model learn which parts of the protein interact with the drug compounds while achieving state-of-the-art prediction performance. The mechanism's self-attention ability works by selectively focusing on the most relevant parts of the protein.

The researchers validated their model using in-lab experiments that measured binding interactions between compounds and proteins and then compared the results with the ones their model computationally predicted. As drugs to treat COVID are still of interest, the experiments also included testing and validating drug compounds that would bind to a spike protein of the SARS-CoV2 virus.

https://www.ucf.edu

Robots and AI to help develop better batteries

Carnegie Mellon researchers used a robotic system to run dozens of experiments designed to generate electrolytes that could enable lithium-ion batteries to charge faster, addressing one of the major obstacles to the widespread adoption of electric vehicles. The system of automated pumps, valves, and instruments, known as Clio, mixed various solvents, salts, and other chemicals together, then measured how the solution performed on critical battery benchmarks. Those results were then fed into a machine learning system, known as Dragonfly that used the data to propose different chemical combinations that might work even better.

In the end, the system produced six electrolyte solutions that outperformed a standard one when the Carnegie researchers placed them into small test cells, according to a new paper in *Nature Communications*. The best one showed a 13% improvement over the top-performing baseline battery cell.

Developing better electrolytes is crucial for improving the performance, safety, and cost of batteries. Faster-charging batteries are especially important for making electric cars and trucks more appealing, as they can ease the annoyance of long delays at charging stations.

In recent years, research labs have increasingly coupled automated systems with machine learning software that identifies data patterns to improve at designated tasks to develop materials ideally suited to particular applications. Scientists have tapped into these methods to identify promising materials for solid-state electrolytes, solar photovoltaic cells, and electrochemical catalysts. Several startups have emerged to commercialize the approach as well, including Chemify and Aionics. Alán Aspuru-Guzik is using AI, robots, and even quantum computing to create the new materials that we will need to fight climate change.

In the case of electrolyte ingredients, "you can mix and match them in billions of ways," says Venkat Viswanathan, an Associate Professor at Carnegie Mellon, a co-author of the Nature Communications paper, and a cofounder and chief scientist at Aionics. He collaborated with Jay Whitacre, director of the university's Wilton E. Scott Institute for Energy Innovation and the co-principal investigator on the project, along with other Carnegie researchers, to explore how robotics and machine learning could help.

The promise of a system like Clio and Dragonfly is that it can rapidly work through a wider array of possibilities than human researchers can and apply what it learns in a systematic way.

In the case of battery experiments, the Carnegie Mellon team was looking for an electrolyte that would speed up the recharging time for batteries. The electrolyte solution helps shuttle ions—or atoms with a net charge due to the loss or gain of an electron—between the two electrodes in a battery. During discharge, lithium ions are created at the negative electrode, known as the anode, and flow through the solution toward the positive electrode, the cathode, where they gain electrons. During charging, that process is reversed. One of the key metrics Clio measured and sought to optimize is "ionic conductivity," or how readily ions flow through the solution, which directly affects how quickly a battery can recharge.

https://www.technologyreview.com

Affordable 3D printed plasma sensors for climate change monitoring

Researchers at the Massachusetts Institute of Technology (MIT) have used 3D printing to create unique plasma sensors with the potential to help scientists better understand the impact of climate change.

Compared to traditional weather-monitoring sensors, the team's laser-cut and 3D-printed alternative can be produced outside of cleanroom conditions, reducing its lead time from weeks to just a few days. This, alongside their relatively

low manufacturing cost, could make the devices ideal for fitting to CubeSats, where they can monitor temperature fluctuations in Low Earth Orbit (LEO).

At the core of the team's redesigned sensor is a laser-cut, five-electrode stack inside a 3D printed glass-ceramic electrode housing and CNC-machined shroud. In practice, the housing is designed to spatially distribute electrodes using a set of grooves that interact with a set of deflection springs. That said, the researchers actually explored two different stack designs, one in which all apertures were of the same size, and another, where clusters were matched to a single aperture in a "floating grid" formation.

Both were made using a Tethon 3D Bison 1000 system and Vitrolite, a durable pigmented glass capable of withstanding temperatures of up to 800°C, and designed with hexagonally packed apertures, to maximize the number that could be fitted in. For each RPA design, the aperture size was also optimized via finite element analyses, in an attempt to achieve optimal ion transmission across the device's grid.

Once ready, the team subjected their prototypes to ion energy distribution simulations and practical testing via electron impact ionizer and helicon plasma testing. In the former, both designs proved able to estimate the average energy of ions accurately, but in practical evaluations, the devices showed potential in different application areas.

In practice, the uniform grid design was especially effective at measuring a wide range of plasmas, similar to those that a satellite would ordinarily encounter in orbit. However, the other, featuring a floating grid alignment, proved better-suited to sensing dense and cold plasmas, at an accuracy of just 50 µm, the likes of which are usually only measurable using ultra-precise semiconductor devices.

Given that testing had revealed their devices could "perform at par with state of the art," the researchers concluded them to have significant potential to facilitate accessible weather monitoring. Moving forward, the team believes that binder jet 3D printing could be used to produce even more of the RPA's parts, in a way that could reduce its mass and improve its performance.

Additive manufacturing continues to find widespread satellite applications, not just in the creation of ancillaries but also in the casings of the devices. ROBOZE, for instance, has partnered with the University of Colorado Boulder to 3D print a weather-monitoring CubeSat designed to analyze the electromagnetic waves caused by lightning strikes.

Alongside Alba Orbital and MiniCubes, CRP Technology has also continually used its Windform XT 2.0 material to 3D print pocket satellites and deployers. Working with the former, the firm previously deployed the technology and its carbon fiber composite to reduce the weight of the "Alba 2" PocketQube deployers by 60%.

On a more commercial level, Franco-Italian aerospace manufacturer Thales Alenia Space continues to use 3D printing in the series production of satellites.

https://3dprintingindustry.com

AI-engineered plastic-eating enzyme

Researchers at the University of Texas (UT) at Austin used a new machine learning (ML) algorithm to create a new variant of enzymes that could potentially degrade plastic. Hal Alper is a lead researcher of the engineering biology team in the McKetta Department of Chemical Engineering at UT at Austin. He is also a professor and fellow of the Les and Sherri Stuewer Professorship in Chemical Engineering at UT. Alper and his team of engineers and scientists created a variant of an enzyme called hydrolase using an ML algorithm. The enzyme is capable of breaking down polyethylene terephthalate (PET), one of the most common plastics used today, into its component molecules.

Once PET plastic waste breaks down, it can be reused to create entirely new PET materials, essentially leading to a circular plastics economy. In the past, attempts in enzymatic degradation were unsuccessful, mainly due to a lack of robustness to acidity (pH), temperature ranges, and slow reaction rates.

During the project, Alper and the team at UT Austin found that the novel plastic-eating enzyme, referred to as FAST-PETase (functional, active, stable, and tolerant PETase), can break down plastics at a much faster rate than other PET hydrolases used in previous studies. It is also capable of degrading both mixed-colour and clear PET plastic products.

Untreated, post-consumer PET from 51 different products was almost completely degraded by the new FAST-PETase enzyme in only one week. At 50°C, the team reported that portions of an entire thermally pretreated water bottle and a commercial water bottle could also be broken down. Because this new enzyme can break down plastics so quickly and on a large scale, it will have virtually limitless potential to assist many industries in their waste reduction efforts.

For many environmental cleanup activities, controlling the outdoor temperature is a major challenge.

The plastic-eating enzyme is sensitive to changes in temperature, rendering enzymatic degradation ineffective. Since the FAST-PETase enzyme degrades plastic and handles variations in temperature simultaneously, it would be effective in non-laboratory conditions. This new discovery could be a major advantage to environmental organizations and other agencies focused on cleaning the environment.

With enough quantity, the enzyme can clean up landfills, waste plants, and other sites that are negatively affected by plastic pollution. The plastic-eating enzyme is affordable, portable, and can be applied extensively. The role of ML in this research is critical. Without the model developed by UT's researchers, the new enzyme discovery might not have been possible.

https://earth.org

Growing Local Roots, Weaving Global Links

Opportunities and Challenges for the Manufacturing Sector in Southeast Asia

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Abstract

As the region develops rapidly, manufacturers in Southeast Asia are faced both by pressures on the part of foreign investors and key customers to "re-shore" some activities or to move some others to low-cost locations. The growing concern about relying on China on the part of Western firms may open a window of opportunity for them to upgrade their participation in global supply chains, creating and capturing more value. This calls for firms and governments to develop locally rooted ecosystems and have them contribute to global supply networks. We outline specific action domains and policies for governments to help develop such ecosystems.

Introduction

Emerging economies in Southeast Asia are facing a dual challenge: The continuation of a "race to the bottom" on the part of some multinational companies (MNCs) and global brand companies and the risk of a growing "re-shoring" of more complex manufacturing activities. As labour costs grow in these emerging economies, the dual challenge can undermine their success in the world economy.

However, they are also presented with an opportunity: the tensions between the West and China have led many firms to reconsider their investment and supply chain policies in China and now favour Southeast Asian economies. This provides an opportunity for local economies to achieve a "step change" in their position in the world economy.

The challenge

Our research in rapidly catching-up economies suggests that growing strong local roots and weaving effective global links offer a key to countering these dual risks and taking advantage of the opportunity to attract and upgrade foreign investments as well as orient local firms with higher value contributions to global supply chains. The precedent of Singapore, although now old, is instructive here. Following independence in 1965, Singapore had transformed itself from relying on ship repairs, an activity inherited from British colonial times, to invest in becoming a transshipment hub for Southeast Asia and a manufacturing centre for electrical and electronics industries. By the 1990s, Singapore realized that its future development depended on becoming a knowledge magnet for these industries (to which pharmaceutical and biological industries were later added). Just remaining a manufacturing centre carried the risk of falling prey to a "race to the bottom" on the part of footloose MNCs. So, key public policy priorities were attracting higher-value activities and anchoring them in Singapore.

Building strongly rooted local industrial ecosystems

Let us start with an example. Singapore had developed a strongly rooted ecosystem around the manufacturing of ink-jet printer cartridges that became a prototype for developing knowledge hubs in other industries. Rather than just being satisfied with Hewlett Packard (HP) having located a plant for printer cartridges and running it, the head of HP undertook to attract complementary companies. Most obviously, he encouraged ST Microelectronics, already present in Singapore, to make printing heads locally. But HP also attracted chemical and plastic part suppliers, like Du Pont and BASF, for ink and other cartridge components. Local Singaporean companies were called to provide plant equipment such as conveyors and other machinery. From generation to generation of cartridges, Singapore became the engineering hub within HP, supporting other plants in Ireland and Puerto Rico. HP also started developing printers in Singapore. Knowledge and know-how spill-overs helped develop a stronger industrial base in Singapore.

Viet Nam has been building a strong, locally rooted ecosystem in consumer electronics, with components for products such as smartphones and laptop computers. However, Viet Nam has been confined to supplying relatively low-tech components to Samsung and others. The fact that Foxconn and other major suppliers to global brand companies, such as Apple, Google, Dell and HP, all are starting assembling plants in Viet Nam may open the opportunity for developing and progressively upgrading a deeply embedded local innovation ecosystem.

Proximity to Shenzhen (China's Silicon Valley) allows the progressive integration of local operations in Viet Nam – locally

or foreign-owned – into efficient supply networks. It also allows MNCs to hedge their bets when facing an uncertain and ambiguous future relationship with China. These factors should allow Viet Nam to move up the value chain, as Singapore did decades ago, and increasingly position itself in the "sweet spot" between research and mass manufacturing.

A key conclusion emerging from our research was the importance of building a local ecosystem, comprised of both local firms and MNC subsidiaries, to increase the embeddedness of the MNCs' local operations, upgrade the skills of local suppliers and partners and operate at intermediate levels of engineering and development between research and mass production. Research, we observed, remained mostly rooted in the home base of the MNC (or in some developed lead countries), and mass manufacturing was highly mobile and risked being caught in a "race to the bottom" (of low-wage locations) or moves towards "re-shoring". In a value chain between the two, manufacturing and research, a growing economy like Singapore's may create a local knowledge cluster.

Local suppliers, complementors, key customers (local or multinational), as well as government investment in education, training and skills advancement all contribute to building locally rooted ecosystems that allow a country to move "up" towards higher value-creation activities. The richness of the ecosystem is made all the more valuable with the evolution of technology (for instance, from one product generation to the next) and competence-enhancing innovations. The local connectedness of various companies' operations makes the ecosystem increasingly robust. Local knowledge-creating institutions, such as universities and public sector labs also provide further anchors to the ecosystem. Speed and agility, for instance, in providing access to test equipment and allowing quick real "in-market" tests for new products or services, also contribute to the uniqueness of the developing local ecosystems. Value chain orchestration skills – for example local logistics and outstanding container terminal management capabilities in Singapore – are often harder to imitate than specific manufacturing or engineering skills. Local knowledge integration skills also allow a particular location to become a magnet for innovations melding knowledge from multiple sites. The greater the knowledge complexity and the more capability-enhancing the magnet's technologies, the stronger and more resilient the magnet is likely to be. Local experience builds global expertise.

Building global links: Connecting with the world

However, not all MNCs may play the game. We labelled the major challenge to this knowledge cluster development process the "long-thin-arm syndrome": activities of MNCs locally take place as if they were at the end of a long, thin arm – narrowly focussed, weakly embedded, with managers oriented more towards the rest of the MNC than towards making the best of the local ecosystem. Each thin arm operates separately, with little local contacts, as a mere executant in a global value chain. In contrast, we observed entrepreneurial subsidiary managers patiently cultivating local contacts and building local embeddedness, but these were relatively few, and often – whether successful in their efforts or not – these managers left the MNC for new ambitious challenges. They outgrow what the MNC could offer them.

An action agenda: Local roots and global links

From a public policy standpoint, four action areas stand out. First comes the need to identify, assess and leverage existing knowledge already available in the country for specific industries, in particular knowledge that lies between research and mass production and is deeply rooted in collective tacit skills in MNCs' local operations or local companies.

Second, a government may act as a catalyst for local knowledge accumulation, for instance, through incentives for multinational companies to collaborate with local firms or public sector institutes. Considering what elements of knowledge would benefit most from co-location and targeting these as the missing pieces in building local ecosystem "puzzles", allows to selectively focus these efforts and encourage complementors (like ST Microelectronics for HP in Singapore) to invest locally.

Third, increasing the number of local linkages via networking initiatives should also be a priority to overcome the "long-thin-arm syndrome". MNC subsidiary managers may see developing local links as opportunities to add more value to their mother company and gain a bigger role in its future development.

Fourth, facilitating searching for and connecting with sources of knowledge away from the country and deliberately strengthening the role of local units in the selected MNC networks can be another positive contribution of the government. This also leads to the identification of interdependent complex knowledge clusters that could be deeply rooted in the country. Industry experts can identify the rooted knowledge core of each industry. Sources of "sticky" (tacit, collective, embedded, process-based) knowledge on which the whole industry depends are potential knowledge cores and knowledge elements that benefit from being co-located with the knowledge core can also be identified. Links between "sticky" knowledge elements benefit the most from co-locations and allow local ecosystems to create and capture value in a global industry. This also provides an early perspective on cross-industry linkages as a way to define an ecosystem based mainly on knowledge links between its members and on the types of knowledge required for the ecosystem to be effective at creating and distributing value.

Conclusion

Considering locally rooted ecosystems that developed global links suggested that national development policies need

to operate both at the macroeconomic level (where most policy discussions take place) and at the "micro" level that of specific knowledge clusters, ecosystems and individual firms, at least in small economies and cities. Specific policies can significantly contribute to the development of such ecosystems, but their success also requires entrepreneurship, both from MNC subsidiaries and local companies. Instead of the traditional subservient model advocated by some MNC heads ("Think global, act local"), we suggest its reverse is needed, that is, to adopt a "Think local and act global" mindset.

Technology Transfer and Innovation Commercialization for Electrical Energy Storage Technology

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Abstract

Various technological innovations resulting from research and development (R&D) from universities must be used optimally to encourage economic development through down-streaming and commercialization. In the commercialization stage, technological innovations face various challenges in entering the market: product, process, innovation, and business issues. These challenges can lead to the failure of the technological readiness level of the innovations developed to meet market industry criteria. Therefore, the Centre of Excellence for Electrical Energy Storage Technology (CE-FEEST) of Universitas Sebelas Maret, Indonesia, has overcome these challenges so that innovative products can cross the valley of death and emerge in the market. CE-FEEST has developed several strategies and commercial models to act as a technology innovator and technology transfer office within the university and support the down-streaming of research results through a series of innovation and technology commercialization strategies. The CE-FEEST contributes to developing know-how and intellectual property, carrying out the incubation process, and building an ecosystem conducive to the growth of creativity and innovation. Lessons can be drawn from CE-FEEST's journey in developing an innovation ecosystem and responding to the challenges of technology commercialization, especially in mobility and stationary storage applications.

Introduction

Higher education institutions (HEIs) have changed worldwide in recent decades (Bramwell & Wolfe, 2008). Nowadays, HEIs are experiencing a challenge to contribute to social, economic, and technological development (Etzkowitz, 2014; Guerrero, et al., 2015). It leads to how the role of HEIs has developed from serving as conventional research and education functions to actively engage in innovation promotion (Arbo & Benneworth, 2007; Uyarra, 2010; Youtie & Shapira, 2008). Accordingly, HEIs as research centers are now considered significant support for regional economic development (Chatterton & Goddard, 2000) and the advancement of a technology-based economy (Clayman & Holbrook, 2003). Due to this demand and pressure, various technological innovation outputs of research and development from HEIs must be maximally utilized to encourage economic development through downstream and commercialization (Leung & Mathews, 2011).

An innovation process will fall into the valley of death if it has a low level of technological, innovation, and manufacturing readiness (Debois, et al., 2015; Flinn, 2019; Ford & Dillard, 2018; Ward, et al., 2018). As a result, technological items are unable to have a strong commercial aspect, be useful, and join the market. The failure of technological innovations to enter the market is due to various challenges and problems: products, processes, innovations, and businesses. They lead to the failure of the technological readiness level (TRL) of the developed innovations to meet market industry criteria (Chirazi, et al., 2019; Hindle & Yencken, 2004; Osawa & Miyazaki, 2006; Sutopo, et al., 2022). Therefore, it is necessary to strengthen approaches to resolve these challenges so that innovations can cross the valley of death and emerge in the market.

A technology transfer office (TTO) is the spearhead of the innovation system because it is responsible for the technology commercialization process. As an intermediary institution, TTO becomes a bridge that connects technology providers; in this case, technology research and development institutions or universities with technology users, namely industry. In addition, TTO is also seeking funding for advanced technology development (Cunningham, et al., 2020; Khademi, et al., 2014). The existence of technology transfer service offices in universities can overcome various problems in the technology transfer process to facilitate

the commercialization of technology (Aqidawati, et al., 2020; Sutopo et al., 2019).

This article used a case study on the commercialization of lithium battery innovation generated by a university. The Centre of Excellence for Electrical Energy Storage Technology (CE-FEEST), Universitas Sebelas Maret (UNS), Indonesia, started researching lithium batteries as a form energy storage in 2012. Currently, CE-FEEST has mastered the development of crucial production formulas and technologies for manufacturing active cathode materials and cells for various lithium battery materials and developing modules and packs of batteries for various applications. In addition, CE-FEEST has also succeeded in fostering several start-ups and has multiple research output patents. CE-FEEST takes on the role of developing intellectual property, carrying out the incubation process, and building an ecosystem conducive to creativity and innovation growth.

Case of CE-FEEST

CE-FEEST is a Ministry of Research and Technology program of Indonesia to strengthen the institutionalization of innovation in the university environment. This institution is under the leadership of Universitas Sebelas Maret (UNS), which focuses on the development of lithium batteries, starting in 2012 through the Indonesia Electric Vehicle program, which is now being developed into lithium batteries at UNS. CE-FEEST has the vision to become the center for developing energy storage technology for electric vehicle applications, and the leading renewable energy in Indonesia by 2025. As one of Indonesia's research and development (R&D) and incubation centers, CE-FEEST is committed to presenting technological innovations and processing methods in the field of renewable energy, among other areas: development of high-performance battery technology for electric vehicles and renewable energy storage systems, processing of local resources for lithium battery raw materials, advanced energy storage technology with available raw materials in Indonesia, and development of battery integration technology with charging systems and equipment.

The facilities and infrastructure are divided into a battery laboratory, lithium battery mini plant, active material mini plant, test, and characterization equipment, charging station, and training and training administration building. Furthermore, the activities carried out to improve competence are in the form of research and development of energy storage technology, for example, prototyping and materials, cells, and pack development. In addition, CE-FEEST also provides testing, training, industrial consulting, incubation, and commercialization services. This institution has produced superior products such as battery packs, two-wheeled and three-wheeled electric bicycles, convertible electric motorcycles, electric cars, e-trikes, public street lighting, and battery-active materials. To create the best results, CE-FEEST continued to develop next-generation batteries, active materials from local raw materials, and battery-based technology startups, and published a journal of Energy Storage Technology and Applications (ESTA).

CE-FEEST plays a role in conducting regional cooperation for innovation and technology transfer. CE-FEEST has carried out collaborative activities with various parties, including a workshop on battery and energy storage technology (BEST), kick-off battery production, soft launching of lithium-ion batteries, visits to automobile trading companies and the Ministry of Industry, signing of MOU with a national energy company, and the launch of a teaching workshop by the Ministry of Research and Technology of Indonesia. CE-FEEST continues to support the development of battery technology with local resources as Indonesia's future innovation energy.

Technology commercialization cooperation and strategy

A new company needs the right technology commercialization mechanism to deliver the products it sells to consumers. CE-FEEST employs various strategies in bringing the university's research potential into a commercial product with an institutional brand accepted by the market. The mechanism used by CE-FEEST to support the transfer of research technology is through patent licensing, operational cooperation, joint ventures, and technology-based startups.

CE-FEEST has produced many works as a result of the development of technological innovations. Licenses for these innovations have been held for various types of patents, copyrights, and brands. The patents issued for the production of lithium batteries include the composition of battery cathode and anode materials, process and method of making battery materials, Li-ion battery test equipment, and techniques. In addition, CE-FEEST has also successfully registered the brand for Li-ion battery products and active materials.

CE-FEEST has implemented an operational cooperation mechanism to support innovation and technology transfer. CE-FEEST carries out active cooperation with various companies in Indonesia to develop and produce technologically innovative products. Collaboration with a national automotive company was agreed upon to develop an electric bus. In addition, cooperation with household appliance manufacturing companies is carried out to establish portable vacuum cleaner products. Collaboration with telecommunications and electricity companies produces street lighting products. Similarly, cooperation with renewable energy semiconductor manufacturers is aimed to develop outboard ships. In the same way, cooperation with environmentally friendly vehicle manufacturers produces e-trike.

Various university research outputs from technological innovations are managed, maintained, and developed by CE-FEEST's business. In its role of managing technological innovation, CE-FEEST has incubated and fostered until the products were launched. In addition, CE-FEEST has also expanded its business and succeeded in establishing innovation-based startups. Until now, three startups have been continuously maintained: a lithium battery

manufacturer and its derivative products, a startup provider of electric vehicle conversion kits, and a battery cathode material manufacturer.

Open innovation at CE-FEEST

CE-FEEST has implemented open innovation in developing energy storage technology to face innovation challenges. CE-FEEST cooperates with many parties at various stages of technological entrepreneurship development. Open innovation was carried out by using the available channels, from knowledge and technology to business development. In this case, CE-FEEST is open to using various external sources of consumer feedback, patent publications, research results, and so on, to encourage internal product/service innovation.

The feasibility study, fundamental research, and perspectives of various stakeholders from numerous organizations are gathered during the idea generation stage. It aims to explore the needs of stakeholders and ensure a common understanding of the technology being developed. This process involves academia, manufacturers, consumers, and the government.

In technology development, open innovation is implemented by collaborating with companies to develop new technologies in a collaborative R&D process. The various collaborations mentioned previously are a form of open innovation that takes place at CE-FEEST. With open innovation, CE-FEEST can obtain resources from other companies and share internal resources to create new products. Thus, CE-FEEST can obtain the company's ideas, technology, knowledge, and capabilities externally.

In addition to technology development, CE-FEEST conducts open innovation for startup incubation. CE-FEEST, together with a national energy company, performed co-incubation for startups, including lithium battery manufacturers, bike-sharing startups, and motorcycle-sharing startups. The co-incubation program intends to support startups for business development and market expansion. CE-FEEST provides facilities by bringing participants to the right partners, opening a business network, providing business consultations with professional mentors, and providing information about the Indonesian market.

UNS, now a university with a State University as Legal Entity, also opens up opportunities for CE-FEEST to cooperate with foreign companies. This opportunity was able to support the derivative startups owned by CE-FEEST. CE-FEEST has increased orders for electric bicycles with the help of university leadership, which has accelerated the growth of startups.

Innovation process and technology transfer: CE-FEEST's role as TTO

A TTO is the spearhead of the innovation system responsible for the technology commercialization process and a bridge that connects technology providers, with technology users. Activities carried out by CE-FEEST in technology transfer, namely, technology disclosure of inventions by researchers, valuation of invention technology, management of intellectual property/patents, and commercialization of patented technology through licenses, spin-off companies, and technology-based startups. It is expected that the existence of CE-FEEST can overcome various problems in the technology transfer process to facilitate technology commercialization. Figure 1 presents the framework for the innovation and technology transfer processes implemented by CE-FEEST so far.

1. Conception and invention

a. Idea generation

The first step in the conception stage is idea generation. Idea generation is a systematic search for a new product idea. Sources of ideas can be internal or external. Internal sources come from research and development conducted by academics at the university. In contrast, external sources come from literature, research, and development results outside the university.

Researchers at CE-FEEST started this conception stage in 2012 to address issues that the environment (market, nation, and society) required them to solve. The establishment of CE-FEEST was motivated by automotive technology, shifting from fossil to electrical energy. The proposed idea is to develop energy storage technology as a potential solution to overcome the pollution and shortage of oil reserve problem; as there are abundant renewable energy sources and natural resources available. Starting from a national electric car development project in 2013 with universities in Indonesia, CE-FEEST has the idea that lithium batteries can be used as a critical component of electric vehicles and renewable energy systems.

b. Research and development

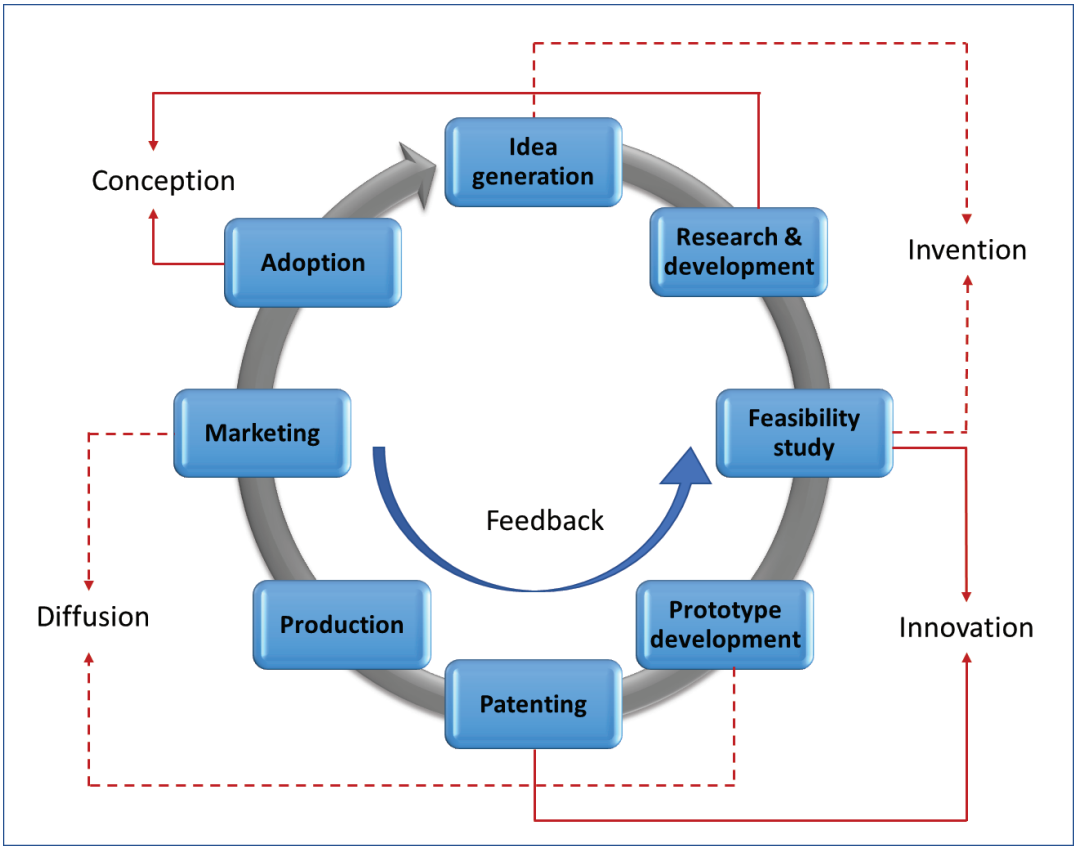
The invention stage started when research and development were carried out in 2012. Various studies were carried out to support the proposed idea of exploring the basic principles of energy storage technology. In addition, we also formulate the concepts and applications of technology needed to answer today's challenges. CE-FEEST researches and develops active materials for lithium battery cathodes using various chemical materials. In addition, research continues to be carried out to generate optimal production processes to yield active materials and design a pilot plant for active material production. Furthermore, it is integrated with the Li-ion battery manufacturing facility to produce high-performance batteries at affordable prices.

In the development of batteries for battery-based electric motor vehicles, the concept is to domestically produce cell production technology for stationary, electric vehicles and reliable, fast charging by 2024. It was the background for designing a mini plant for lithium battery production.

2. Innovation and diffusion

a. Feasibility study

After the technological product concept had been developed, a feasibility study was carried out to measure and assess the feasibility level of lithium battery



Source: Modified from van Waarden, et al., 2002.

Figure 1. Innovation process and technology transfer framework

production. This activity was carried out to determine how feasible a project plan was. This study is necessary to develop the mini plant business for lithium battery production. In this way, potential bottlenecks can be avoided and the estimated cost to run the project can be determined. In addition to reviewing the economic aspect, we also conducted a feasibility study by evaluating the technical and operational aspects of running a mini plant business, such as production capacity and resources.

Furthermore, market aspects were also evaluated to predict market share, analyze the demand for lithium batteries, and formulate appropriate marketing strategies. In addition, various alternative solutions for research and product development feedback were also proposed based on the evaluation of the feasibility study. Finally, the pilot plant for mass production of lithium batteries was officially launched in 2017.

b. Prototype development

CE-FEEST has mastered lithium battery production technology. The next step is to develop a product prototype. The goal is to develop a product model or design into a final product that can meet user demands. During the product development stage, users can take part by evaluating and providing feedback. The feedback provided can be used as a reference in product development stage. In addition, using prototypes can bring up new ideas that can be developed into a feature to complement the product.

In 2014, the prototype for the cell lithium battery was successfully created. Meanwhile, the battery module/pack prototype was successfully developed in 2015. The resulting prototype was also been tested for suitability in the laboratory. This Li-ion battery product can be applied to various equipment, such as a power bank, laptop, and bicycle. The wide application of Li-ion batteries has prompted CE-FEEST to develop prototypes for products derived from lithium batteries. The research background for developing modules and packs is to support electric vehicle systems and energy storage based on lithium batteries. The products produced from the research that CE-FEEST has carried out include convertible electric bicycles, electric motorcycles, e-trikes, and electric cars.

c. Patenting

CE-FEEST has produced various outcomes through research and development from 2012 to 2021. The outputs of this research have received official legal recognition and protection through patenting. The patents issued for the production of lithium batteries include the composition of battery cathode and anode materials, process and method of making battery materials, Li-ion battery test equipment, and methods. In addition, CE-FEEST has also successfully registered trademarks for Li-ion battery products and active battery materials. Figure 2 presents the patents held by CE-FEEST.

2014	2019	2021
1. Cathode composition, method of producing lithium secondary battery cathode composition 2. Monitoring Battery Discharge Using an Arduino Uno Microcontroller Based on LabVIEW 3. Algorithms and Methods for Calculation of State of Charge (SOC) and Degree of Discharge (DOC) batteries for electric cars 4. LiFePO4 Battery Test Equipment and Method 5. Graphite-Based Battery Electrodes Used in Primary Batteries 6. Application of Budget Monitoring System and Digitalization of Financial Accountability Documents MOLINA 7. SmartUNS	1. Process of Manufacturing Battery Separators from PVDF/SiO2 . Nano Fibers 2. NMC (Nickel-Manganese-Cobalt) Li-Ion Cathode Manufacturing Process 3. Lithium Nickel Cobalt Aluminum Cathode Material Manufacturing Process 4. Oxide (NCA) SiO2/C Composite Li-Ion Batteries from Coal Derivatives 5. Lithium Nickel Cobalt Aluminum Oxide NCA Cathode Material Composition and Manufacturing Method 6. Composition of Carbon Silica Anode Composite Material from Fly Ash and Manufacturing Process 7. NCA Cathode Manufacturing Process with Environmentally Friendly Chelation Materials	1. The process of making a battery separator from PVDF/SiO2 . nanofibers 2. SiO2/C composites from coal derivatives in Li-ion batteries 3. Method of making lithium nickel cobalt aluminum oxide (NCA) cathode material 4. Material composition of lithium nickel cobalt aluminum oxide (NCA) cathode and method of manufacture 5. Composition of carbon silica (C-SiO2) anode composite material from coal fly ash (fly ash) and its manufacturing process 6. The Process of Manufacturing Lithium Nickel Cobalt Aluminum Oxide (NCA) Cathode Materials with Environmentally Friendly Chelating Agents 7. The process of recycling lithium nickel cobalt aluminum oxide (NCA) cathode material from waste lithium ion battery production (certificate production) 8. The Composition of Lithium Nickel Cobalt Aluminum Oxide (Nca) Cathode Materials And The Manufacturing Method 9. Method of Manufacturing Lithium Nickel Cobalt Manganese Oxide Rich Nickel Cathode Material 10. Polymine

Figure 2. Patents generated by CE-FEEST

d. Production

In 2012, UNS became one of the five universities to manufacture the National Electric Car (Molina). After three years of development, UNS, through CE-FEEST, has demonstrated the advantages of its specialization in lithium batteries and is now able to produce with a target of 1000 batteries per day. CE-FEEST has successfully built a pilot plant of a production unit for lithium battery cells in 2015 and active cathode materials in 2019. This entity has been used to validate various models, methods, and supply chain network designs and an ongoing basis for evaluating production and service quality.

Smart UNS, the lithium battery found by CE-FEEST researchers, has two types, namely lithium iron phosphate ($LiFePO_4$; LFP) 18650 and NCA 18650, with a voltage of 3.2 volts and 3.7 volts and capacities of 1400 mAH and 2700 mAH, respectively. Using LFP technology, this battery has high safety because it does not cause an explosion in the event of a short circuit. In addition to being rechargeable and economical, this battery has a long service life of up to 3000 cycles of use, is longer than current commercial products (500 cycles), and can withstand relatively high temperatures, namely up to 70°C.

The production process does not produce waste harmful to the surrounding environment. In addition, the production process is equipped with equipment that meets the standards. This product can be applied to electric cars, bicycles, public street lighting, notebook PCs, toys, UPS, and power banks. For production funding, CE-FEEST has collaborated with the national energy company, the Ministry of Education, Culture, Research, and Technology, and the Indonesian Endowment Fund for Education.

e. Marketing

At this stage, energy storage technology is developed in such a way that it reaches a point where the technology can be applied to a profitable production or consumption activity. To get CE-FEEST products on the market, marketing is used. In this situation, learning how to conduct product research that can survive the valley of death and compete in the market is crucial. Thus, a proper commercialization strategy is needed. In order for an innovation to meet market requirements, it must be technologically prepared so as to avoid failure. Readiness is needed to not result in the technological readiness of the innovation being developed failing so that it can meet market criteria. The commercialization strategy carried out by CE-FEEST, namely Li-ion batteries and their derivative products and electric vehicles, into commercial products with institutional brands has been accepted by the market. The commercialization strategies implemented are through patent licensing, the establishment of technology-based startup companies, joint ventures, and operational cooperation.

f. Adoption

From the whole innovation process, from idea generation to marketing, adoption is the last stage that determines the success of the diffusion of technological innovations carried out by CE-FEEST. The products produced, such as e-bikes, e-motorcycle, and power wall, are real examples of the adoption of energy storage technology.

Early supply chain to accelerate technology commercialization

Regarding the issue of lithium battery innovation, there are several reasons for integrating the supply chain into the commercialization process at an early stage, namely, the supply chain has a special and unique component. In addition, each product of technological innovation has its own unstable and evolutionary supply chain. Furthermore, innovation would lead to modification of the supply chain. Supply chain integration with technology commercialization processes can also provide support-seeking options to shorten the time to market with intervention. Therefore, early supply chain engineering can be used as an intervention instrument to help startups survive and win the market by creating a competitive advantage.

CE-FEEST has produced research outputs that can address the technology

commercialization challenges. Figure 3 explains the early supply chain engineering to solve commercialization challenges. The research outputs produced by CE-FEEST have resulted in five intervention options to increase the level of technology readiness more quickly and at a cheaper investment:

1. Technology development and standardization;
2. Incubation cycle;
3. Engineering, procurement, and construction in production facilities;
4. Material sourcing and selection; and
5. Distribution and marketing cycle.

In order to discover a successful solution that would enable the faster adoption and diffusion of technology, an open innovation system with collaboration between supply-chain players, universities, and the government is needed.

1. Product challenge

The challenge of product development and innovation does not necessarily have a standard reference for development. CE-FEEST has mastered the development of formulas and critical production technologies for manufacturing cathode-active materials and cells in various lithium materials. Technological innovation needs to be supported with standard references. Standards should encourage innovation rather than hinder it. The efficient standards have been designed with necessary and sufficient conditions that have a solid correlation to increase product competitiveness. The economics of standard implementation has been modeled, considering the testing entity's strengthening and technology readiness (Aqidawati, et al., 2019, 2022). The research also contributes to the availability of five standard references and national standards related to testing and product quality standards for cells, modules, and battery packs. Cost-estimation models for lithium battery cells, modules, and packs have been developed as an accurate business decision tool.

2. Innovation challenges

The challenge with innovation is that the developed technology must be maintained and promoted through commercialization. The lessons learned from the development of lithium battery technology include the creation of new methods for effective technology transfer and open innovation as well as a number of proposed entity-strengthening models in the licensing, joint venture, and startup processes. The intervention for accelerating incubation time uses a co-incubation approach with battery user companies. The technopreneur model was used to strengthen human resources who exceled in the development and management of technology-based companies.

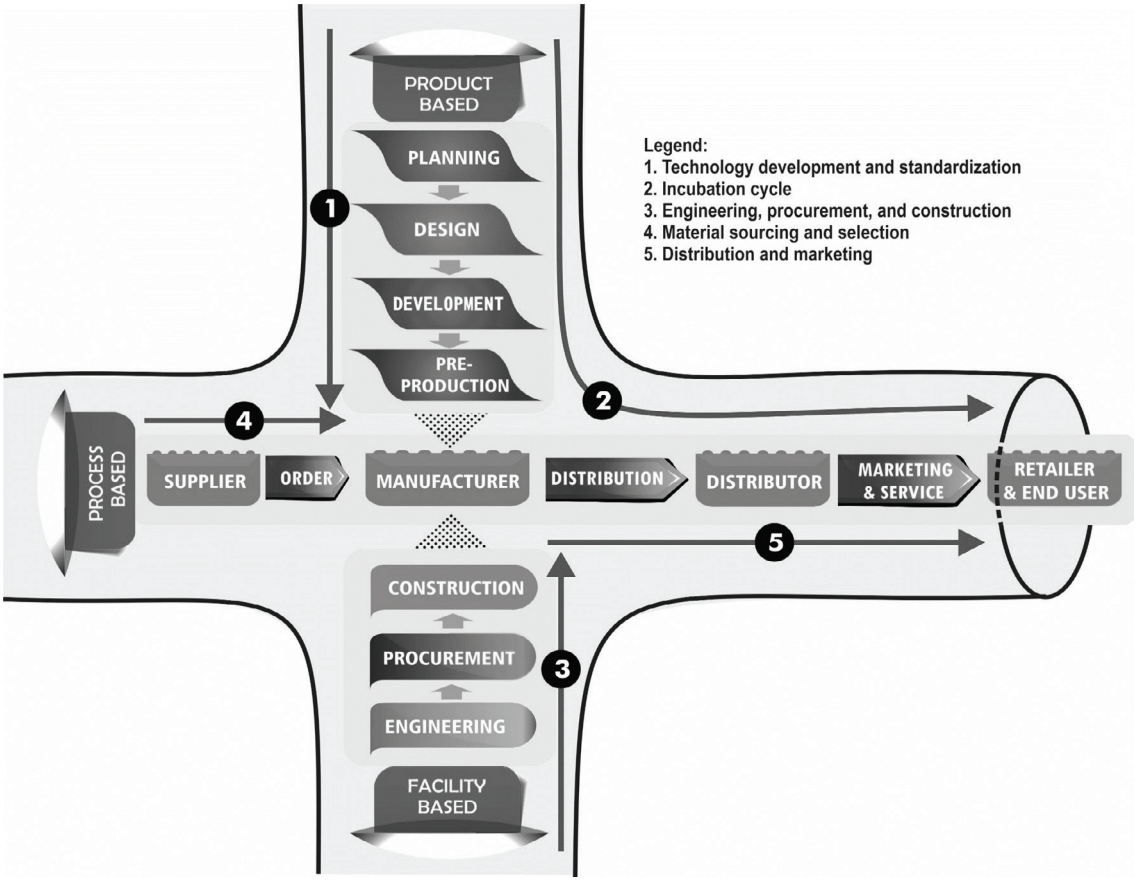


Figure 3. Early supply chain framework

3. Process challenges

In order to build a low-cost product manufacturing process, it is necessary to look for lower investment options from the engineering, procurement, and construction phases of production facilities. Process improvement was carried out by material sourcing and vertical integration from the stage up to the incubation stage, followed by the co-incubation stage with battery pack users in various product applications that use lithium battery packs. The intervention option has recommended strengthening the entity providing raw materials with a benefit, opportunity, cost, and risk (BCOR) analysis to obtain cheap and safe sources of raw materials. Strengthening inbound logistics through entities providing raw materials and outbound logistics for battery pack users was also used to create product competitiveness. The initial distribution and marketing process was carried out to shorten the time to market through the business-to-business (B2B) and business-to-consumer (B2C) market segments.

4. Business challenges

Developing new models, methods, and systems have been tested in a natural business environment. Using research funding from various sources, UNS built a lithium battery cell production unit in 2015, and an active cathode material production line in 2019. Lithium battery packs made by CE-FEEST are suitable for use in a range of electric vehicle systems and products. These production entities have been used to validate various models, methods, and designs of supply chain networks and, on an ongoing basis, to evaluate the quality of production and distribution services. Efforts to minimize investment for business acceleration have been tested in real terms. In early 2020, a startup was formed due to the co-incubation of CE-FEEST with a national energy company. The startup has been used to validate commercialization acceleration intervention options for electric bicycle battery packs, a startup for electric motorcycle battery packs, and other users for various lithium battery pack applications.

Lessons learned: CE-FEEST-technology innovation enabled go-to-market

CE-FEEST was established as the estuary of a long journey of battery research at UNS. CE-FEEST focuses on activities related to the development of lithium batteries and advanced energy storage technologies to support electric vehicles and renewable energy. As one of the critical components, batteries have an important role in adopting electric vehicles. CE-FEEST focuses on developing lithium batteries, placing concerns ranging from raw materials, cells and pack manufacturing, and battery management systems to battery testing and safety. Furthermore, CE-FEEST is also concerned with battery applications. CE-FEEST provides derivative products of Li-ion batteries, such as power wall, street lighting, e-bike, converted e-motorcycle, and e-cars. Therefore, CE-FEEST can create the capability of storage and charging system products that are robust, reliable, and a substitute for imported products (Figure 4).

The cooperation is being developed through collaborations with academics, businesses, and the government approach. CE-FEEST has collaborated with companies from various sectors, testing and certification centers, and national standardization bodies. In addition, startups also have foreign cooperation in supplying battery cells.

Various output products are licensed into registered patents, namely, patents for lithium battery active materials and patents for battery production. The copyrights are managed in the same manner and a business is developed through sophisticated commercialization technology. Thus, startups were established, and one of them is PT Batex Energy Mandiri (Batex).

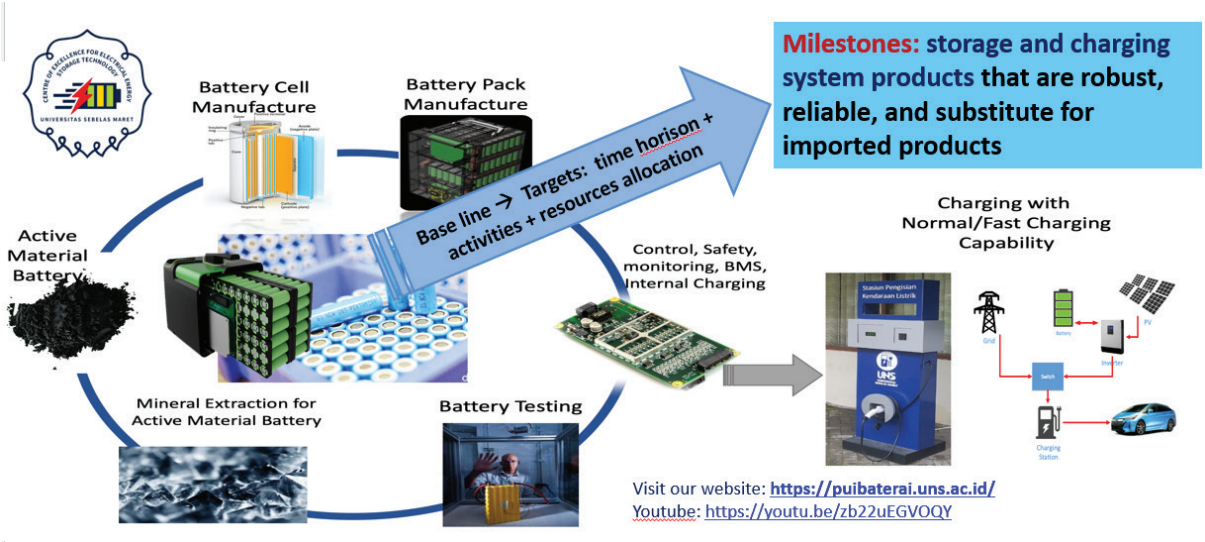


Figure 4. CE-FEEST capabilities

Batex is a tech startup that provides lithium-ion batteries and its derivative products and serves a range of critical applications, and meets the needs of various markets. Batex was formed due to the co-incubation of UNS with a national energy company, PT Pertamina. This startup is used to validate commercialization acceleration intervention options. Batex, as the first lithium battery manufacturing startup in Indonesia, uses all of its domestic resources, from materials to labor.

Batex has produced LFP-type lithium batteries, which are very safe, durable, stable at high temperatures, and economical. Battery products are suitable for use in tropical climates such as Indonesia.

Batex produces lithium batteries in the form of cells and packs. Its products have been used for e-scooters in several cities in Indonesia. In addition, Batex also provides power walls, e-bikes, and public street lighting.

Batex continues to collaborate with companies, incubators, and government agencies to provide high-quality products that meet market expectations. Collaboration is also done to get support in dealing with challenges in the development of energy startups, such as product development, market access, and capital. Therefore, Batex can create energy security in Indonesia. Figure 5 shows the products provided by Batex.

Conclusion

CE-FEEST has played an important part in technology transfer and innovation commercialization. In carrying out its role, CE-FEEST has established various regional co-operations to support downstream research results, startup incubation, and new product development. The process of innovation and technology transfer carried out by CE-FEEST generates several things: lessons learned from innovation and technology development, lessons learned for startups; development tenants through incubation; fostering business/startups in TTO; and measuring the effectiveness of commercialization strategy.

Figure 5. Batex products: (a) Lithium iron phosphate (LFP) battery cell, (b) LFP battery pack, (c) battery management system, (d) e-bike conversion kit, (e) foldable e-bike, and (f) power wall

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Skill-based Diversification Through Customer-Oriented Cross-Industrial Collaboration: Sozai Business in the Craft Industries

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Abstract

Technological and product innovations are the two most important factors of continuous business development and economic growth. However, these innovations necessitate significant financial and human resources for research and development (R&D), which small and medium-sized enterprises (SMEs) cannot secure. Small and medium-sized manufacturers are specialized in particular tasks in production networks to work for large firms as their subcontractors, and therefore, not familiar with product markets. In-house R&D for these innovations are not necessarily a realistic growth and survival strategy for SMEs. The case study of Sozai business in the craft industries presents the importance of cross-industrial business-to-business (B2B) collaboration that enables a better use of high skills and techniques accumulated in SMEs through daily learning by producing as a more practical approach to unlocking the potentials of SMEs in non-traditional markets.

Introduction

Incumbent firms confront more challenges that accelerate the maturity of their businesses, while such structural changes are business opportunities for new entrants who bring innovations into the markets dominated by the incumbents. A driver of the structural changes is freer competition intensified by globalization and the rise of China and less developed Asia as world production bases. E-commerce strengthened this international price competition and made more products commoditized and less profitable. The important current factor accelerating market saturation for traditional products and services is the evolutionary development of digital technologies that create new combinations of hardware and software to provide consumers with more attractive alternatives. The international commitment to de-carbonization is a long-term hard-to-overcome challenge that enforces fossil energy-related product and service industries (e.g., internal-combustion engine manufacturing) to make radical structural changes.

An incumbent firm will take various measures to avoid the saturation of its existing products and services, prolong its lives, or boost its growth potentials by cost reduction, geographical market expansion, development of new products and services to its current market, and business diversification into a new market to the firm. These strategies involve innovations. Therefore, more importance is placed on research and development (R&D) and the adoption of new technologies in business survival and growth strategies in the competitive market with uncertainty suggested by studies on the ambidextrous organization (O Reilly and Tushman, 2004) that exploit existing capabilities and explore new opportunities simultaneously.

However, R&D investment is a heavy burden for small and medium-sized enterprises (SMEs), so that many cannot develop organizations or personnel dedicated to R&D activities. It is a reality that firms have achieved innovations without R&D or non-R&D innovations (Tsuji, et al., 2018). As the above-exemplified countermeasures against market saturation suggest, firms can take a different approach to innovations, which do not necessarily require significant technological developments but involve non-technological and managerial attempts.

The Sozai business, which this article introduces, is one of the methods for firms to achieve non-R&D product innovations by combining their unique manufacturing techniques and external knowledge through cross-industry collaborations. The Sozai business is an innovative approach, promoted initially by the traditional craft industries in Kyoto, to reactivate the long-term low performance of the Japanese traditional craft industries. However, the concept of Sozai will help understand the importance of non-R&D-based non-technological innovations for business diversification and sustainability across different industries.

Decline of Japanese traditional craft businesses

Since a long time, Japan has been providing support to the traditional craft industries to promote and preserve them. The government enacted the Act on the Promotion of Traditional Craft Industries in 1974. The Act defines traditional craft products as articles used mainly in daily life, manufactured mainly by hand, manufactured using traditional craftsmanship

or techniques, made of traditionally used raw materials, and produced on a certain scale in a particular locality. The Ministry of Economy, Trade and Industry (METI) designates traditional craft products according to these criteria. Since the designation of the 11 craft products on February 17, 1975, more craft industries have become eligible for policy supports developed under the Act. As of March 18, 2022, 237 products are recognized as traditional crafts.

Although the number of traditional craft products has increased, traditional craft industries reached maturity at the beginning of the 1980s. In 1974, when the Act was developed, 33,909 firms with about 280,000 employees produced a value of 384.4 billion Japanese yen. The industries reached their peaks at 34,043 firms and 288,000 employees in 1979 and a production value of 540.6 billion Japanese yen in 1983. Since then, these figures were declined to 18,187 firms, 115,000 employees, and 278.4 billion Japanese yen in 1998. The traditional craft industries have not been able to get out of the declining trend until recently (Ueki and Kamiesu, 2019). Some prefectural and city governments also define traditional craft industries and provide policy support to the traditional craft businesses that fall outside the scope of the central or prefectural supporting policies. But the results of their policies have not been enough to revitalize the industries as observed in the national policy.

The lack of appropriate customer orientation is just one of several elements that make Japan's policy for traditional craft industries unsatisfactory. The promotion of traditional crafts under the sales copy of "Made in Japan" is a typical case. Made in Japan is a convenient phrase to appeal high product quality Japanese products to consumers. Japanese producers tend to believe that consumers buy high-quality products. This belief has actually led to the quality enhancement of products made in Japan and the confidence of consumers in Japanese products. However, high quality is not a sufficient condition for consumers to buy a product. High-quality products do not always meet consumer needs; therefore supplying good-quality products is not enough to encourage consumers to purchase. Traditional craft products may be the typical case.

The example of the Kimono, a traditional Japanese garment, helps us understand this problem easily. Kimono has several characteristics that attract the interest of people, including the use of high-quality silk and sophisticated woven patterns. These advantages had been nurtured in the traditional lifestyle where the Kimono used to be an article of daily use. However, current citizens rarely have occasions to wear Kimono, while some consumers still pay a premium price for Kimono, especially those produced in well-known production areas such as Kyoto as authorized local brand products. Due to the mismatch between Kimono's traditional design and the current westernized lifestyle in Japan, the Kimono market has been shrinking. This problem of mismatch will make it much more difficult to sell a significant volume of a traditional craft product continuously as it is in foreign markets on a commercial basis, even though Kimono is well recognized as a Japanese cultural and premium article.

The observations suggest that Japan's supporting measures for the traditional craft industries, which simultaneously seek two substantial goals of commercial promotion and cultural preservation, might be designed without facing up to the business reality seriously and had not worked effectively to maintain the production size enough for preserving the traditional manufacturing. How to revitalize traditional craft businesses, and maintain them as premium producers of an authorized local brand product has been a policy challenge.

Sozai business: A proposal to reactivate craft businesses from Kyoto

A strategy to overcome this challenge is the "Sozai" business, which was initiated for traditional craft industries in Kyoto by Mr. Junya Kitagawara, a Japanese interior and lifestyle producer. Sozai is a Japanese word meaning materials. This business strategy uses traditional raw materials and techniques to develop new markets for the traditional craft industries. The traditional raw materials and techniques are inherent to traditional craft products. These elements are important sources of their value and brand identity. On the other hand, the traditional way of using them has been binding the Japanese traditional craft industries to their traditional markets.

The Sozai business is a proposal to break this constraint to explore non-traditional market. This new business concept was created to make use of Japanese craft materials and traditional techniques to develop new products suitable to westernized lifestyles and marketable in western markets through collaborations for customer-oriented design-driven product innovation. The Sozai business depends mostly on whether craft producers can identify designers and corporate customers who share interests in promoting inter-sectoral collaborations. Participation in trade fairs is the initial step for craft producers to meet designers from different industries who will be interested in making commercial use of traditional raw materials and skills in different ways for different corporate customers from those for traditional craft articles. By demonstrating Sozai (e.g., fabric) instead of final products (e.g., cloth) in the form of a wall panel, craft producers can attract designers or architects who can come up with exciting ideas far beyond the traditional ideas from existing corporate customers to their booths to initiate talks about possible collaborations for business development.

This novel approach to diversification was designed based on unsuccessful experiences in new product development promoted by the policy support for the traditional craft businesses in Kyoto. What makes the policy measures difficult to succeed is the fragmented supply chain of the traditional craft industry unique to Kyoto, which comprises craft persons who are mostly specialized in a particular production process and do not have direct contact with markets of the final products.

New product development trials made by producers with policy support tend to be implemented without identifying or correctly understanding target customers. The Sozai business does not seek to improve producers' knowledge of product development. The strategy creates opportunities for artisans to meet their (current and potential) consumers and understand their needs and enables them to be dedicated to their strongest point of productive activities through collaborations with designers. Designers specialized in different business fields can act as a bridge between craft producers and customers in non-traditional markets for traditional craft industries. The Sozai business expects that this type of producer-designer collaboration will be more likely to bring business to new market development projects than independent attempts by producers or designers without customer orientation.

Since 2005, the Kyoto traditional craft industries have been pursuing the concept of Sozai business through "Kyoto Connection" in cooperation with the Kyoto Chamber of Commerce and other industry and administrative organizations (Kamiesu, 2019). Craft firms in Kyoto capable of international business have been participating in the world's top interior and design-related trade fairs like Maison et Objet in Paris since 2007 to encounter western designers looking for new materials and techniques. Those who are domestic market-oriented have been participating in LIFE × DESIGN Exhibition at the Tokyo International Gift Show since 2017 for the same purpose. Some traditional craft firms from Kyoto have succeeded in achieving concrete results from these efforts. For example, Kaji Orimono and Hosoo developed projects with western companies to use traditional Japanese textiles for interior purposes after participating in Maison et Objet.

Transfer of the Sozai business to Lao PDR and Thailand

Two organizations have made efforts to transfer the concept of Sozai business, as a method already ascertained its efficacy by the traditional craft industries in Kyoto, to Southeast Asia.

The first organization is the Institute of Developing Economies (IDE)/Japan External Trade Organization (JETRO). The IDE launched the research project on the Sozai business in 2018 to transfer the knowledge of the Sozai business to Lao PDR in collaboration with the Lao Handicraft Association (LHA) and JETRO Vientiane. Mr. Kigawara, as the research project member, gave a lecture to the members of the LHA in the workshop held in September 2018 at the Lao National Chamber of Commerce and Industry (LNCCI) to introduce the Sozai concept and Sozai Contest plan. JETRO Vientiane, in cooperation with LHA, organized the Sozai Contest as a part of the Lao Handicraft Festival in October 2018. The award winners of the Sozai Contest participated in the LIFE × DESIGN Exhibition/Tokyo International Gift Show in February 2019. Since this experimental activity, some of the LHA members have been continuing the effort to develop the Sozai business as a private initiative. On the other hand, the research projects shifted their focus to assessing the potential of Sozai business from the viewpoint of handicraft user industries. The study team conducted interviews with Lao interior designers, architects, and hotel consultants to confirm their interest in using Lao materials for interior decorations and discuss necessary actions to promote the new business idea. The research project also conducted questionnaire surveys of handicraft SMEs in the Japanese fiscal year (FY) 2018 (Ueki, 2019) and hotels in FY2020 (Ueki, 2021), respectively.

The second organization is the Department of International Trade Promotion (DITP), Ministry of Commerce of Thailand. Independently of the JETRO's collaboration with the LHA, the DITP hired Mr. Kitagawara on their own budget to introduce the Sozai business to the Thai craft industries. Similar to the JETRO's project for the Lao handicraft industries, the participants in the project received technical assistance from Mr. Kitagawara and demonstrated their materials at the LIFE × DESIGN Exhibition in Tokyo since 2019.

It may be too early to make a quantitative assessment of the impact of these knowledge transfer projects on the craft businesses in Southeast Asia. Still, it is possible to find positive opinions on the effect of these projects. In Lao PDR, Mr. Vannavong Sithammarath, an architect at Tomi Atelier who had been willing to use natural materials of Lao PDR before the IDE's Sozai business project, could actually use local raw materials such as bamboo and wood for interior decorations of Cafe Buratino in Vientiane. The architect told the author in October 2022 that the IDE's project was helpful for identifying potential suppliers of Lao craft materials and facilitating the development of collaboration with the suppliers who had already become aware of the Sozai business concept through the Sozai project. The other interesting anecdote was provided by a Thai participant in an exhibition held in Dubai. According to his observation, Thai firms that demonstrated materials and products could attract more visitors to their booths than those who displayed only products. Although this remark is not directly related to DITP's project to promote the Sozai business, this fact may reflect that more buyers are looking for natural and sustainable materials and products made of such materials and that the project helped Thai firms to increase the awareness of craft material values and the current international market trend.

Implications

As stated by the Japan's Act on the Promotion of Traditional Craft Industries, craft industries use natural materials and unique skills that have been passed down from generation to generation. However, westernization and modernization of lifestyle will saturate or weaken the traditional craft markets. In such a situation, artisans need to consider what they should produce for whom to make their businesses and traditions sustainable, although they could have been dedicated to producing traditional products.

The Sozai business highlights the importance of the strategic use of trade fairs

for diversifying craft end-user markets and invigorating the craft industries. The Sozai business encourages craft producers to participate in trade fairs to meet present and potential customers and understand what they want. Trade fairs can give craft businesses the chance to meet with designers or buyers who might generate ideas for new goods or connect conventional sectors with non-traditional markets, as well as suppliers of new materials and other inputs. The increasing interest in natural and sustainable products in the global market will allow the craft industries to make more effective use of exhibitions to increase their values and brand image locally nurtured through their traditional business activities. By shedding light on craft materials, the Sozai business can lead to a re-expansion of consumer interest in traditional businesses. In other words, the Sozai business will be an enabler for the craft industries to exploit the traditional businesses and explore the potential of craft materials and techniques in the non-traditional market for the craft industries. By learning through the Sozai business, SMEs will be able to understand diversified market needs and acquire the capability of developing their own products and brands without radical technological innovations.

The Sozai business was attempted by the traditional craft industries in Kyoto initially. Their experience was transferred to Lao PDR through international cooperation and Thailand through the national initiative. This knowledge sharing indicates common characteristics to the craft industries in these three countries and the potential of Sozai business as a solution to the common challenges. Nevertheless, this knowledge will not create considerable competition among craft industries in different countries at least in each domestic market due to the different historical, cultural, and product characteristics. This nature of Sozai business for the craft industries will be important to promote international cooperation.

Finally, it should be noted that the experiences in the craft industries can be generalized to provide implications to SMEs in the modern manufacturing industries. SMEs support many industries as original equipment manufacturers (OEMs) or subcontractors responsible for material processing or assembly for a particular product category. SMEs can exploit the existing market while exploring new markets by participating in trade fairs to encounter buyers from different industries to develop collaborations. SMEs will be able to take advantage of their skills and know-how as their core competence to develop collaborations and realize diversification without significant amount of R&D expenditure for technological innovations (Markides and Williamson, 1994). SMEs will be more likely to achieve product and market diversification by developing connections with diversified partners (Machikita and Ueki, 2011). It will not be easy to find potential partners for such collaborative attempts at online trade fairs. The effective use of trade fairs that involve the movement of businesspersons will increase the importance of businesses and supporting organizations in their COVID-19 exit strategy.

The Sozai business also suggests the necessity for business and trade promotion agencies to understand business realities and bring their promotion approach in closer alignment with buyers' business practices. These organizations should provide policy support for marketing capacity building and participation in trade fairs to SMEs with unique products and material processing skills but do not have sufficient marketing capability. Production and quality management are prerequisites for the Sozai business. Traditional programs for supporting the building of these capabilities will be still useful for SMEs who make steady efforts for continuous improvements.

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Tech Events

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Dec 12–14 Hyderabad India
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Email: acml2022-organizing-committee@googlegroups.com; chengsoon.ong@anu.edu.au; adityakmenon@google.com
https://www.acml-conf.org/2022/cfp.html

Dec 14–16 Semarang, Indonesia
Global Offshore Wind Summit (GOWS) 4th International Conference on Innovation in Science Technology (ICIST 2022)
Contact: Conference Secretariat
Email: contact@icist.asia
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Dec 17–18 Dhaka, Bangladesh
3rd International Conference on Sustainable Technologies for Industry 4.0 (STI 2022) - STI Expo 2022
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Email: sti@green.edu.bd
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2023

Jan 02–03 Singapore
2023 International Conference on Green Energy and Environmental Technology (ICGEET-2023)
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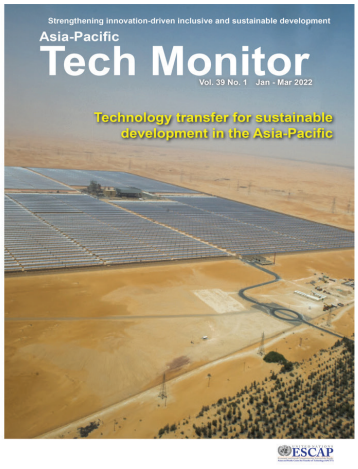

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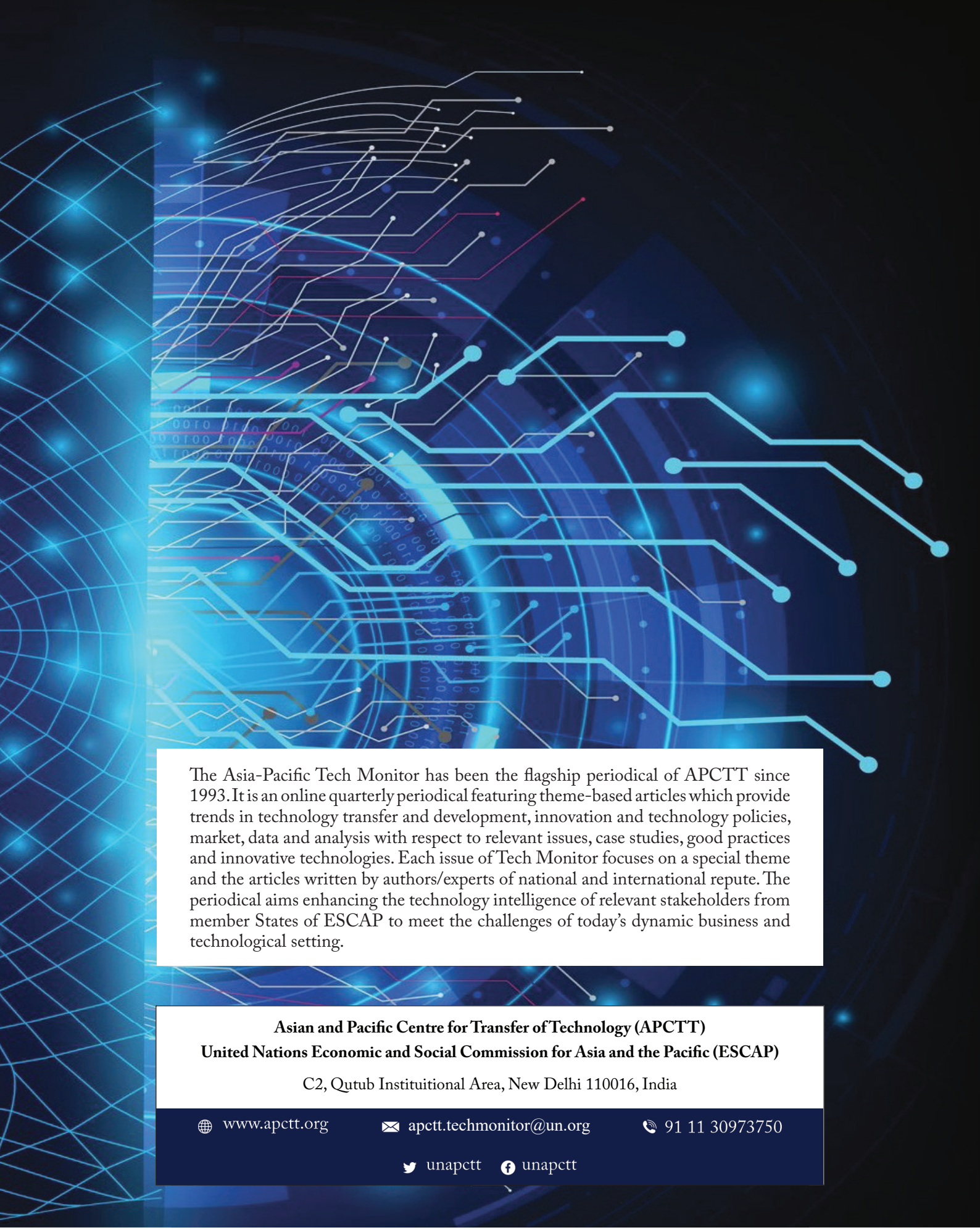
Technology transfer for sustainable development in the Asia-Pacific

Oct-Dec 2021

Harnessing fourth industrial revolution technologies for healthcare

Jul-Sep 2021

Technologies for adaptation to climate change in Asia-Pacific



The Asia-Pacific Tech Monitor has been the flagship periodical of APCTT since 1993. It is an online quarterly periodical featuring theme-based articles which provide trends in technology transfer and development, innovation and technology policies, market, data and analysis with respect to relevant issues, case studies, good practices and innovative technologies. Each issue of Tech Monitor focuses on a special theme and the articles written by authors/experts of national and international repute. The periodical aims enhancing the technology intelligence of relevant stakeholders from member States of ESCAP to meet the challenges of today's dynamic business and technological setting.

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