ASEAN+3 Start-up Program for
Promoting Sustainable Development

Study Report on "Bolstering Deep Tech Entrepreneurship for Sustainable Development in the ASEAN+3 Countries"

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1. Introduction

1.1. Motivation for This Study

Deep tech entrepreneurship has received increasing attention and investment for the last several years. It has been discussed in the context of both developed countries (e.g. the U.S. and Europe), and in some emerging economies. Supporting deep tech entrepreneurship is becoming a global agenda, also when it comes to solving grand challenges. Given the concept and goals of deep tech (i.e., aiming at both technological and social dimensions) and its potential contribution to sustainable development (Schuh *et al*., 2022; la Tour *et al*., 2019), it is time to re-think deep tech entrepreneurship in the context of Asian developing and developed economies, including ASEAN Plus 3 (hereafter, APT) countries (Nedayvoda *et al*., 2021). Deep tech startups, entrepreneurial ecosystem (EE), and supporting policies, if properly developed, can influence achieving sustainable development goals (SDGs) through appropriate means such as digital or green transformation and the creation of innovation-driven startups (Rosiello *et al*., 2022; Ajmone Marsan and Litania, 2023; Kim, 2023; G20/Startup20, 2023).

Taking the background into account, this study report aims to investigate the factors which can bolster deep tech entrepreneurship for sustainable development in APT countries. Specifically, it will address the following:

- Understanding the concept of deep tech startups and entrepreneurial ecosystem for APT countries;
- Analysing key public policies for deep tech entrepreneurship, including a nexus of business change and deep tech adoption or advancement of deep tech, for SDGs in the APT countries;
- Identifying successful or promising cases of deep tech startups from the entrepreneurial ecosystem perspective;
- Reviewing current trends and suggesting implications for key stakeholders and policymakers.

This study is the first attempt to overview the deep tech startups, their entrepreneurial ecosystem, and policies in the context of the APT countries and with a focus on SDGs by exploring current status, finding existing achievements or, investigating progress and challenges, and proposing policy agendas.

The remainder of this report is organized as follows. In the next parts of Chapter 1, the concept of deep tech startups and their ecosystem will be described. The potential contribution of deep tech startups to sustainability development will be also addressed in the context of the APT countries. In Chapter 2, the common factors of the entrepreneurial ecosystem will be drawn from the literature review. We will propose the factors of the entrepreneurial ecosystem (i.e. enablers promoting entrepreneurship) for deep tech startups and relevant indicators for each factor. The data will be collected and analysed for a variety of indicators influencing the entrepreneurial ecosystem for deep tech startups. In Chapter 3, the policies supporting deep tech startups or entrepreneurial ecosystems for them in the APT countries will be reviewed. For the countries with policies or plans related to deep tech startups and ecosystems, the meaning of deep tech startups, policy terminology and target goals, and/or practical tools will be compared across the countries. Constraints, barriers or regulations, as well as supportive policies in each country will be discussed, if they exist. In Chapter 4, successful cases of deep tech startups (if any exist), or trends of entrepreneurial ecosystem for deep tech startups will be discussed in the APT countries. In the final Chapter 5, we will suggest policy implications for the promotion of deep tech entrepreneurship for sustainable development by considering the differences in the startups and EE features across the APT countries.

1.2. Definition and Features of Deep Tech Startups

The concept of deep tech startups

The term "deep tech" startup has been conceptually defined in various ways but common features have been found in literature and in practice.[1] Deep tech startups refer to specific types of new firms focusing on either exploiting technological (or engineering) innovation, or on developing significant scientific discovery and technological solutions, in order to apply them to business transformation, and address grand societal challenges (Romasanta *et al*., 2022; Wareham *et al*., 2024).[2] In particular, deep tech startups aim to disrupt existing markets or create new markets with capital- and resource-intensive technologies and test processes (Schuh *et al*., 2022, Kask and Linton, 2023). Although deep tech startups are based on technological innovation or scientific discovery, they are not considered part of the technological or scientific community due to their goals toward market and societal impacts.

[1] The term "deep tech" is prevalently used in practice, but relatively less concretely defined in the academic literature since the term originated in the community of venture capitals in the mid-2010s (Siegel and Krishnan, 2020; Kim, 2023; Wareham *et al*., 2024).

[2] 'Deeptech' is a terminology for technologies that are based on scientific or engineering breakthroughs and have the potential to be commercialized (Nedayvoda *et al*., 2020). The features of deep technologies will be further explained in the below paragraphs.

The features of deep tech startups

Deep tech startups can differ from other (regular or shallow-tech) startups in several aspects (Romasanta *et al*. 2022; Schuh et al., 2022; Dealroom.co, 2021; Kim, 2023). Deep tech startups tend to draw on technological innovations requiring investment in a range of resources (e.g., human capital and expertise, funding resources, or physical equipment or infrastructure). Other startups, however, rely on proven technologies and strategies (e.g., first developing business models and attaching required technologies later) or prioritize a business model without capital-intensive technologies or intensive test processes. Furthermore, deep tech startups combine visionary ambition, fundamental research, and commercial pragmatism (Gourévitch *et al*., 2021). Hence, deep tech startups have multiple risks, such as technology (e.g., R&D or technological feasibility) risk and market (e.g., product-market fit) risk simultaneously, which differs from other startups with only market risk (Dealroom.co, 2021; Romasanta *et al*., 2022). Refer to Table 1.1 for a comparison of deep tech startups and other startups.

Table 1.1. Comparison of deep tech startups and other (regular or shallow tech) startups

	Deep Tech Startups	Other Startups
Base and Moat	Solutions based on significant technological innovation	Business model
Goal	Disruptive business transformation or new market creation; Seeking market and societal impacts	Not always toward a disruptive change of business and market; Less focus on societal impact
Critical Validation for Product-Market Fit	Rigorous test or stepwise development for both technology and market	Iterative market-focused development and test
Required Time and Resource Investment	Long and more expensive development or test (> 3 years); Initially capital- and resource-intensive investment	Quick and less expensive development or test (< 1 or 2 years); Lower initial investment
Risk	Technology risk + Market risk	Market Risk
Target Customers	Typically B2B	B2C
Ecosystem Boundary and Partners	Broad scope; Complementary industry-/sector-level partners	Narrow scope; Specific business-level partners

Sources: Romasanta *et al*. (2022), Schuh *et al*. (2022), Dealroom.co (2021), Kask and Linton (2023), and Kim (2023).

Deep tech startups can be characterized by underlying attributes of 'deep technology': novelty, impact, time and scale, and investment (de la Tour *et al*., 2019; Porticaso *et al*.,

2021). Refer to Table 1.2. for the main attributes of deep technologies shaping the features of deep tech startups. The attributes of deep technologies (e.g., significant impact, significant time to reach market-ready maturity, and requirements for significant capital and resource investment) can not only hinder the creation of deep tech startups in a business context, but also present obstacles that lead to failure of the startups in the market (de la Tour *et al*., 2019; Kask and Linton, 2023).

Table 1.2. Main attributes of deep technologies underlying deep tech startups

Feature	Description
Novelty	Deep technologies are novel and offer significant advances over technologies currently in use. They require substantial R&D to develop practical business or consumer applications, and to bring them from the lab to the market.
Impact	Many deep technologies address big societal and environmental challenges and will likely shape the pressing global problems are approached. These technologies have the power to create their own markets, or to disrupt existing industries.
Time and Scale	Deep technologies take time to move from theory to applicable technology. The amount of time varies substantially by technology.
Investment	Continuous investment is necessary from ideation through to commercialization, and these intensive capital requirements are complicated by technology risk as well as market risk. Full development generally requires both public and private funds and resources.

Sources: Porticaso *et al*. (2020), de la Tour *et al*. (2019), and Romasanta *et al*. (2022).

Deep tech startups share the above-mentioned characteristics. In addition to the comparison between deep tech startups and other business-oriented startups, it is important to recognize the difference between deep tech startups and general tech-based startups. Unlike general startups, deep tech startups are based on successful deep tech innovations which have the power to fundamentally change existing industries and to create new markets (Schuh *et al*., 2023; Nedayvoda *et al*., 2020, de la Tour *et al*., 2021). Several main features distinguish deep technology and deep tech startups from other technological classifications, and from general tech-based startups (Schuh *et al*., 2023; Nedayvoda *et al*., 2020; de la Tour *et al*., 2021; Kim, 2023): First, deep tech based innovations are subject to a comparably high risk of technological feasibility (i.e., technology risk), since such innovations are newly developed and untested. Second, in addition to technology risk, deep tech startups usually face an extraordinarily high market risk due to their high degree of novelty. Markets for deep technology may not exist as development begins, meaning that commercialization cannot always be guaranteed. Third, deep tech startups often adopt a convergence of technologies (e.g., technology

integration or multidisciplinary technological fields). Lastly, when compared to other tech-based startups, deep tech startups are more likely to depend on a range of industry/sectoral-level partners for initial development, market expansion to handle complex functions, and know-how in design and engineering, as well as commercial immaturity.

Furthermore, it should be noted that deep tech startups do not directly refer to startups for a specific technological field or industry. “There is no such thing as a ‘deep technology’.” (de la Tour *et al*., 2021, p. 12). Similarly, “there is no such thing as a ‘deep tech industry’.” (Kim, 2023). Although investment for deep-startup startups tends to focus on certain technological fields, or those deep tech startups draw from a variety of established technologies, including AI, big data analytics, robots, semiconductors, photonics, advanced materials, biotechnologies and synthetic biology, autonomous driving, and other advanced or emerging technologies (Sigel and Krishnan, 2020; la Tour *et al*., 2021), all startups simply using those technologies are not always regarded as deep tech startups. That is, ‘deep tech’ startups are not synonymous with ‘specific technology’ or ‘specific industry’ startups. Deep tech startups are not constrained in certain technology or industry fields because they tend to seek the integration of technologies, and thus, their business models can include a variety of industries. For example, some deep tech startups maintain their business in the agriculture industry, although that industry is not R&D-intensive.

Finally, successful deep tech startups share certain complementary attributes (de la Tour *et al*., 2021; Gourévitch *et al*., 2021): (a) They are problem-oriented, aiming to solve large and fundamental issues and challenges. Most deep tech ventures contribute to at least one of the UN’s sustainable goal development goals (SDG). (b) They exploit the convergence of technologies. Most deep tech ventures harness at least two technologies, and the majority of them use more than one advanced technology. (c) They have shifted from digital innovation to digital and physical innovation, and mainly develop physical products, rather than software. Many deep tech ventures involve designing or building products with hardware components. (d) They are at the centre of the ecosystem, catalysing the emergence of a cross-organizational ecosystem for investment, support, research, and application development. They receive support from a variety of entrepreneurial ecosystem (EE) actors, including governments, universities, and other partners (e.g., large firms, SMEs, public or private research institutes, etc.).

The definition of deep tech startups

Considering the characteristics described above, we define deep tech startups in the context of this study as follows:

“Startups which are new firms (less than 10 years old), with a key business offering that (a) is developed based on deep technologies and their convergence; (b) has novel (or

disruptive) features in its business and/or technology approach toward impactful problem-solving; (c) has the potential for high-growth or scalability (scale-up); and (d) requires time and investment for business and technology development."

1.3. Why and How Deep Tech Startups Contribute to Sustainable Development in the APT Countries?

Introduction

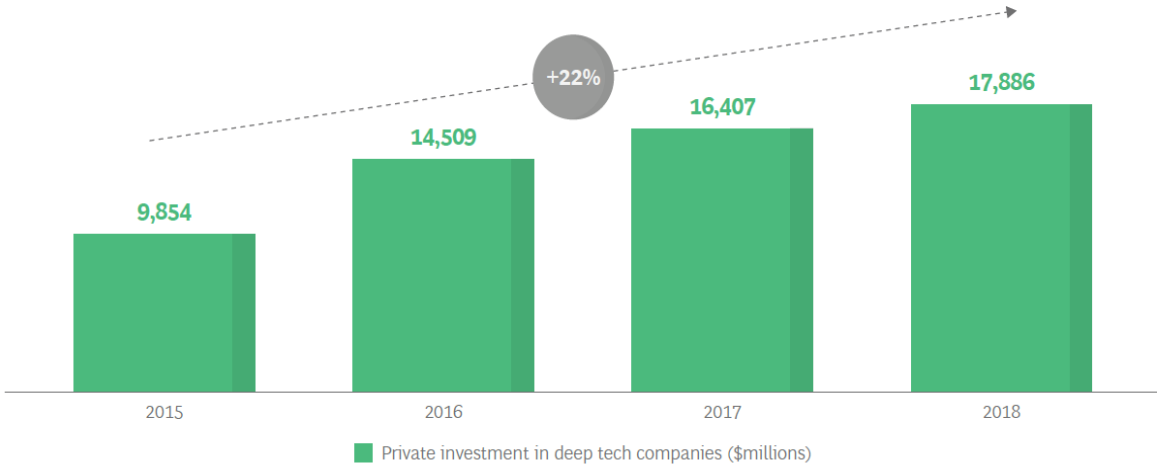
Deep tech startups can drive development in alignment with the United Nations Sustainable Development Goals (SDGs) by leveraging advanced technologies to address pressing environmental, social, and economic challenges (Nedayvoda *et al*., 2020; p. 2-3). Gourévitch *et al.* (2021a; p.3) unveil that 97% of deep tech ventures studied strive to meet at least one of the SDGs. Deep tech startups can also lift countries out of the so-called 'middle-income trap'; a challenging economic phase where countries struggle to transition from labour-intensive industries to knowledge-based economies.[3] This subchapter explores how deep tech startups contribute to sustainable development, by addressing business needs, contributing to the green transition and social inclusion.

Deep tech startups drive innovation, enhance productivity, create high-value industries, and can create partnerships between APT countries. These startups focus on breakthrough innovations in areas like artificial intelligence, biotechnology, advanced materials, and clean energy. By integrating cutting-edge research and technology, deep tech startups aim to tackle complex problems such as climate change, resource scarcity, and social inequalities in ways that traditional approaches cannot. For instance, AI and biotechnology can improve healthcare outcomes and agricultural productivity, while advanced material development can enhance disaster response and mitigation efforts.[4] There has been an increase in private sector investment in deep tech from 2015 to 2018, see Figure 1.1.

[3] https://www.worldbank.org/en/publication/wdr2024

[4] Accelerating Artificial Intelligence Discussions in ASEAN (eria.org)

Figure 1.1. Global private investment deep tech has increased over time



Sources: Capital IQ; Quid; BCG Center for Innovation Analytics; BCG and Hello Tomorrow analysis.

Note: Includes investment in seven deep tech categories: advanced materials, artificial intelligence, biotechnology, blockchain, drones and robotics, photonics and electronics, and quantum computing. Private-investment sums are based on transactions with disclosed amounts. Some 41% of private investments in deep tech companies remain undisclosed.

Source: de la Tour *et al*. (2019)

Deeptech startups work to fulfil business needs

Deeptech offers opportunities to innovate business models that lead to cheaper and more efficient solutions to traditional business problems. An apparent example in populous ASEAN cities is the boom of ride-hailing services. In these cities, regional players, such as Grab and Gojek compete with national companies, such as Green SM in Viet Nam. Now publicly listed companies, Gojek and Grab illustrate the link between deep tech and real-world applications. Both companies rely heavily on data-intensive processes and AI models to enhance their services. Their platforms leverage advanced machine learning algorithms for route optimization, demand forecasting, and personalized user experiences. This deep tech capability is foundational to their operations, enabling them to efficiently manage complex logistics and large-scale customer interactions.[5] Motorbike-hailing service was first introduced as a derivative, then quickly grew into a major shipping industry.

Beyond their core ride-hailing and food delivery services, many startups such as Grab are offering financial services like microloans and micro-insurance.[6] Here, deep tech plays a crucial role as well. By analysing vast amounts of user data and applying AI-driven risk assessments, they can offer financial products tailored to underserved populations who

[5] https://www.technologyreview.com/2022/04/21/1050381/the-gig-workers-fighting-back-against-the-algorithms/

[6] https://www.dealstreetasia.com/partner-content/how-grab-is-democratising-access-to-wealth-management-and-protection-for-southeast-asians

lack traditional credit histories.[7] This diversification is just one example of how deep tech enables the scaling of inclusive financial solutions in emerging markets.

A well-developed startup ecosystem can also significantly enhance the technological capabilities of traditional MSMEs. Prominent ASEAN startups that have grown into major tech players illustrate this dynamic. Digital marketplaces and fintech platforms in the region, such as Tokopedia, Shopee, and Traveloka, have introduced innovations that benefit traditional MSMEs like small shops, restaurants, and tourism companies. These platforms help expand the customer base, improve revenue streams, and broaden business opportunities for these enterprises. Additionally, the data-driven business models of these tech companies enable a more accurate assessment of customer risk profiles. This has led many fintech startups to diversify their offerings to include micro-loans and micro-insurance schemes that are especially advantageous for MSMEs and micro-entrepreneurs (Mackintosh and Monga, 2024).[8]

These examples demonstrate the crucial connections between startups and MSMEs, and show how collaborations, particularly in tech-intensive sectors, can introduce innovations to traditional businesses, enhancing their productivity and benefiting the broader economy. However, it is important to recognize that technological advancements can also lead to massive economies of scale. This can result in market concentration, reducing competition and creating barriers for MSMEs and startups, as large tech companies integrate and dominate markets, often to the detriment of consumers (Ajmone Marsan, 2022a; Yan Ing and Markus, 2023).

They contribute to the green transformation…

In the APT regions, where rapid industrialization and urbanization pose sustainability challenges, deep tech innovations can help transitions towards greener economies, and help address climate change through mitigation and adaptation. Innovations focused on energy efficiency, carbon capture, and other sustainable practices directly support efforts to mitigate and adapt to climate change in the region. Technologies promoting recycling, waste reduction, and resource efficiency also advance the circular economy, encouraging sustainable production and consumption patterns.

For instance, startups developing renewable energy technologies, energy storage solutions, and smart grid systems are crucial for countries aiming to reduce carbon emissions and improve energy efficiency (Ajmone Marsan and Litania, 2023).[9] Innovations

[7] https://dealstreetwebsite.s3.amazonaws.com/uploads/2024/08/Preview_-The-Evolution-of-Digital-Payments-in-SE-Asia.pdf

[8] Preview: The Evolution of Digital Payments in SE Asia: From E-wallets to Lending.docx (dealstreetwebsite.s3.amazonaws.com)

[9] 06_Author_article_Tech-based Entrepreneurship.pdf (apctt.org)

in precision agriculture and biotechnology can enhance food security and reduce environmental degradation, which are critical issues in many Southeast Asian countries. Moreover, these startups often focus on localizing solutions to meet specific regional needs, making their impact more targeted and effective.

In environmental management, many deep tech startups focus on clean technologies such as renewable energy, waste management, and water purification, addressing pressing environmental issues in the region. Additionally, in the agriculture sector, startups leverage advanced technologies like precision farming, biotechnology, and AI to enhance crop yields and ensure food security, particularly in regions that face significant impacts from climate change (Ajmone Marsan and Sirois, 2024)[10]. One example is Sagri, a Japanese agriculture deep tech startup, incorporating AI and satellite data to analyse soil health conditions to optimize the use of fertiliser, and to expedite efficient production methods in agriculture.

Furthermore, deep tech startups focused on smart cities and infrastructure contribute to urban sustainability. Innovations in smart city technologies, such as IoT and big data analytics, help improve urban planning, reduce traffic congestion, and enhance public services, and thus improve liveability. In transportation, advancements in electric vehicles and mobility solutions help reduce the carbon footprint of urban areas.

…and address social inclusion issues

Deep tech startups contribute to social development by improving access to essential services such as healthcare, education, and financial services. The multi-faceted impact of climate change on poverty and health can also be addressed in APT through deep tech startups. Impoverished communities often lack access to healthcare and nutritious food, leading to increases in malnutrition and preventable diseases. By promoting sustainable agriculture and eco-friendly practices, green entrepreneurship can enhance food security and health. Supporting green entrepreneurs with access to financing, education, and talent attraction can address environmental challenges while benefiting society (Ajmone Marsan and Singh 2023)[11].

Other notable examples include advancements in medical diagnostics and healthtech can help bridge healthcare gaps in rural areas, while AI-powered education tools offer personalized learning opportunities to underserved communities. In the healthtech space, they drive innovations in telemedicine, diagnostics, and biotechnology, improving healthcare access and outcomes, especially in underserved areas. Additionally, biotechnology advancements support better responses to health crises, enhancing public

[10] Horizon : A Perspective of Malaysia's Digital Economy | MDEC

[11] https://seads.adb.org/solutions/poverty-prosperity-power-green-entrepreneurship-asean

health resilience. HaloDoc from Indonesia is a leading telemedicine platform that uses AI to connect patients with doctors, pharmacies, and diagnostic services, making healthcare more accessible. Another example is Korea's Lunit, which uses AI for cancer diagnostics, focusing on enhancing medical imaging accuracy. Another example is TOY EIGHT from Japan, which offers diagnosis services for infants and children, with the goal of identifying developmental disorders early in childhood.

Additionally, fintech startups using blockchain and AI technology are fostering financial inclusion by providing secure and affordable services to unbanked populations, driving economic empowerment in APT countries. For example, the Chinese company Ant Group leverages both AI and blockchain technologies through its Alipay platform to promote financial inclusion across Asia-Pacific regions. Using AI-driven algorithms, Ant Group provides personalized credit scoring and microloans to millions of individuals without traditional banking histories. Blockchain technology ensures that transactions are secure, transparent, and tamper-proof. By offering affordable and trustworthy financial services, Ant Group has enabled unbanked populations to access banking, savings, and credit facilities, thereby driving economic empowerment and inclusion in the region.[12] Soramitsu, a Japanese fintech startup, introduced Bakong, a CBDC in Cambodia, allowing Cambodians to use this currency system with services such as digital wallets, mobile payment, online banking and financial applications.

In femtech, companies are providing support for women's health and wellness, providing a platform that offers access to a wide range of products, from menstrual health tools to fertility tracking devices. For example, Fermata is a notable femtech startup based in Japan, operating within the Asia-Pacific region. Fermata provides educational resources, helping to increase awareness and destigmatize conversations around women's health. Fermata's efforts contribute to improved healthcare access and education for women across Asia-Pacific, empowering women to take control of their health and well-being. Bonzun from China is gaining traction with its AI-driven prenatal care and fertility solutions, offering personalized health tracking for women. These examples highlight how deep tech innovations in the region are expanding across diverse fields, and bringing impactful solutions.

Deep technology-based startups can also enhance digital literacy for women and people with disabilities by developing inclusive and accessible technologies. For instance, AI-driven tools can offer personalized learning platforms that adapt to individual needs, enabling those with disabilities to navigate digital environments more effectively (Singh, 2023a)[13]. Additionally, startups focused on edtech can create programs designed to

[12] https://www.antgroup.com/en

[13] https://seads.adb.org/solutions/technology-and-disability-trends-and-opportunities-digital-economy-asean

empower women with essential digital skills, helping bridge the gender gap in technology and fostering greater participation in the digital economy (Singh, 2023b).[14]

Collaboration within APT

The collaborative ecosystem in the APT regions further strengthens the contribution of deep tech startups to sustainable development. China, Japan, and South Korea have well-established tech ecosystems and are increasingly investing in Southeast Asia's innovation landscape. This exchange of expertise and investment catalyses the growth of deep tech solutions, fostering a collective push toward the SDGs. Overall, deep tech startups are not only innovators but also key enablers of sustainable development in these rapidly evolving regions.

Cross-border partnerships, facilitated by regional frameworks, enable the sharing of knowledge, resources, and market access. One example is the ASEAN-Japan Innovation Network (AJIN), which facilitates collaboration between Japanese and ASEAN businesses, universities, and research institutions. This network encourages the exchange of technology and expertise, particularly in areas like smart cities and sustainable development. Another example is the China-ASEAN Technology Transfer Center (CATTC), established to promote technology transfer and innovation between China and ASEAN member states. This partnership has led to various joint projects in fields such as agriculture, renewable energy, and information technology, enhancing the region's overall technological capabilities and market reach.

Sustainable Development Goals

The 17 Sustainable Development Goals (SDGs) represent a global framework with 169 targets aimed at addressing critical social and environmental challenges. Startups in the APT countries are uniquely positioned to drive progress towards these goals due to their innovative nature. Unlike more established corporations, startups thrive on developing breakthrough technologies and solutions that address modern challenges while disrupting traditional, unsustainable practices.

Startups are typically more agile and adaptable, allowing them to respond rapidly to market signals, test new ideas, and pivot strategies when needed. This flexibility is especially valuable in promoting sustainable and socially responsible initiatives in a rapidly changing world. By challenging the status quo, startups often lead in offering alternative solutions which align with SDG objectives, from clean energy solutions to equitable access to healthcare.

[14] https://www.eria.org/news-and-views/women-and-leadership-in-the-asean-digital-economy/

As a result, startups in deep tech sectors across these regions play a key role in accelerating SDG progress through their capacity for innovation, adaptability, and commitment to transformative change.

Please see Figure 1.2 for examples of potential contributions of deep tech startups to SDG in the APT countries.

Figure 1.2. How deep tech startups in APT contribute to SDGs

Source: Adapted from ERIA (2024).

1.4. Why We Need to Consider the Ecosystem for Deep Tech Startups?

Introduction

The ecosystem for deep tech startups in the APT countries refers to the network of startups and organizations that focus on developing advanced technology solutions. The deep tech landscape comprises a diverse and expansive ecosystem with various participants, each engaged in smaller, specialized ecosystems focused on specific research areas, technologies, industries, or missions. These ecosystems stand out from traditional business collaborations due to their inclusivity of diverse players and their dynamic nature, allowing participants to join or leave as needed and form new, often informal, relationships. Unlike conventional partnerships, deep tech collaborations are less reliant on a central organizer and thrive on complex interactions among participants. While financial investment is crucial, other forms of exchange—such as knowledge, data, skills, expertise, connections, and market access—are equally important in linking players within these ecosystems. Due to these benefits, numerous traditional companies have transitioned to an ecosystem model. This approach allows them to acquire the technologies, expertise, and capabilities required to digitalize their operations and services (de la Tour et al., 2019). This chapter describes the key actors in deep tech ecosystems, and the dynamics and challenges in APT as an ecosystem at large.

Key actors of ecosystems for deep tech startups

A deep tech startup ecosystem is a complex network of stakeholders that contribute to the development, scaling, and commercialization of technology-driven innovations. These ecosystems are characterized by the convergence of cutting-edge science, advanced engineering, and high-impact societal applications, in areas such as AI, biotech, quantum computing, and advanced materials. The key actors in this ecosystem include startups, research institutions, government agencies, venture capitalists, corporate partners, accelerators, and learning organizations. Each of these stakeholder groups is further described.

1. **Startups:** At the core of the ecosystem are deep tech startups, which are typically founded by scientists, engineers, or technologists with a vision to commercialize breakthrough innovations. These startups face unique challenges, such as long development cycles, high capital requirements, and the need for specialized knowledge. Startups have diverse needs. In a 2017 survey by BCG,[15] funding emerged

[15] BCG and Hello Tomorrow conducted a survey of over 400 deep tech startups to explore their needs and preferred partners. The surveyed ventures span ten sectors—including aerospace, environmental technology, beauty and wellness, data science, energy, food and agriculture, healthcare, Industry 4.0, transportation, and water and waste management—across more than 50 countries. The aim was to gain insights into the challenges faced by deep tech startups and how they engage with other stakeholders in the ecosystem. Additionally, in-depth interviews were carried out with key

as the most common priority, with 80% placing it among their top three requirements. However, startups require much more than just financial support. They seek assistance from the ecosystem for market access (61%), technical expertise (39%), and business knowledge (26%). As startups progress and their products near market readiness, their needs shift, as does the appeal of different types of funding partners (de la Tour *et al*., 2019).

2. **Research Institutions and Universities**: These institutions play a crucial role by generating the fundamental scientific knowledge that underpins deep tech innovations. They often collaborate with startups to translate research into marketable products. Startups can also originate from these universities as spin-offs when researchers realise there are commercial applications for their research discoveries. Tsinghua University (China): Often referred to as "China's MIT," Tsinghua University in Beijing is renowned for its strong emphasis on engineering, computer science, and technology research. It plays a significant role in China's innovation ecosystem, producing top-tier talent and groundbreaking research in areas like AI, quantum computing, and advanced manufacturing. Located in Daejeon, South Korea, Korea Advanced Institute of Science and Technology (KAIST) is a leading research university specializing in science and engineering. It is known for its contributions to creating deep tech startups in diverse fields, including robotics, biotechnology, and nanotechnology. KAIST serves as a key hub for deep tech innovation in South Korea, fostering collaboration between academia, industry, and government. In the ASEAN, ASTAR (Agency for Science, Technology, and Research) in Singapore is a leading example. ASTAR works closely with industry partners and startups to drive innovation in areas like biomedicine, advanced manufacturing, and digital technologies.

3. **Government Agencies**: Governments are pivotal in fostering a supportive environment for deep tech startups through funding, policymaking, and infrastructure development. They often provide grants, tax incentives, and regulatory support to reduce the risk for startups and attract investment. For example, the Ministry of SMEs and Startups (MSS) is a key actor, offering policies such as the ‘ Super-Gap Startup 1000+ Project’ to support deep tech startups in South Korea. As the public agency for the MSS, the Korea Institute of Startup and Entrepreneurship Development (KISED) has developed and managed a range of public programs supporting policies for deep tech startups. [16] Enterprise Singapore is also spearheading the growth of deep tech startups in Singapore, as well as the development of a deep and vibrant ecosystem that enables such startups to grow and scale. Working in concert with other government agencies and a strong network

ecosystem participants such as investors, support organizations, and mentors. Source: https://www.bcg.com/publications/2017/technology-digital-joint-ventures-alliances-what-deep tech-startups-corporate-partners

[16] https://www.kised.or.kr/menu.es?mid=a20204010000

of partners comprising investors, corporates, and academic or technical experts, Enterprise Singapore's efforts support the deep tech startups' needs in areas such as funding, proof-of-concept and proof-of-value validation, test-bedding and piloting of new products, talent, mentorship, and market access.

4. **Venture Capitalists (VCs) and Investors**: VCs are essential in providing the necessary financial capital to scale deep tech startups. They often bring not just funding but also strategic guidance and industry connections. In Japan, Deepcore is one such example of a VC firm focused on deep tech, investing in AI and robotics startups, and leveraging its connections with academic institutions and large corporations. Investors and venture capitalists are showing heightened interest in the region's deep tech landscape due to its potential for innovation and technology-driven growth. HongShan Capital, previously known as Sequoia Capital China, is a leading venture capital firm in China that invests across various sectors, including technology, healthcare, consumer products, and financial services. The firm is known for funding high-profile companies such as ByteDance (the parent company of TikTok), Meituan (a leading e-commerce platform for services), and Alibaba (one of the world's largest e-commerce companies).

5. **Corporate Partners**: Large corporations often engage with deep tech startups to access cutting-edge innovations and integrate them into their own operations. These partnerships can take the form of joint ventures, acquisitions, or strategic investments. In B2B markets, corporate partnerships are crucial for validating proof of concept under real-world conditions. For instance, Canard Drones collaborated with Groupe ADP, allowing the startup to test its solution for aeronautical navigation aids in an actual airport managed by Groupe ADP (de la Tour *et al*., 2019). Large companies are particularly valuable when addressing challenges that go beyond digital tools, such as establishing a pilot production line, scaling to a full factory, or connecting with suppliers (de la Tour *et al*., 2019). For example, KT, Naver, Samsung, and LG in South Korea have increasingly collaborated with or made strategic alliances with deep tech startups in fields such as semiconductors, AI, big data analytics, biotechnology, and battery development to stay at the forefront of technological innovation. Large foreign tech firms like Google, AWS and Microsoft have all programmes to support tech startup development in Southeast Asia, and actively collaborate with emerging startups. However, entrepreneurs remain cautious; they understand that cultural differences, challenging corporate partnerships, and potential failures present real risks. Rather than combining startup agility with corporate strength, these collaborations often falter due to the startup's vulnerabilities and the large company's inertia (de la Tour *et al*., 2019).

6. **Accelerators and Incubators**: These organizations provide startups with mentorship, networking opportunities, and often seed funding to help them grow. They provide crucial navigation during the early stages of development, and also provide connections with potential investors and partners. An example of such an organization is Deepcore, a Tokyo-based AI startup incubator and investment firm, which supports deep tech startups by providing resources and mentorship to develop innovative ideas into viable businesses. Plug and Play Japan is a prominent accelerator that focuses on fostering deep tech startups in various fields, including fintech, healthtech, and IoT, providing the startups with access to global networks and resources. The Malaysian Global Innovation & Creativity Centre (MaGIC) is another similar startup accelerator in Malaysia. It offers programs that support entrepreneurs through mentorship, funding, and networking opportunities. MaGIC focuses on fostering innovation and scaling startups, particularly in areas like fintech, healthtech, and green technology.[17] This accelerator plays a key role in developing Malaysia's startup ecosystem by connecting local startups with global markets and resources.

7. **Learning Organisations:** Successful deep tech startups can help build robust innovation ecosystems, including universities, research institutions, and other startups. That, in turn, improves the quality of education, promotes STEM (science, technology, engineering, and mathematics) fields, and provides continuous learning opportunities for the workforce (Pause, 2017).[18] Entrepreneurship skills can be developed through a foundation of technical knowledge, critical thinking, and opportunities for hands-on learning and innovation. Through research programs, industry partnerships, and entrepreneurial hubs, universities help students transform ideas into viable businesses, equipping them with both the technical and business acumen needed to succeed.

   École 42 exemplifies a non-traditional approach to education in this space. With no formal teachers or traditional classrooms, it emphasizes peer-to-peer learning and project-based experiences, allowing students to develop strong problem-solving abilities and coding skills essential for tech entrepreneurship. This model is particularly effective in fostering creativity and collaboration, which are key to thriving in the rapidly evolving STEM fields. 42 Bangkok in Thailand adopts this innovative learning model. The curriculum is gamified, allowing students to earn points and advance by completing projects. Similarly, 42 Kuala Lumpur (42KL) in Malaysia offers a peer-learning approach with an introductory 26-day coding bootcamp aimed at individuals over 18. This program is designed to develop a future-ready digital workforce through hands-on learning and industry placements. École42

[17] https://central.mymagic.my/resource/by/163?brand=

[18] Escaping the Middle-Income Trap: Innovate or Perish | Asian Development Bank (adb.org)

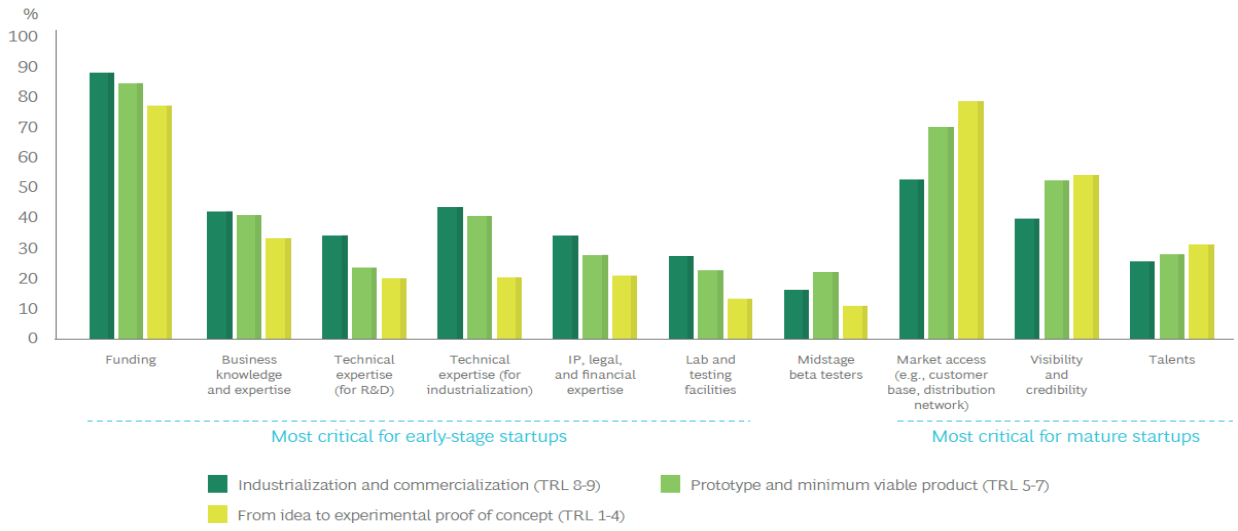
is also offered in Japan,[19] Korea,[20] and Singapore.[21] Skills issues are covered more in detail in the next section.

Dynamics of Stakeholder Relationships

Deeptech ecosystems tend to be more dynamic and fluid than other ecosystems. As emerging technologies or industries develop, the relationships among ecosystem stakeholders evolve as well. From research to commercialization, roles and expectations shift. For instance, while early-stage startups prioritize expertise and access to lab and testing facilities, more mature startups in the commercialization phase focus increasingly on talent, visibility, and market access.

The appeal of partners shifts as startups progress, depending on resource needs. For instance, among startups in the 2018 Hello Tomorrow Challenge, those seeking corporate help with product development dropped from 38% to 24% as they moved from experimental to commercialization stages, while those seeking distribution support increased from 24% to 47%. Early in tech development, corporations and investors may prioritize access to knowledge or securing a stake, but as commercialization nears, financial goals take precedence. This evolution drives changes in collaboration models and partnership strategies within ecosystems (de la Tour *et al*., 2019).

Figure 1.3. Deep tech startups' needs evolve as they mature



Sources: Hello Tomorrow Challenge; Hello Tomorrow and BCG analysis.

Note: Based on data from 1,646 deep tech startups that qualified for the second round of the Hello Tomorrow Challenge in 2018 (from 4,500 applications). TRL = technology readiness level on a NASA-originated scale of 1 to 9.

Source: de la Tour *et al*. (2019)

[19] https://www.42network.org/campus/42-tokyo/

[20] https://42seoul.kr/en/seoul42/admission/admission.html

[21] https://www.42network.org/42-schools/?r=asia

Need for talent in STEM

Talent development, circulation and attraction are essential for deep tech startups (Ajmone Marsan and Litania, 2023).[22] The region benefits from a diverse talent pool, with numerous universities and research centres producing skilled graduates in STEM fields.

However, there remains a need to enhance training and development programs to meet the growing demand for tech talent. This need is especially critical as market demand for advanced technology solutions continues to rise across industries such as healthcare, agriculture, transportation, and finance. The expanding market presents a significant opportunity for deep tech startups to thrive.

National deep tech ecosystems can also help attract and retain qualified talent, boosting domestic STEM—reliant industries. In addition, regional economies often benefit from knowledge spillovers from universities that incubate deep tech startup commercialization. By sharing knowledge, resources, and best practices, member states can collectively advance their technological capabilities and address common challenges.[23]

Innovation Hubs and Spillovers

Geographically, established innovation hubs in cities such as Singapore, Seoul, Tokyo or Shenzhen, and emerging hubs such as those in Kuala Lumpur, Jakarta, and Ho Chi Minh City are emerging as key centres for deep tech activity. These hubs attract talent and investment while hosting accelerators and incubators that offer resources and mentorship to startups. The development of such ecosystems is further strengthened by collaborations and partnerships between deep tech startups and universities, research institutions, and large corporations. These alliances help leverage expertise and resources, accelerating innovation and the development of cutting-edge solutions. While challenges persist, the ecosystem's potential for innovation and growth remains strong, paving the way for deep tech to play a transformative role in the region's development.

Deep tech startup ecosystems can further create positive spillover effects to boost economic development across the region. Countries that have harnessed new technologies have consequently expanded their economies. When a deep tech solution succeeds, it provides a platform technology that can enable disruption across markets and jumpstart new industries. The solutions developed by deep tech startups can elevate traditional industries in low-income countries by creating new types of infrastructure or technologies that can address existing bottlenecks.

[22] Attracting Global Talents (eria.org)

[23] How ASEAN can drive its digital economy | World Economic Forum (weforum.org)

2. Entrepreneurial Ecosystem for Deep Tech Startups

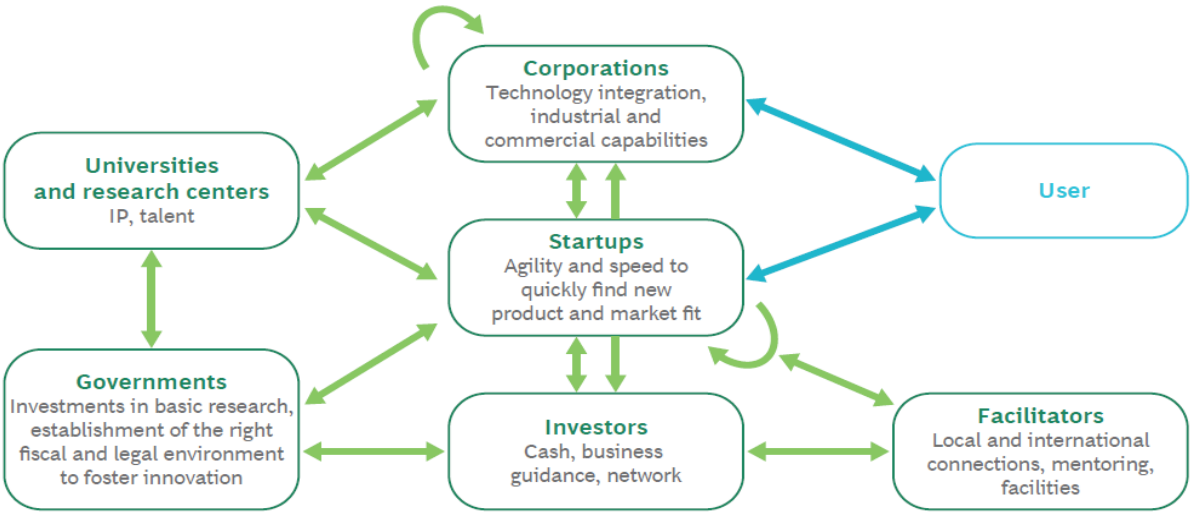
2.1. The Concept, Factors and Indicators of an Entrepreneurial Ecosystem

The term 'entrepreneurial ecosystem' has been increasingly used in academia (Stam, 2015, 2018) and in practice (Isenberg, 2010; WEF, 2013; ASEAN, 2020) to describe entrepreneurial support systems within certain countries, regions, and cities since the early 2010s (Stam and van de Ven, 2021; Rosiello *et al*., 2022).[24] An entrepreneurial ecosystem can be defined as a set of interdependent actors and underlying factors that are coordinated in such a way that they enable productive entrepreneurship to create and scale startup companies (Stam and van de Ven, 2021; GSMA, 2022; ASEAN, 2020). Drawing on the concept of an entrepreneurial ecosystem, policymakers concerned about economic development can describe policies which aim to promote high levels of entrepreneurial activity, subsequently leading to new value creation and job creation through startup formation and growth (Kansheba and Wald, 2020; Stam and van de Ven, 2021). Policymakers are increasingly taking approaches based on entrepreneurial ecosystem concepts and structures, in order to strengthen startup activity, as such approaches promote strategic, long-term, and holistic views (ASEAN, 2020).

A variety of actors engage in the entrepreneurial ecosystem. The primary actors are startups, incumbent firms (e.g., existing large firms and SMEs; supplementary or complementary to the startups), investors (e.g., venture capitals, angels, private investors, etc.), government or public entities, users of the startups' products or services, universities providing knowledge, talent, and labour forces to the startups and incumbent firms, and facilitators (e.g., mentors, supportive or startup-oriented service organizations, etc.). As presented in Figure 2.1, the entrepreneurial ecosystem of deep technology includes diverse actors who contribute in various ways and are interconnected (de la Tour *et al*., 2019). Notably, deep tech startups are at the centre of the ecosystem of deep technologies. These startups play an important role in promoting research, development, and commercialization of new technology or products, and sometimes in leading radical innovation that is too risky for incumbents. In addition, they closely interact with other actors, such as incumbent corporates, investors, governments, universities, and facilitators.

[24] We have found from the literature review that some studies used the term 'entrepreneurial ecosystem', while others employed the term 'startup ecosystem'. We adopt the former term in this study report because the former tends to be more frequently used than the later in the literature (Kansheba and Wald, 2020; Wurth *et al*., 2021).

Figure 2.1. Actors in the entrepreneurial ecosystem of deep technologies



Source: de la Tour *et al*. (2019).

Full development of the factors comprising entrepreneurial ecosystems is still in its infancy, and requires greater understanding of theoretical elements and adequate measurement of their contributions to the system (Stam, 2018; Kansheba and Wald, 2020; Stam and van de Ven, 2021; Wurth *et al*., 2021). Several studies have proposed a diverse range of factors influencing the entrepreneurial ecosystem. For example, Isenberg (2011) sets the domains of an entrepreneurial ecosystem as market, finance, human capital, support, policy, and culture. WEF (2013) proposed the components of the entrepreneurial ecosystem as accessible markets, human capital workforce, funding and finance, support systems (including mentors and advisors), regulatory framework and infrastructure, education and training, major universities as a catalyst, and cultural support. Stam (2015) suggested the interactive key elements of the entrepreneurial ecosystem, including demand, finance, talent (e.g., skills and human capital), knowledge, physical infrastructure, formal and informal institutions, and support services (e.g., intermediaries). Unlike previous studies focusing on conceptual elements, OECD (2017) and Stam (2018) first specified concrete measures for each element of the entrepreneurial ecosystem. For instance, OECD (2017) listed the indicators for seven ecosystem factors: market conditions, access to finance, capabilities, knowledge creation and diffusion, infrastructure, regulatory framework, and culture. Citing the factors proposed by OECD (2017), ASEAN (2020) identifies guidelines for developing entrepreneurship and the startup ecosystem across ASEAN countries. By reviewing these studies, ASEAN-ROK (2021) proposed a framework and the ASEAN startup ecosystem and specified the indicators for the ecosystem's elements. Unlike existing studies focusing on the entrepreneurial ecosystem of general startups, GSMA (2022) articulated the five key enablers for the ecosystem of digital-tech startups in the ASEAN: economic readiness, investment, regulation, digital talent, and digital infrastructure, investment. However, GSMA (2022) did not utilize diverse indicators for each factor due to limited data

availability in the ASEAN countries, but measured only one indicator for each individual ecosystem element.

Our literature review identifies common factors of entrepreneurial ecosystems. The factors are summarized in Table 2.1.

Table 2.1. Common factors of an entrepreneurial ecosystem in the literature

OECD (2017) ASEAN (2020)	ASEAN-ROK (2021)	GSMA (2022)	Isenberg (2011)	WEF (2013)	Stam (2015, 2018)
Market Conditions	Markets	Economic Readiness	Market	Accessible Markets	Markets and Demand
Access to Finance	Funds, Investment	Investment	Finance	Funding and Finance	Finance
Capabilities	Human Resource	Digital Talent	Human Capital	Human Capital	Talent (including skills and human capital)
Creation and Diffusion of Knowledge (including R&D)	Knowledge (including R&D)			Education and Training	Knowledge
Infrastructure	Infrastructure (tangible, intangible)	Digital Infrastructure		Infrastructure	Physical Infrastructure
Legal and Regulatory Framework	Support Policies	Regulation	Policy	Gov't and Regulatory Framework	Formal Institutions, Support Services
Etc. (entrepreneurial culture)			Etc. (support; culture)	Etc. (support systems; universities)	Etc. (intermediaries, network; culture)

Considering the comment factors of an entrepreneurial ecosystem, which have been articulated through the literature review, we propose the following primary factors of the entrepreneurial ecosystem for deep tech startups: (a) market and economic conditions; (b) finance and investment; (c) human capital talent for deep tech; (d) technological innovation, knowledge creation and transfer; (e) infrastructure favourable to deep tech and startups; (f) startup barriers and government regulation.

Although most existing studies conceptually proposed factors of the entrepreneurial ecosystem in the ASEAN context, they have not directly measured the quantitative indicator for each factor in diverse countries (ASEAN, 2020) or utilized a limited range of indicators or survey responses in the ASEAN countries (ASEAN-ROK, 2021; GSMA, 2022). This limitation arises because the majority of indicators corresponding to the factors proposed in the literature are based on data sources mostly or only available to advanced countries such as the EU, the U.S., and other OECD countries (Stam 2018; Stam and Van de Van, 2021; OECD, 2017). Limited data availability and constraints on relevant data collection are critical challenges in measuring the indicators for the ASEAN countries in practice (Rosiello *et al*., 2022; GSMA, 2022). This study has attempted to fill the gaps found in the existing studies. We have explored the data availability of the indicators, which are consistent with the common factors and corresponding measures found in the literature, and searched for both survey datasets and secondary datasets provided by credible international organizations. Hence, considering the meaning of indicators and the availability of relevant data in the APT countries, we propose three indicators for each factor of the entrepreneurial ecosystem for deep tech startups, as presented in Table 2.2.

Table 2.2. Primary factors and indicators of the entrepreneurial ecosystem for deep tech startups

Factor	Indicator and meaning	Data Source
Market and Economic Conditions	[A1] GDP per capita PPP: a proxy of middle income for purchasing power or overall economic development	World bank
	[A2] Buyer sophistication: a proxy for private demand for technology and potential of differentiated market segments (survey responses to purchasing decisions: measured 1 = based solely on the lowest price, 7 = based on a sophisticated analysis of performance)	WEF, *Global Competitiveness Index*
	[A3] Share of medium and high-tech industry value added in total value added of manufacturing: a proxy of industrial/hardware bases for deep technologies	*UNIDO, Competitive Industrial Performance*
Finance and Investment	[B1] Share of firms using banks to finance working capital: a proxy of accessibility to debt financing based on bank loan	World Bank, *Enterprise Surveys*
	[B2] Venture capital availability: a proxy of accessibility to venture capital (VC) financing: a proxy of accessibility to equity financing by VC fundraising (survey response to how easy it is for entrepreneurs with innovative but risky projects to find venture capital (VC) in your country: measured 1 = extremely difficult, 7 = extremely easy)	WEF, *Global Competitiveness Index*
	[B3] Average deal size raised by VC financing: a proxy for the scale of private and VC investments	Statista, *Traditional Capital Raising Report*

Human Capital and Talent for Deep Tech	[C1] Share of graduates from Science, Technology and Engineering (STEM) programs in tertiary education: a proxy of the pool of founders and laborforce for deep tech startups	UNESCO, *Education Indicator*
	[C2] Government expenditure on tertiary education as a percentage of GDP: a proxy of overall investment in training human resources for deep tech startups	UNESCO, *Education Indicator*
	[C3] Researchers in million people: a proxy of talent and human capital for deep tech startups	UNESCO, *Science, Technology and Innovation Indicator*
Technology, Knowledge Creation and Transfer	[D1] Publications per population: a proxy of national research outputs for knowledge creation	Scopus Database, *Scimago Journal and Country Rank*
	[D2] Gross domestic expenditure on R&D (GERD) as a percentage of GDP: a proxy of national investment in technology generation and advancement	UNESCO, *Science, Technology and Innovation Indicator*
	[D3] University-industry collaboration in R&D: a proxy of the effectiveness of technology transfer and sharing, and R&D collaboration for knowledge creation (survey responses to the level of collaboration between business and universities in R&D: measured 1 = non-existent collaboration, 7 = extensive collaboration)	WEF, *Global Competitiveness Index*
Infra -structure	[E1] Individuals using the Internet in the total population: a proxy of digital infrastructure	ITU World Telecommunication, *ICT Indicators*
	[E2] Startup ecosystem scores of top 1100 global cities: a proxy of innovation hub cities	Startup Blink, *Global Startup Ecosystem Index*
	[E3] Sufficiency of education or support services: a proxy of infrastructure for supporting startups	ASEAN-ROK Startup Ecosystem Report
Startup Barriers and Government Regulation	[F1] Time required to start a business (days): a proxy of barriers to startup	Word Bank, *Doing Business*
	[F2] Cost of business start-up procedures (% of GNI per capita): a proxy of startup regulations	Word Bank, *Doing Business*
	[F3] Time spent dealing with the requirements of government regulations (% of senior management time): a proxy of governmental or regulatory barriers for business	World Bank, *Enterprise Surveys*

For the factor of market and economic conditions, we include three indicators: GDP per capita PPP [A1], buyer sophistication [A2], and share of medium and high-tech industry value added in total value added of manufacturing [A3]. GDP per capita PPP is a proxy of middle income for purchasing power or overall economic development; this indicator can reflect

economic readiness for tech-based startups (Stam, 2015, 2018; GSMA, 2022). Such data can be collected from the World Bank database. Buyer sophistication can reflect the level of private demand for technology and the potential of differentiated market segments (OECD, 2017; Arora and Gambardella, 2010). The indicator is measured through the survey data (WEF, surveys for 'Global Competitiveness Index') on the responses of purchasing decisions on a seven-point Likert scale, where 1 denotes a purchasing decision based solely on the lowest price, and 7 denotes a decision based on a sophisticated analysis of performance. The share of medium and high-tech industry value added in the total value added of manufacturing is an indicator of industrial or hardware bases for deep technologies (Romasanta et al., 2022; Wareham et al., 2024). It is also associated with the measure of market conditions for industry and innovation at the country level, as it indicates the required infrastructure to promote inclusive and sustainable industrialization and foster innovation.[25] The data for this indicator can be collected from the Competitive Industrial Performance in the UNIDO dataset.

For the factor of finance investment, we use three indicators: share of firms using banks to finance working capital [B1], venture capital availability [B2], and average deal size raised by VC financing [B3]. The share of firms using banks to finance working capital represents accessibility to debt financing based on bank loans (Stam, 2015, 2018; OECD, 2017; ASEAN, 2017). Venture capital availability is a proxy of accessibility to venture capital (VC) financing, which is selected due to the tendency for startups to look to VC for their financing (Stam, 2015, 2018; OECD, 2017). This indicator is measured through survey responses by the World Bank (i.e. 'Enterprise Surveys') regarding the ease with which entrepreneurs with innovative but risky projects secure venture capital (VC) in a given country, and is measured on a seven-point Likert Scale, where 1 denotes 'extremely difficult' and 7 denotes 'extremely easy'. The average deal size raised by VC financing measures the scale of private and VC investments (Portincaso et al., 2020; GSMA, 2022), and can be collected from the Traditional Capital Raising Report in the Statistia database.

For the factor of human capital and talent for deep tech, we utilise the following indicators: the share of graduates from Science, Technology and Engineering (STEM) programs in tertiary education [C1], government expenditure on tertiary education as a percentage of GDP [C2], and the ratio of researchers to the population [C3]. The share of graduates from STEM programs in tertiary education represents the pool of founders and the labour force for deep tech startups (Wareham et al., 2024; Kim, 2023). Government expenditure on tertiary education as a percentage of GDP measures the level of overall investment in training for deep tech startups (Stam, 2015, 2018). The data for indicators C1 and C2 can be collected from the Education Indicator provided by UNESCO. The ratio of researchers to populations is a proxy of talent and human capital for deep tech startups

[25] Refer to UN statistics for SDG: https://unstats.un.org/sdgs/report/2019/Overview/

(Stam, 2018; Kim, 2023). It is the number of researchers per million people, collected from the data of Science, Technology and Innovation Indicator, provided by UNESCO.

For the factor of tangible and intangible infrastructure to support deep tech startups, we use three indicators: individuals using the Internet in the total population [E1], startup ecosystem scores of the top 1100 global cities [E2], and sufficiency of education or support services [E3]. The share of individuals using the Internet in the total population is often used as a proxy of digital infrastructure for tech-based startups (GSM, 2022). It can be collected from the data on ICT indicators of ITU World Telecommunication. Startup ecosystem scores of the top 1100 global cities can be a proxy of innovation hub cities where deep tech startups are likely to be located (Stam, 2015, 2018; WEF, 2013). The data of scores for the top 1100 global cities in each country can be gathered from Startup Blink's 'Global Startup Ecosystem Index'. The level of sufficiency of education or support services represents the existence and effectiveness of infrastructure for supporting startups (Stam, 2015, 2018; WEF, 2013). It can be collected from the data in the ASEAN-ROK Startup Ecosystem Report (ASEAN-ROK, 2021).

For the factor of startup barriers and government regulation, we utilize three indicators: Time required to start a business [F1], cost of business start-up procedures [F2], and time spent addressing government regulations related to startups [F3]. The time required to start a business, measured in days, is a proxy of barriers to startup (OECD, 2017). Similarly, the cost of business start-up procedures, measured in the unit of % of GNI per capita, reflects the state of startup regulations (OECD, 2017). The data on the two indicators can be collected from the data of the World Bank's surveys ('Doing Business'). The amount of time required to meet government regulations, measured in the unit of percentage (%) of senior management time, represents the level of governmental or regulatory barriers to business (OECD, 2017). The data of this indicator can be collected from the survey responses of World Bank ('Enterprise Surveys').

Although all of these proposed indicators affect the ecosystem for deep tech startups, some are connected to the specific ecosystem for deep technologies, while others are more related to the general ecosystem for startups. Studies show that the ecosystem for deep tech startups can be constructed through the effective integration of both ecosystems (de la Tour *et al*., 2019; Romasanta *et al*., 2022). For example, some factors, such as 'human capital and talent for deep tech' (corresponding indicators A1, A2, and A3), 'technology, knowledge creation and transfer' (corresponding indicators C1, C2, and C3) are more related to the ecosystem of deep technologies. Other factors, such as 'startup barriers and government regulation' (corresponding indicators F1, F2, and F3) are related to the general ecosystem of startups. The remaining factors, such as 'market and economic conditions', 'finance and investment', and 'infrastructure' relate to both types of ecosystems. The following Table 2.4 summarizes the relevance.

Table 2.3. Relevance of the entrepreneurial ecosystem's indicators

Factor	Indicator	More relevant ecosystem type
Market and Economic Conditions	[A1] GDP per capita PPP	Startups
	[A2] Buyer sophistication	Deep Technologies
	[A3] Share of medium and high-tech industry value added in total value added of manufacturing	Deep Technologies
Finance and Investment	[B1] Share of firms using banks to finance working capital	Startups
	[B2] Venture capital availability	Startups
	[B3] Average deal size raised by VC financing	Deep Technologies
Human Capital and Talent for Deep Tech	[C1] Share of STEM programs in tertiary education	Deep Technologies
	[C2] Government expenditure on tertiary education as a percentage of GDP	Deep Technologies
	[C3] Researchers in million people	Deep Technologies
Technology, Knowledge Creation and Transfer	[D1] Publications per population	Deep Technologies
	[D2] Gross domestic expenditure on R&D (GERD) as a percentage of GDP	Deep Technologies
	[D3] University-industry collaboration in R&D	Deep Technologies
Infra -structure	[E1] Individuals using the Internet in the total population	Deep Technologies
	[E2] Startup ecosystem scores of top 1100 global cities	Startups
	[E3] Sufficiency of education or support services	Startups
Startup Barriers and Government Regulation	[F1] Time required to start a business	Startups
	[F2] Cost of business start-up procedures	Startups
	[F3] Time spent dealing with the requirements of government regulations	Startups

2.2. The Measurement of the Ecosystem Indicators for Deep Tech Startups in the ASEAN+3 (APT) Countries

Factor A. Market and Economic Conditions

Regarding the factor of market and economic conditions, we have collected data for three indicators: GDP per capita Purchasing Power Parity (PPP), buyer sophistication, and share of medium and high-tech industry value added in total value added of manufacturing for the ASEAN+3 (APT) countries. The indicator results for the APT countries are presented in Table 2.4.

Table 2.4. Indicators for market and economic conditions

Country	Indicators		
	[A1] GDP per capita, Purchasing Power Parity (PPP) (measure unit: Current international dollar)	**[A2] Buyer sophistication** (measure unit: 7-point Likert scale)	**[A3] Share of medium and high-tech industry value added in total value added of manufacturing** (measure unit: %)
Brunei Darussalam	86,445.7	3.07	3
Cambodia	5,624.1	3.62	0
Indonesia	15,612.8	3.59	31
Laos (Lao PDR)	9,326.3	3.84	4
Malaysia	37,247.7	4.78	45
Myanmar	5,905.2	n.a.	24
Philippines	10,755.5	3.78	42
Singapore	141,500.2	4.81	82
Thailand	23,422.9	4.33	41
Viet Nam	15,194.3	3.87	40
South Korea (ROK)	54,033.2	5.43	64
Japan	50,206.6	4.96	56
China	24,557.6	4.49	41
Average	36,910.2	4.21	36

Data period and source for the indicator:

[A1] GDP per capita, Purchasing Power Parity (PPP): year 2023, https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD;

[A2] Buyer sophistication: year 2019, https://prosperitydata360.worldbank.org/en/indicator/WEF+GCI+EOSQ100;

[A3] Share of medium and high-tech industry value added in total value added of manufacturing: year 2021, https://databank.worldbank.org/source/world-development-indicators/Series/NV.MNF.TECH. ZS.UN

When it comes to the indicator of GDP per capita PPP [A1] as a proxy of middle income or overall economic development, we find that the average for the APT countries is 36,910.2 international dollars ($). This indicator level is relatively higher in the country group of Singapore, Brunei Darussalam, South Korea (ROK), Japan, and Malaysia. These countries' levels are above 37,000 international dollars. These countries can be regarded as having the preferable economic conditions in terms of personal income to accept or adopt deep technologies, even if such conditions would not always guarantee the success of deep tech startups in the countries. Thailand, China, Viet Nam, Indonesia, and the Philippines are regarded as the middle-level group, covering from 10,000 to 25,000 international dollars.

These countries have approached the minimum level of economic readiness in terms of personal income to promote deep tech startups. Cambodia, Laos (Lao PDR) and Myanmar belong to the low-level group, below 10,000 international dollars. However, in addition to the simple categorization of the APT countries into three groups, we need to note that this indicator dispersion across the APT countries is quite severe from 6,000 to 140,000 international dollars even if the indicator's average is approximately 38,000 international dollars, which implies that the APT countries have considerable heterogeneities in economic income readiness and market conditions (in terms of middle personal income and overall economic development) for deep tech startups.

Looking at the distribution of the indicator of buyer sophistication [A2] across the APT countries, we find that the average for the APT countries is 4.21 on the seven-point Likert scale, which implies that the purchasing decisions of buyers are based on both the price and performance of products and services or they are likely to make their decisions considering the performance, rather than prioritizing low price. This indicator level is relatively greater in the group of South Korea, Japan, Singapore, Malaysia, and China, at above approximately 4.5 points on the seven-point Likert scale. In general, the majority of buyers in these countries are likely to have sufficient private demand for technology or be differentiated in their preferences in diverse market segments, which might act as baselines for utilising the products or services provided by deep tech startups. Thailand, Viet Nam, Laos (Lao PDR), Philippines, Cambodia, and Indonesia can be regarded as the middle-level group, covering approximately 3.6 to 4.3 points. These countries have built up differentiated market demands at the minimum level to accept a diverse range of products or services provided by deep tech startups. The level of Brunei Darussalam is relatively lower (below 3.1 points) than other countries' levels in this indicator. Unlike the indicators obtained from the secondary datasets, it needs to be cautious in interpreting this indicator collected from the survey data.

Finally, regarding the share of medium and high-tech industry value added in total value added of manufacturing [A3], the indicator's average of the APT countries is 36%. This indicator level is relatively higher in the group of Singapore, South Korea, and Japan. The shares of medium and high-tech industries in these countries are above 56%, which means that compared to other APT countries, these three countries have better conditions for advanced industrial bases to manufacture or operate deep technologies. Malaysia, China, Philippines, Thailand, and Viet Nam belong to the middle-level group, in which the industries' shares are approximately 40% to 45%. These countries have maintained or reached the minimum level of manufacturing industrial bases to support deep tech startups. Compared to the above-mentioned countries, the shares of medium and high-tech manufacturing industries are relatively lower in Indonesia, Myanmar, and Laos (Lao PDR). This lower share value does not necessarily indicate weak levels of industrial bases for deep tech startups. Rather, it likely indicates that the countries could specialize in industries other than medium and high-tech manufacturing industries in the country's industrial structure. It is worth

noting that the shares of these industries are above 30% in many APT developing countries except a few countries, which is much higher than the indicator's average (around 17%) in other developing countries around the world.[26] This finding supports the possibility that the industrial bases for deep tech startups in many APT developing countries are sufficient when compared to other developing countries, and the existing industrial bases can be effectively used as ecosystem components for deep tech startups.

Comparing the distribution of the three indicators across the APT countries, we find that some countries have higher or lower levels for all indicators while other countries have limited advantages in one or two indicators. For instance, Singapore, Japan, and South Korea have higher levels in all three indicators [A1, A2, and A3] than other APT countries. Malaysia belongs to the high-level group in terms of GDP per capita PPP [A1] and buyer sophistication [A2] but is within the middle-level group in terms of share of medium and high-tech manufacturing industries [A3]. China is in the midst of the middle-level and high-level groups for all three indicators [A1, A2, and A3]. Viet Nam, Thailand, and the Philippines are in the middle-level group for all three indicators [A1, A2, and A3]. Brunei Darussalam belongs to the high-level group in terms of GDP per capita PPP [A1,] but is within the low-level group in terms of buyer sophistication [A2] and share of medium and high-tech manufacturing industries [A3].

Factor B. Finance and Investment

For the factor of finance and investment, we have collected data on three indicators, including the share of firms using banks to finance working capital, venture capital (VC) availability, and average deal size raised by VC financing, for the APT countries. The indicator results for the APT countries are presented in Table 2.5.

Table 2.5. Indicators for Finance and Investment

Country	Indicators		
	[B1] Share of firms using banks to finance working Capital (measure unit: %)	[B2] Venture capital (VC) availability (measure unit: 7-point Likert scale)	[B3] Average deal size raised by VC financing (measure unit: million USD)
Brunei Darussalam	n.a.	3.19	4.93
Cambodia	12.3	3.19	7.07

[26] Refer to this data: https://unstats.un.org/sdgs/report/2019/goal-09/

Indonesia	23.5	3.76	8.88
Laos (Lao PDR)	23.1	3.17	8.07
Malaysia	32.1	4.57	9.75
Myanmar	11.2	n.a.	7.78
Philippines	11.6	3.56	8.17
Singapore	22.7	4.81	12.60
Thailand	28.9	3.77	7.19
Viet Nam	38.7	3.27	10.18
South Korea (ROK)	41.2	3.43	9.26
Japan	n.a.	4.34	7.85
China	22.1	4.42	15.52
Average	24.3	3.79	9.02

Data period and source for the indicator:

[B1] Share of firms using banks to finance working capital: most recent year(2015-23), https://data.worldbank.org/indicator/IC.FRM.BKWC.ZS?end=2023&name_desc=false&start=2002;

[B2] Venture capital (VC) availability: year 2019, https://prosperitydata360.worldbank.org/en/indicator/WEF+GCI+EOSQ089;

[B3] Average deal size raised by VC financing: year 2022-2023, https://www.statista.com/outlook/fmo/capital-raising/traditional-capital-raising/venture-capital/worldwide#capital-raised

On average, the share of firms using banks to finance working capital is 24.3% for the APT countries. When firms need funds to cover day-to-day operation expenses, only about one out of four can obtain bank loans. Firms in Malaysia, Thailand, Viet Nam, and South Korea (ROK) where this indicator [B1] is 32.1%, 28.9%, 38.7%, and 41.2% respectively, are more reliant on bank financing than those in the other countries. In Cambodia, Myanmar, and the Philippines, approximately one out of every 10 firms can access bank financing. The indicator levels are similar in Indonesia (23.5%), Laos (23.1%), and Singapore (22.7%). Though the financial system of Singapore is considered highly developed (IMF, 2013),[27] the share of firms using banking to finance working capital in Singapore is even lower than that of Laos. The availability of venture capital (VC) may provide an explanation for this phenomenon.

Singapore has the highest level of indicator for VC availability [B2] in the APT countries, at 4.81 on the 7-point Likert scale. This indicator is measured by survey responses to "how easy it is for entrepreneurs with innovative but risky projects to find venture capital", where 1 = extremely difficult and 7 = extremely easy (World Economic Forum, 2015)[28]. This

[27] International Monetary Fund (IMF), Singapore: Financial System Stability Assessment, IMF Staff Country Report, 2013, Singapore: Financial System Stability Assessment (imf.org)

[28] World Economic Forum, *The Global Competitiveness Report 2015-2016*, Geneva, 2015, Global_Competitiveness_Report_2015-2016.pdf (weforum.org)

corresponds to the popularity of Singapore as an international financial centre. Not only do many ASEAN startups go to Singapore to meet VC investors, but also limited partners from South Korea (ROK), Japan, and China prefer registering venture funds in the city-state. The attractiveness of Singapore's financial sector results from an advanced banking infrastructure, with almost universal access to bank accounts, a high degree of openness, a relatively corruption-free environment, and a strong regulatory framework (IndexMundi, 2021).[29] Perhaps these characteristics may inspire other ASEAN state members to implement reforms to their financial sectors.

It is relatively easy to access venture capital in Japan, China, and Malaysia where the indicator of accessibility to VC [B2] is 4.34, 4.42, and 4.57, respectively. Similar to Singapore, the availability of venture funding may be the answer to a low share of firms using banks to finance working capital in China. The indicator for taking loans to raise working capital [B1] in China is 22.1%. While the developed economies of Japan and Malaysia, with an average B2 indicator of 3.79, allow relatively easy access to venture capital, the B2 indicator for South Korea (ROK) is lower, at 3.43. With stronger support from the government of South Korea – including developing government agencies which act as limited partners in venture capital funds, implementing tax incentives to encourage venture capital activities, and implementing the TIPS matching program – Korean venture capitals might become more active in the ASEAN markets than at home, perhaps.

It is most difficult to access venture capital in Laos (3.17 on the seven-point Likert scale)and in Brunei Darussalam and Cambodia which share the same B2 indicator, 3.19. While it is difficult to access venture capital in Brunei Darussalam, venture capital investors tend to support early-stage startups in the country. The average deal size raised by VC financing [B3] is the smallest in Brunei Darussalam: $4.93 million. This suggests a small and early startup ecosystem in the sultanate. The average VC deal size [B3] of Brunei Darussalam is approximately half of that of the next group where the B3 indicator varies from $7 million to $8 million. Average deal sizes raised by VC financing in Cambodia, Thailand, Myanmar, Japan, Laos, and the Philippines are $7.07 million, $7.19 million, $7.78 million, $7.85 million, $8.07 million, and $8.17 million respectively. VC investors may favour later-stage startups in ASEAN in order to lower business risks and optimize transaction costs. Meanwhile, Japanese conservative culture might prevent venture funding at the early stages of business.

The average VC deal size [B3] is $12.6 million in Singapore, $9.26 million in Korea (ROK), and $9.75 million in Malaysia, which also boast relatively developed economies. However, the amount of this indicator for Viet Nam is $10.18 million – the third-highest following China, at $15.52 million. When examining the 100-million-population and growing economy, it seems that VC investors prefer later-stage investment in startups.

[29] IndexMundi, Singapore: Economy Overview, 2021, Singapore Economy - overview - Economy (indexmundi.com)

A comparison between Indonesia and Viet Nam is interesting as VC investors often consider the two countries as alternatives. Firms in Viet Nam are more reliant on bank financing, while venture capital is more available in Indonesia. The difference in average deal size raised by VC financing is quite substantial. It is $1.3 million smaller in Indonesia ($8.88 million). The combination of three indicators B1, B2, and B3 points to a more developed Indonesian startup ecosystem, while the Viet Namese ecosystem is growing rapidly. For instance, there are 14 unicorns (startups valued at over $1 billion) in Indonesia[30] and 8 in Viet Nam[31], as of September 2024 (tracxn.com, 2024).

The finance and investment indicators have two implications for deep tech startups. First, bank financing is challenging, as deep tech startups struggle to borrow from banks, especially in the early stages. Because their products are often new to markets, sales predictions are uncertain. Banks may also be concerned about the stability and continuity of deep tech businesses. Second, venture capital funding can be more readily attainable, but only at a later stage of development. Due to either risk aversion, or conservative business culture, or both, VC investors in ASEAN+3 prefer late-stage investment. Deep tech startups must seek product-market fit to attract venture capital, in order to become financially sustainable and attract VC investors, as described by Rayport (2024)[32].

When both banks and VCs are unavailable, the remaining sources of funding for deep tech startup founders are bootstrapping, family-friends-fools, crowdfunding, grants and subsidies, competition awards, and corporate partnerships. Many deep tech businesses begin with bootstrapping. Their founders are often well-educated and have experience in well-paid positions in advanced research and development institutions or multinational corporations. They seek to create valuable products and services with large impacts on the market, and this desire leads to the entrepreneurial decision to invest accumulated savings into new ventures. When the savings are not enough, family members and close friends often support the founders with their savings as well. Outside investors who are attracted by the disruption of new technologies and the enthusiasm of the founding teams may also contribute to these ventures. Word-of-mouth and personal networking can attract early adopters, who may offer some advances in order to be early pioneers. Deep tech founders require government support, including regulation on technology trials and experiments, access to research and testing facilities, as well as financial grants and subsidies on commercialization. Deep tech startups that address Sustainable Development Goals also have chances to win competition awards. These awards may not offer large financial resources, but can result in recognition and confirmation of economic impacts. Last but not least, founders of deep tech startups should seek partnerships rather than work alone.

[30] List of 14 unicorn startups in Indonesia (Sep 2024) - Tracxn

[31] List of 8 unicorn startups in Viet Nam (Sep 2024) - Tracxn

[32] Jeffray Rayport, 'How to scale a startup', *Harvard Business Review*, 2024, How to Scale a Start-Up (hbr.org)

Collaborating with established corporations can provide both funding and market access. Such partnerships can also offer complementary technical and business management expertise, allowing the founders to concentrate on developing solutions and releasing products to the market as soon as possible.

Factor C. Human Capital and Talent for Deep Technologies

Regarding the factors of technology, knowledge creation and transfer, we have collected the data of three indicators for the APT countries: share of graduates from science, technology and engineering (STEM) programs in tertiary education, government expenditure on tertiary education as a percentage of GDP, and researchers per population. These indicators are a proxy for the availability of skills for deep tech ecosystems in each country. These skills are at the core of deep tech startup ecosystems. The indicator results for APT countries are presented in Table 2.6.

Table 2.6. Indicators for human capital and talent for deep technologies

Country	Indicators		
	[C1] Share of graduates from STEM programs in tertiary education (measure unit: %)	**[C2] Government expenditure on tertiary education per GDP** (measure unit: %)	**[C3] Researchers per population** (measure unit: the number of researchers in million people)
Brunei Darussalam	38.39	0.84	513.6
Cambodia	23.20	0.18	30.8
Indonesia	19.42	0.57	399.6
Laos (Lao PDR)	23.14	0.04	16.0
Malaysia	40.23	0.63	726.5
Myanmar	33.67	0.31	19.0
Philippines	26.27	0.64	172.0
Singapore	35.94	0.75	7,224.8
Thailand	31.74	0.60	1,699.1
Viet Nam	22.68	0.68	779.3
South Korea (ROK)	30.42	0.92	9,081.9
Japan	19.00	0.60	5,638.4

China	41.00	0.12	1,687.1
Average	29.62	0.53	2,152.9

Data period and source for the indicator:

[C1] Share of graduates from science, technology and engineering (STEM) programs in tertiary education: the most recent year; https://data.uis.unesco.org/index.aspx?queryid=3830

[C2] Government expenditure on tertiary education as a percentage of GDP: the most recent year; https://data.uis.unesco.org/index.aspx?queryid=3852

[C3] Researchers per population: the most recent year; https://data.uis.unesco.org/index.aspx?queryid=3685

The indicator which measured the share of graduates from science, technology and engineering (STEM) programs in tertiary education [C1] represents university linkages for deep technologies. According to the latest available data, the average value for this indicator is 29.62% in the APT countries. Universities from China had the highest number of graduates from STEM programmes (41.00%), followed closely by Malaysia (40.23%), followed by Singapore (35.94%) and Korea (30.42%2). The role of universities in deep technology development within the APT countries cannot be overstated. Unlike other areas of technology, deep tech relies heavily on cutting-edge research and development, and on strong connections between academia and industry. Universities serve as foundational pillars for R&D, nurturing talent and fostering innovation through cutting-edge programs in STEM, and thus are fundamental actors of deep tech innovation ecosystems. In countries with robust university systems, these institutions are often at the forefront of ground-breaking research, facilitating technology transfer to industry and contributing directly to the growth of deep tech sectors. Strong university-industry linkages enable the commercialization of research, supporting the emergence of startups and driving economic growth.[33,34] However, not all APT countries benefit from strong university systems. In some nations, higher education infrastructure is underdeveloped, with limited resources allocated to R&D and innovation.[35] These limitations can hinder the development of deep tech industries, as local talent may lack access to the advanced training and research opportunities necessary to compete globally. To address these gaps, countries must invest in strengthening university systems, enhancing the quality of education, and expanding research capabilities.

The indicator measuring government expenditure on tertiary education as a percentage of GDP [C2] reflects a country's investment in the development of human resources for the pool of deep tech startup founders and employees. Investing in talent development is crucial for unlocking the full economic potential of technologies.[36] Korea (0.92%), Brunei (0.84%), Singapore (0.75%), and Malaysia (0.63%) belong to the high-level group for this indicator.

[33] Venni (2019): https://www.mdpi.com/2199-8531/5/3/43

[34] University-Industry Collaboration | OECD

[35] https://uis.unesco.org/sites/default/files/documents/higher-education-in-asia-expanding-out-expanding-up-2014-en.pdf

[36] https://www.mckinsey.com/capabilities/people-and-organizational-performance/our-insights/the-organization-blog/the-future-of-work-the-now-the-how-and-the-why

However, in less developed countries, such as Cambodia and Laos, investments in tertiary education remain considerably lower than the average. Investing in talent development is crucial for unlocking the full economic potential of deep tech, and countries where investment is low should seek ways to boost that investment, in order to develop their deep tech ecosystems.[37] By enhancing educational programs, fostering industry-academia partnerships, and creating incentives for talent retention and attraction, these countries can mitigate the risks associated with talent shortages. Building a robust talent pipeline not only attracts investment but also strengthens local ecosystems, contributing to sustainable economic growth.[38] As deep tech startups continue to reshape industries and societies, prioritizing talent development is key to maintaining a competitive edge and driving long-term innovation.

Finally, regarding the indicator of researchers per million habitants [C3], as of the latest available data, Korea (5638.4) emerges as a leader, followed by Singapore (7224.8) and Japan (5638.4). These figures closely coincide with the gross domestic expenditure on R&D (GERD) as a percentage of GDP, presented in Table 2.6 later for the indicator D2. These two indicators are typically correlated, as a significant portion of GERD is devoted to the training of research and development personnel. According to the data set, Korea appears to be a leader with respect to GERD per GDP, followed by Japan, China, and Singapore. The data also shows that, for this indicator, the gap between more and less advanced countries in the APT is evident, with Cambodia, Laos and Myanmar ranking at the bottom of the group.

The indicators described above ultimately underscore the disparity in human capital development necessary for a thriving and sustainable innovation ecosystem in the APT countries. The talent diversity of the region is reflected in its varying levels of economic development, educational systems, and innovation ecosystems.[39] Advanced talent ecosystems, such as China, Japan, Korea, and Singapore, benefit from well-established educational institutions, robust R&D infrastructure, substantial investment for innovation, and strong government support. While intermediate ecosystems such as Thailand, Malaysia, Indonesia, Viet Nam and the Philippines are also making strides in developing their deep tech ecosystems, they continue to encounter obstacles hindering innovation. These obstacles include limited access to venture capital, a smaller pool of high-tech talent, and bureaucratic challenges. Emerging or nascent ecosystems such as Cambodia, Laos, and Myanmar struggle with hindrances relating to limited access to quality education, underdeveloped R&D infrastructures, weaker intellectual property protections, and weaker institutional support for innovation.[40] At this stage, these countries may require more

[37] Ibid
[38] https://www.bcg.com/publications/2023/deep tech-investing
[39] https://www.mckinsey.com/mgi/our-research/asia-on-the-cusp-of-a-new-era
[40] https://www.eria.org/RPR-2007-4.pdf

government support and international partnerships to build their capacities and advance their innovation ecosystem.

Moreover, while the region may benefit from a diverse talent pool, the existing supply of talent is still insufficient to meet the growing demands of the deep tech industry. As market demand for advanced technology solutions continues to surge across various sectors, including healthcare, agriculture, transportation, and finance, the need for specialized STEM talent becomes more pronounced.[41] The shortage of talent in deep tech across many countries within the APT region itself is reflected in international assessments, such as the Programme for International Student Assessment (PISA),[42] which show that some APT countries underperform in STEM education compared to global standards. While PISA scores may not fully capture the impact of informal education and other forms of talent development that are particularly important in some APT countries, they serve as important indicators of a country's potential to develop a future-ready workforce, particularly in the digital economy and in sectors driven by innovation and entrepreneurship. High scores typically indicate strong problem-solving and analytical skills among students, crucial for success in technology-intensive industries, while lower scores can signal potential difficulties in cultivating a workforce with the skills necessary for digital innovation and global competitiveness.[43]

As the APT countries continue to evolve as a global hub for deep tech, addressing the talent deficit will be key to unlocking its full potential.[44] The ability to leverage a broad spectrum of skills also becomes critical as the countries continue to advance in deep tech fields.[45] Consequently, talent shortages may pose a notable bottleneck for VC investment in these regions. Inadequate availability of skilled professionals can stymie the growth of deep tech startups, deter foreign investments, and slow the pace of technological adoption. Investors and firms are often reluctant to commit resources to nations where there is a limited supply of high-calibre talent, preferring instead to invest in markets with more robust talent ecosystems.[46] National deep tech ecosystems play a critical role in attracting and retaining qualified talent, which is essential for bolstering domestic STEM-dependent industries. These ecosystems, when well-developed, not only support the growth of local startups but also foster knowledge spillovers from universities that incubate deep tech commercialization.

[41] https://www.mckinsey.com/featured-insights/future-of-work/jobs-lost-jobs-gained-what-the-future-of-work-will-mean-for-jobs-skills-and-wages

[42] PISA, which assesses the competencies of 15-year-olds in reading, mathematics, and science every three years, offers a comparative view of secondary education quality across the globe.
Refer to OECD's PISA 2018 and 2022 results: https://www.oecd.org/en/publications/pisa-2018-results-volume-i_5f07c754-en.html; https://www.oecd.org/en/publications/pisa-2022-results-volume-i_53f23881-en.html

[43] https://www.oecd.org/en/about/programmes/pisa.html

[44] How ASEAN can drive its digital economy | World Economic Forum (weforum.org)

[45] https://www.insead.edu/sites/default/files/assets/dept/globalindices/docs/GTCI-2020-report.pdf

[46] https://hbr.org/1998/11/how-venture-capital-works

In the absence of strong domestic university systems, countries also have the alternative to leverage global talent circulation and the rise of digital nomads to meet their deep tech needs. By attracting top-tier talent from around the world, nations can compensate for local deficiencies and inject fresh expertise into their innovation ecosystems[47], which, in turn, can stimulate innovation and enhance the competitiveness of local industries. Accordingly, countries within ASEAN are enacting more favourable policies, such as digital nomad visas and incentives, to attract these professionals, fostering an environment that supports innovation and entrepreneurial growth.[48]

A 2024 survey conducted by the ERIA highlighted the importance of talent mobility programs in addressing the uneven distribution of expertise across the region, as they are essential for redistributing expertise and ensuring that all member states can participate in and benefit from the region's deep tech evolution. Expanding this perspective to the APT, even global technology and innovation leaders such as China, Japan, Korea and Singapore are recognizing the value of integrating more flexible and inclusive talent strategies to enhance their innovation ecosystems, tapping into a global pool of expertise that complements their domestic strengths. This approach not only accelerates technological advancements, but also fosters a more interconnected regional economy where knowledge and innovation flow seamlessly across borders, driving sustained growth and development throughout the APT.

Factor D. Technology, Knowledge Creation and Transfer

Regarding the factor of technology, knowledge creation and transfer, we have collected the data of the three indicators for the APT countries: publications per population, gross domestic expenditure on R&D (GERD) per GDP, and university-industry collaboration in R&D. The indicator results for the APT countries are presented in Table 2.7.

[47] https://www.imd.org/news/talent-management/how-are-global-economies-and-businesses-coping-with-talent-migration-changes-since-the-pandemic/

[48] https://www.eria.org/uploads/Bringing-Digital-Nomads-Highly-Skilled-into-ASEAN-web.pdf

Table 2.7. Indicators for technology, knowledge creation and transfer

Country	Indicators		
	[D1] Publications per population (unit: publications per million people)	[D2] Gross domestic expenditure on R&D (GERD) per GDP (unit: %)	[D3] University-industry collaboration in R&D (unit: 7-point Likert scale score)
Brunei Darussalam	3,126.9	0.28	3.36
Cambodia	51.3	0.12	3.20
Indonesia	209.8	0.28	4.21
Laos (Lao PDR)	44.0	0.04	3.66
Malaysia	1,330.8	0.95	5.10
Myanmar	11.2	0.15	n.a.
Philippines	67.2	0.32	4.45
Singapore	4,701.4	2.16	5.28
Thailand	374.7	1.21	4.25
Viet Nam	194.2	0.43	3.52
South Korea (ROK)	1,961.1	4.93	4.45
Japan	1079	3.30	4.74
China	739.4	2.43	4.39
Average	1,068.5	1.28	4.22

Data period and source for the indicator:

[D1] Publications per people: year 2023,
Number of publications: https://www.scimagojr.com/countryrank.php ; Population: https://data.worldbank.org/indicator/SP.POP.TOTL?end=2021&start=2021&view=map&year=2023

[D2] Gross domestic expenditure on R&D (GERD) per GDP: year 2023;
https://data.uis.unesco.org/index.aspx?queryid=74

[D3] University-industry collaboration in R&D: year 2019, https://prosperitydata360.worldbank.org/en/indicator/WEF+GCI+EOSQ072

When it comes to the indicator of publications per population [D1] as a proxy of knowledge creation, the distribution of this indicator shows that research institutions such as universities vary in quality across the APT countries. As reflected by this indicator [D1], which captures research output counted as the number of research publications per population, it can be noted that different APT countries exhibit significant variability in terms of the quantity of research produced: while some countries (notably Singapore, South Korea,

Malaysia and Japan) are at the forefront with strong research institutions and numerous publications, other countries lag behind and still need to build strong research institutions, as in the case of Cambodia, Laos (Lao PDR) or Myanmar. This difference in research output can have a strong effect on the elements of the ecosystem for deep tech startups. Deeptech startups typically rely on technological advancements and cutting-edge research in their business models. Research institutions are very important players for ecosystems of deep tech startups, as deep tech startups sometimes originate from research institutions, such as in the case of university spin-offs, or might be closely connected to research centers and technology transfer offices which oversee the commercialization of public research. Therefore, the countries in the high-level groups for this indicator are likely to offer better environments to provide knowledge or technologies to deep tech startups, which can then commercialize the research outputs, than other countries in middle- or low-level groups.

Looking at the distribution of the indicator of gross domestic expenditure on R&D (GDRD) per GDP [D2] as a proxy of investment in technology creation and advancement, we find that the average for APT countries is 1.28% and the data varies greatly across the APT countries. This means that there exists a significant gap in R&D intensity across the APT countries reflecting the large variability in terms of maturity and sophistication of national innovation ecosystems. This indicator reflecting national R&D intensity is considerably high in the group of South Korea, Japan, Singapore, and China, approximately above 2.16% to 4.93% (nearly double the average). It is evident that these countries have invested significantly in technology creation and advancement for decades. This provides a favorable environment in which deep tech ventures are likely to begin and prosper. Thailand, Malaysia and Viet Nam can be regarded as the middle-level group, covering 0.43% to 1.21%. These countries have increased domestic investment in R&D, which can bolster basic ecosystem elements to promote the creation of deep tech startups. Other countries, such as the Philippines, Indonesia, and Brunei Darussalam belong to the middle-low-level group with approximately 0.3% (0.28% to 0.32%) of GERD per GDP. Cambodia, Lao PDR, and Myanmar are in the low-level group (below 0.12%), significantly lower than other country groups.

Finally, regarding the indicator of university-industry collaboration in R&D as a proxy of the effectiveness and ease of technology transfer share [D3], Singapore (5.28) and Malaysia (5.1) are the two leaders in the APT countries. China (4.39), South Korea (4.45), and Japan (4.74) are the followers. Except for Malaysia and the Philippines where the levels of gross domestic expenditure on R&D (GDRD) per GDP [indicator D2] are relatively low - i.e., 0.95% and 0.32% respectively - collaborations between universities and industry partners are stronger where the indicator of GERD per capital [D2] is large, i.e. more than 2%. The level for the indicator of university-industry collaboration in Thailand and Indonesia are on average, 4.25 and 4.21, correspondingly. Values for Cambodia (3.2), Brunei Darussalam (3.36), Viet Nam (3.52), and Laos (3.66) suggest a need to promote university-industry linkages. Viet Nam has the highest expenditure portion on R&D in this bottom group, at 0.43%, however the university-industry

collaboration in Viet Nam is weaker than in Lao PDR where the GERD per GDP [indicator D2] is the lowest (0.04%). These facts suggest that other measures in addition to national R&D expenditure are needed in order to promote partnerships between universities and corporations.

Comparing the distribution of the three indicators across the APT countries, we find that some countries have higher or lower levels for all indicators, while other countries have a limited range of comparative advantages in certain one or two indicators. For instance, Singapore, Japan, and South Korea have higher levels in all three indicators [D1, D2, and D3] than other APT countries. Japan and South Korea have superior advantages in technology advancement, supported by higher levels of GERD per GDP [D2], while Singapore is relatively better at knowledge creation and technology transfer, supported by higher levels of publications per population [D1] and university-industry R&D collaboration [D3] respectively. China belongs in the high- or high-middle-level groups for all three indicators [D1, D2, and D3]. Malaysia holds superior features in knowledge creation and transfer [D1 and D2] but relatively lower advantages in technology advancement [D2]. Thailand is in the middle-level groups for the three indicators [D1, D2, D3], while Viet Nam and Indonesia are in the middle-low-level groups in the indicators. Brunei Darussalam belongs to the high-level group of knowledge creation [D1] but is in the low-level group of technology advancement [D2] and university-industry knowledge transfer [D3]. Once again, these indicators reflect the large diversity in maturity of innovation ecosystems across the ASEAN+3 region. This diversity has an impact on the capability of different ecosystems to generate and scale up deep tech startups in the region.

Factor E. Infrastructure

For the factor of infrastructure, we have collected data on the three indicators, including individuals using the Internet in the total population, startup ecosystem scores of the top 1100 global cities, and sufficiency of education or support services" for the APT countries. The indicator results for the APT countries are presented in Table 2.8.

Table 2.8. Indicators for infrastructure

Country	Indicators		
	[E1] Individuals using the Internet in the total population (unit: % of population)	**[E2] Startup ecosystem scores of top 1100 global cities** (unit: score out of 1000)	**[E3] Sufficiency of education or support services** (unit: 5-point Likert scale)
Brunei Darussalam	98.1	n.a.	3.4

Cambodia	60.2	0.3	2.7
Indonesia	62.1	33.2	2.1
Laos (Lao PDR)	62.0	n.a.	2.8
Malaysia	96.8	10.9	3.0
Myanmar	44.0	0.5	n.a.
Philippines	52.7	8.8	2.5
Singapore	96.9	41.5	4.0
Thailand	85.3	10.0	n.a.
Viet Nam	74.2	11.1	2.5
South Korea (ROK)	97.6	39.3	3.7
Japan	82.9	61.9	n.a.
China	73.1	287.0	n.a.
Average	75.8	45.9	3.0

Data period and source for the indicator:

[E1] Individuals using the Internet in the total population: year 2021; https://databank.worldbank.org/source/world-development-indicators/Series/IT.NET.USER.ZS

[E2] Startup ecosystem scores of top 1100 global cities: year 2023, Global Startup Ecosystem Index 2024 (Startup Blink)

[E3] Sufficiency of education or support services: year 2021, ASEAN-ROK Startup Ecosystem Report

It is meaningful to review the ecosystem indicator related to information and communication technology, as the digital and information revolution has changed the way the world learns, communicates, and conducts business. New information and communication technology (ICT) offers vast opportunities to speed up business and empowering value added to business with technologies in all countries. This means that deep tech startups which can access the infrastructure for ICT or digital technologies such as the Internet will effectively offer more business opportunities and better advantages.

On average, the percentage of individuals using the internet in the total population [E1] is 75.8. In relation to this indicator, the top 5 countries are Brunei Darussalam (98.1%), South Korea (97.6%), Singapore (96.9%), Malaysia (96.8%), and Thailand (85.3%). These countries also have well-established telecommunication companies. For example, Singtel in Singapore is the largest telecommunication company in the Southeast Asia region. SK Telecom and KT in South Korea, and AIS, DTAC, and the True Corporation company in Thailand are examples of the largest telecommunication companies in the APT countries. On the other hand, countries with lower percentages of individuals using the internet in the local population are Myanmar (44.0%), the Philippines (52.7%), and Cambodia (60.2%). In these countries, the geography is not conducive to providing comprehensive internet services, and so reliable

access is more difficult to obtain. In addition, these countries lack government regulations regarding the right to access the Internet.

Regarding the indicator of urban infrastructure (e.g. which cities are considered innovation hubs), the Global Startup Ecosystem Index of the top 1100 global cities [E2], provided by Startup Blink, shows startup ecosystem scores of relevant infrastructures for deep tech startups. China, with a score of 287, has the highest level of this indicator [E2] in the APT regions. China has many leading cities with the top-level ecosystem score (e.g. Beijing, Shanghai, Shenzhen, Hangzhou, etc.). A significant transition has been made in China: from a developing country based on low-technology, to a middle-income country with a cutting-edge technological powerhouse, which has been supported by the development of tech-oriented hub cities. The nation prioritizes R&D expenditure and has made technological advancement a strategic goal, as evidenced by the massive government investments channeled into its state-of-the-art regional tech hubs. China's most prominent unicorns are focused on deep tech technologies such as automation and AI, along with a strong Hardware & IoT presence in the Shenzhen startup ecosystem. Regarding this indicator E2, Japan has the 2nd highest rank (61.9) among the APT countries. With a proven record of innovation, Japan remains a global tech pioneer. Apart from its historical success in building powerhouse companies such as Sony and Panasonic, the country also recognizes the importance of startups, which results in several leading cities with startup ecosystem infrastructures (e.g., Tokyo, Osaka, Kyoto, etc.). Japanese corporations are increasingly adopting open innovation, and actively seeking collaboration with startups. This commitment is exemplified by initiatives such as the Open Innovation Lab, which plays a key role in bridging startups and established corporations in the hub cities. The 3rd highest scoring is Singapore (41.5). Singapore is making strides both at the country and city levels, consistently advancing its position in the global rankings every year. This move represents the only shift within the top five and the most significant advancement in the top ten worldwide. It is truly remarkable for a city-state to achieve such a high ranking. Over the last five years, Singapore has developed the fastest-growing startup ecosystem in the world. Singapore is ranked 3rd in the business environment score, which is two spots better than its overall global ranking, indicating a particularly favorable regulatory environment for startups. Singapore has solidified its position as Asia's leading startup ecosystem. However, the average score of this indicator is 45.9 despite several top-level countries' high scores. Several countries in the APT regions scored lower than average: e.g., Cambodia (0.3), Indonesia (33.2) Malaysia (10.9), Myanmar (0.5), Thailand (10), and Viet Nam (11.1). These scores show that there is room for improved development of the startup infrastructure and ecosystem.

Finally, the sufficiency of education or support services [E3] as a qualitative indicator, which is selected from the ASEAN-ROK Startup Ecosystem Report (2021), aims to measure a range of startup support considerations. The indicator refers to the availability and adequacy of resources that can help startups grow and succeed. The resources include the following: (i)

educational institutions which provide relevant entrepreneurship and innovation courses; (ii) mentoring and coaching services which provide access to experienced entrepreneurs and industry experts who can offer guidance, advice, and business support; (iii) incubators and accelerators which provide startups with office space, funding, mentorship, and networking opportunities; (iv) workshops and training programs which provide entrepreneurs with opportunities to develop skills such as business planning, marketing, and financial management; and (v) availability of networking events where startups can connect with potential partners, customers, and investors. Unfortunately, this indicator is not available in Myanmar, Thailand, Japan, and China. Regarding the indicator of sufficiency of education or support services [E3], Singapore, South Korea (ROK), and Brunei Darussalam are the three countries where education and support services are the most sufficient. The indicator is 4 in Singapore, 3.7 in South Korea, and 3.4 in Brunei Darussalam, in comparison to an average of 2.97. Singapore and South Korea also have comparatively high levels for the urban startup ecosystem indicator [E2] - i.e., 41.5 and 39.3 respectively. Indonesia has a good level in the urban startup ecosystem indicator (E2: 33.2), but has the smallest startup support sufficiency indicator (E3: 2.1). While Viet Nam and Malaysia have similar levels in terms of the startup urban ecosystem indicator [E2] (i.e., 10.9 and 11.1, respectively), the sufficiency of education or support services in Malaysia (E3: 3) is higher than that in Viet Nam (E3: 2.5). The levels for the indicator of startup education and support services in Laos (E3: 2.8) and Cambodia (E3: 2.7) are also more sufficient than in Viet Nam, although the urban ecosystem indicator is low in the two countries.

Factor F. Startup Barriers and Government Regulation

For the factor of startup barriers and government regulation, we have collected the data of three indicators, including time required for a startup business, cost of business start-up process, and time spent satisfying requirements of government regulations, for the APT countries. The indicator results for the APT countries are presented in Table 2.9.

Table 2.9. Indicators for startup barriers and government regulation

Country	Indicators		
	[F1] Time required to start a business (unit: days)	**[F2] Cost of business start-up procedures** (unit: % of GNI per capita)	**[F3] Time spent meeting government regulations** (unit: % of senior management time)
Brunei Darussalam	5.5	1.1	n.a.

Cambodia	99.0	53.4	6.2
Indonesia	12.6	5.7	1.3
Laos (Lao PDR)	173.0	4.6	0.8
Malaysia	17.5	11.1	5.2
Myanmar	7.0	13.3	0.8
Philippines	33.0	23.3	7.2
Singapore	1.5	0.4	6.8
Thailand	6.0	3.0	4.8
Viet Nam	16.0	5.6	4.5
South Korea (ROK)	8.0	14.6	0.1
Japan	11.2	7.5	n.a.
China	8.6	1.1	0.9
Average	30.7	11.1	3.5

Data period and source for the indicator:

[F1] Time required to a startup business: year 2019, https://data.worldbank.org/indicator/IC.REG.DURS

[F2] Cost of business start-up process: year 2019, https://data.worldbank.org/indicator/IC.REG.COST.PC.ZS

[F3] Time spent dealing with the requirements of government regulations: the most recent year (2005 – 2023), https://data.worldbank.org/indicator/IC.GOV.DURS.ZS

In order to encourage a healthy entrepreneurial ecosystem for deep tech startups, the three indicators [F1, F2, and F3] of the factors regarding startup barriers and regulations are very important to consider.

The difficulty in starting a business is determined by several important factors. In the case of time required to start a business, startup managers often choose to reduce the time required when possible, even if doing so incurs greater cost.[49] The average for the time required to start a business in the APT countries is 30.7 days. Singapore is the country with the shortest time required to start a business (at just 1.5 days), whereas Laos (Lao PDR) and Cambodia require 173 and 99 days. However, there are 5 countries belonging to a group with an above-average level: Brunei (5.5 days), Myanmar (7.0 days), Thailand (6.0 days), South Korea (8.0 days), and China (8.6 days). Singapore has been renowned as a top country for business, as Singapore provides an environment with significantly less regulatory bureaucracy. Results in Table 2.9 show that many founders register their company in Singapore in just one day, due to Singapore's open environment that fosters investment in the country. Well-prepared startup founders can take advantage of Singapore's business-

[49] World Bank, Doing Business project (https://archive.doingbusiness.org/en/doingbusiness)

friendly environment and register their company in less time than in other countries.[50] Other factors include the consideration period before registering a company in various countries, including researching legal issues that will benefit or protect investors, as this information will be used to assess risks and decide on which country to invest in. Another factor is the convenience of holding or managing real estate. The World Bank stated that improving the regulatory system for registering companies started by foreign entrepreneurs can encourage new investment and business operations.

The second indicator is the cost of the business start-up process [F2]. Business costs tend to increase, especially financial costs, due to the direction of domestic interest rates, which are likely to be adjusted upwards, including utility costs such as electricity costs, or even the cost of skilled labour, which is in demand by many businesses. In addition, the direction of exchange rates may be volatile amid the vulnerabilities of both major and emerging economies around the world. The average of this indicator in the APT countries is 11.1 % of GNI per capita. Singapore, China, and Brunei Darussalam are regarded as countries with lower costs for business startup procedures. Singapore's cost of business start-up process is 0.4% of GNI per capita, whereas costs in China and Bruni Darussalam are 1.1% of GNI per capita, respectively. The countries with relatively large numbers for this indicator are Cambodia (53.4 %) and the Philippines (23.3%), which are much greater than the average (11.24%). Starting a business demands careful financial planning and precise accounting, particularly in the initial stages. Many entrepreneurs make the mistake of not properly estimating and budgeting for startup costs, relying too much on a sudden influx of customers. This approach often leads to poor results and even the business's failure.[51] A solid financial plan is key not only for managing startup costs, but also for building a foundation for a venture's future growth.[52]

The last factor among the indicators of the entrepreneurial ecosystem for deep tech startups is the time spent meeting the requirements of government regulations [F3]. The average of this indicator in the APT countries is 3.5 % of senior management time. Entrepreneurs in the Philippines spend the longest time meeting government regulations, (7.2 % of Senior management time) followed by those in Singapore (6.8%). A group of countries in which less than 1 % of senior management time is spent in South Korea (0.1), Laos and Myanmar (0.8), and China (0.9). Therefore, these countries offer more streamlined regulatory measures, e.g., simplified taxes, customs, labour regulations, licensing and registration, including dealings with officials, and simplified form-filling processes, which allow more opportunities for beginning new businesses and startups. It is notable that the

[50] Intracorp, How Long Does it Take to Incorporate a Company in Singapore? https://intracorp.com.sg/company-incorporation-time-singapore/

[51] The 4 Most Common Reasons a Small Business Fails, Investopedia: https://www.investopedia.com/articles/personal-finance/120815/4-most-common-reasons-small-business-fails.asp

[52] How to Estimate Business Startup Costs and What It Covers, Investopedia: https://www.investopedia.com/articles/pf/09/business-startup-costs.asp

indicators are consistent with the World Bank's annual Ease of Doing Business rankings, and show the results of the government's efforts to improve regulations to make it easier for foreign investors to start businesses.

The above-mentioned indicators regarding the factor of startup barriers and government regulations address one of the key impact factors in the entrepreneurial ecosystem for deep tech startups. The timing when setting up a company, and the ease of government regulations can present barriers or encouragement to startups on “Ease of Doing business”. The cost of the business start-up procedure is also important, as startup entrepreneurs must take all costs into account. Deep tech startups must give special attention to the costs of science technology and innovation (STI), costs included in the STI infrastructure, licensing, and so on.

2.3. Limitations of the Indicator Analysis and Necessity of the Complementary Approach

We have measured the indicators of the entrepreneurial ecosystem for deep tech startups in the APT countries and interpreted the results and their implications. Although such indicators offer considerable insight, the indicator approach might not be perfect for capturing all the features and heterogeneities of the entrepreneurial ecosystem for the APT countries. The indicators were derived from theoretical and conceptual backgrounds via the literature review. However, they should also be appropriately selected to ensure that these indicators cover cases within the APT countries as closely as possible with the data available. For example, some indicators regarding the startup ecosystem presented in the literature (such as OECD, 2017) might be better suited for the OECD countries than those related to this study, but the appropriate data could not be properly collected for many of the APT countries. Furthermore, it is difficult to construct and measure the indicators regarding deep technologies for a diverse range of countries in practice. Finally, the indicator approach presents pros and cons as a quantitative and secondary research methodology for cross-country/region comparison (Stam, 2018; Stam and van de Ven, 2021). For example, the indicators would not explain the heterogeneity in specific policies or regulations for deep tech startups across the APT countries – e.g. some countries have specific policies or systems supporting deep tech startups while others do not.

In the next chapters (Chapters 3 and 4), we will attempt to address the limitations of the indicator approach (e.g. qualitative features, heterogeneous or specific situations within each country, practical examples of policies and cases of deep tech startup, etc.) and further scrutinize the entrepreneurial ecosystem for deep tech startups in the APT countries.

3. Review of Policies for Deep Tech Startups

3.1. Selection Criteria and Basic Information of Policy Cases

A major policy for deep tech startups in each of the ASEAN+3 (APT) countries was selected. Selected policies are related to one of the following types: specific policies to support deep tech startups creation or growth with a focus on sustainable development goals (SDGs); related national plans, policy initiatives and strategies; related public programs or other support tools (including public organizations focused on the support of deep tech startups). For example, policy-related support can cover public grants, tax returns, matching subsidies, public procurement, initiatives to support university spin-offs and industry-science linkages, policies to support startups and scale-ups, VISA schemes and talent attraction policies for startups and tech entrepreneurs or tech talent in general, and so on.

The study group (SG) members screened the policy by searching for appropriate policies by themselves or with support from the steering committee (SC) according to the following criteria:

- Policy goals should be specific and related to deep tech startups or any related startups (e.g., a policy supporting a broad range of general startups is not appropriate).
- Policy should target deep tech startups or related startups (e.g., high-tech startups, tech-based startups with both scalability potential/evidence and impact, etc.).
- As per the above, policy targets and tools need to be specified.
- If a current policy changed or complemented related previous policies, it should differ from previous policies in certain aspects (e.g., policy targets, tools, program/grant period, government/private co-investment ratio, the amount of grant or co-investment etc.).
- The policy should be related to sustainable development and/or the SDGs framework.

This report considers that policies can reflect on differences in the concept, definition, and scope of deep tech startups across the APT countries, depending on country-specific context and economic, industrial and societal issues, and sustainability development agendas. For example, issues and agendas in the APT countries can relate to AI/carbon-free technology applications to the agriculture industry, a combination of big data analytics with medical technologies, cloud computing services for Industry 4.0-based manufacturing, and so on.

For the policy review, the SG received the policy recommendation and information from the SC, and complemented them by conducting secondary research and utilizing other information, if necessary, and consulting with SG members with relevant knowledge and expertise. The following information for each policy will be collected and reviewed in the next section of this chapter:

- Policy goal and/or major goal: what the country aims to achieve through the policy support ultimately; goals in terms of quantity or quality (e.g., the total and yearly number of deep tech startups supported by the policies, the quality or level of the startups to be supported, etc.)
- Policy targets or scope: e.g., the definition or meaning of 'deep tech startups' in the country.
- Period for the policy support: e.g., the time of policy launch and lasting period
- Organizations and financial budgets for policy design and implementation: e.g., in-charge ministries/agencies/other institutes, total and yearly amount for each startup or policy.
- Criteria used to select policy targets: how the government (or public or private agencies) selects the startups to be supported.
- Means of support: e.g., specialized programs, grants or tax returns for the development and advancement of business models; enabling technologies; commercialization of technologies or research outputs; accelerating early-stage startups; linking startups to private investors (e.g., venture capitals); support of workplaces or business tests; network-building and related events; infrastructures; talent development or attraction.
- Policy performance: if the policy supports have been executed for the last 3 or 5 years; achievements and limitations, etc. The policy's evaluation or successful outcomes/cases would be included if relevant data is available.
- Other considerations or critical review of the policy beyond the summary: e.g., what key factors are considered for policy design, reflecting on deep tech startups or the country's situation; how/which aspects this policy tackles the issues or problems of deep tech startups/ecosystems in the country; complementary factors to be considered to maximize this policy's successful implementation, policy benefit, or appropriate supports to the deep tech startups; review opinions regarding this policy's existing implementation or further/future plan; etc. If necessary or relevant, the concept and features of deep tech startups (presented in Chapter 1) and their ecosystem and each country's situations (presented in Chapters 1 and 2) are mentioned.
- Information sources: cited or relevant information sources; secondary data sources.

The SG selected one major policy for deep tech startups in the country as presented in Table 3.1.

Table 3.1. Major policies for deep tech startups in the APT countries

Country	Name	Policy Category	Focused on Deep Tech Startups
Brunei Darussalam	**Digital Economy Masterplan 2025**	National Strategy	Indirectly Related
Cambodia	**Techo Start-up Center**	Organization	Indirectly Related

	(Digital Platform and Reverse Innovation Programs)	(Programs)	
Indonesia	**AI National Strategy 2020-2045**	National Strategy	Indirectly Related
Laos (Lao PDR)	**Policy on Creating Business Environment for Deeptech Startups Establishment and Operation**	Policy Plan	Directly Focused
Malaysia	**Malaysia Startup Ecosystem Roadmap (SUPER) 2021-2030**	National Strategy	Indirectly Related
Myanmar	**Startup Challengers Program**	Policy Program	Indirectly Related
Singapore	**Startup Singapore (SG) Programs (Startup SG Tech and Startup SG Equity)**	Policy Program(s)	Directly Focused
Philippines	**Innovative Startup Act**	National Law	Indirectly Related
Thailand	**National Higher Education, Science, Research and Innovation Policy**	National Strategy	Indirectly Related
Viet Nam	**844 Program (Program on Supporting the National Innovation Initiative)**	Policy Program(s)	Indirectly Related
South Korea (ROK)	**Deep tech Incubator Project for Startup (DIPS)**	Policy Program(s)	Directly Focused
Japan	**Deep Tech Startups Support Program (DTSU)**	Policy Program(s)	Directly Focused
China	**Promoting the Innovation and Development of Future Industries**	Policy Plan	Indirectly Related

Notes: 'Policy Program' means a policy and its directly related programs for deep tech startups. 'National Strategy' refers to a national-level policy without directly related programs for deep tech startups. 'Policy Plan' means a policy initiative either launched in 2024 or to be launched later (but detailed policy features or supports have not been specifically established yet). 'Organization' refers to a public or not-for-profit organization supporting deep tech startups or related tech startups. 'Directly focused' refers to policies (including public programs) focused on or specifically targeting deep tech startups while 'indirectly related' refers to policies broadly targeting a whole range of tech startups and general startups or related policies for industrial or science and technology (S&T) innovation.

3.2. Review of Major Policies to Support Deep Tech Startups in Each Country

This section summarizes and reviews major policies for deep tech startups in each APT country. The policies of the 'Plus Three' countries (Japan, Korea and China) are presented first and then the policies of the ASEAN countries are presented in the alphabetical order of

the country's name.

Review of Japan's Policy: 'Deep Tech Startups Program (DTSU)'

- Policy brief and/or major goal: The Deep Tech Startups Support Program (DTSU) and its specialized extension in the Green Transformation (GX) field aim to accelerate the creation and development of deep tech startups that can address critical societal challenges and drive Japan's innovation economy. These programs prioritize supporting startups leveraging advanced science and technology, particularly in areas crucial for achieving carbon neutrality and sustainable development. Quantitatively, the programs aim to increase the number of successful deep tech startups annually. Qualitatively, the emphasis is on nurturing ventures that contribute transformative solutions in fields such as energy, environment, and sustainability.
- Policy targets and scope: The programs define 'deep tech startups' as ventures centred on breakthrough technologies with high potential for impact and commercialization. The GX field focuses specifically on startups contributing to Japan's Green Transformation, which includes renewable energy, energy efficiency, and technologies that reduce carbon footprints.[53] These initiatives reflect Japan's strategic focus on achieving its 2050 Carbon Neutrality Goal[54] and addressing global environmental challenges through innovation.
- Period for the policy: The DTSU runs for 10 years from FY2023 to FY2033 and the GX field program operates for 8 years from FY2024 to FY2032. The DTSU and GX programs operate within multi-year frameworks, as they involve 3 phases that typically spanning 2 to 6 years. These durations allow for sufficient product R&D, development of technology and validation, and market entry research and execution. The programs are part of ongoing efforts, with periodic evaluations to adjust priorities based on technological and market trends.
- Organizations and financial budgets/investments for the policy design and implementation: Both programs are managed by the New Energy and Industrial Technology Development Organization (NEDO), in collaboration with key government ministries, universities, and private sector partners. Key partners include *J-Startup*, which promotes networking events and international partnerships to further integrate Japan's startups into the global ecosystem.[55] The Kawasaki-NEDO Innovation Centre[56] serves as a consultation hub for research and development startups, offering support in creating business plans. Additionally, the Japan Open Innovation Council[57] advocates for and facilitates open innovation initiatives. The DTSU has a total program budget of Japanese

[53] https://www.weforum.org/stories/2023/01/davos23-japan-accelerate-efforts-carbon-neutral-society/#:~:text=In%20the%20face%20of%20the,to%202013%20levels%20by%202030.

[54] https://www.japan.go.jp/kizuna/2024/01/together_for_action_japan_initiatives.html

[55] https://www.j-startup.go.jp/en/about/

[56] For more information, see: https://www.k-nic.jp/

[57] For more information, see: https://stip.oecd.org/stip/interactive-dashboards/policy-initiatives/2023%2Fdata%2FpolicyInitiatives%2F15286

Yen (JPY) 93 billion and the GX field program has an initial budget of JPY 20–30 billion for FY2024. The financial budget for these programs includes substantial annual allocations to support research, development, commercialization, and ecosystem-building activities. These budgets reflect Japan's commitment to fostering innovation in critical areas like green energy and sustainable technology.

- Criteria to select policy targets: Eligible projects are those that involve long-term research and development, substantial funding to advance technology, and efforts to commercialize and integrate it into society. These projects aim to address critical economic and social challenges, such as carbon neutrality, resource sustainability, and economic security, on a national or global scale, despite the inherent high risks. This program is designed to enhance corporate value and support start-ups in achieving unicorn status, and offer large-scale exit opportunities and global expansion.
- Means for support and/or related detailed information: The DTSU and GX programs offer a variety of support mechanisms, including: (i) Grants and subsidies for R&D and technology commercialization. The program provides grants totaling up to JPY 3 billion across all phases, supporting activities ranging from early prototyping to mass production. The funding structure is adaptable, with eligibility determined by market readiness and R&D maturity. (ii) Networking opportunities, connecting startups with investors, industry leaders, and international collaborators. (iii) Access to testing and development infrastructure, including facilities for energy and environmental technology validation. (iv) Talent development and recruitment programs, focusing on upskilling and attracting researchers, engineers, and entrepreneurs in green and deep tech fields. (v) International collaboration support, particularly for GX startups addressing global sustainability goals.
- Policy performance: The DTSU and GX programs have recently begun and are contributing to the growth of startups in fields like renewable energy, green hydrogen, and sustainable materials.
- Other considerations: Challenges may include bridging the gap between pilot projects and large-scale commercialization, as well as ensuring long-term financial sustainability for startups. Evaluations suggest that the programs have successfully aligned with Japan's innovation and environmental priorities, though additional efforts are needed to scale impact. The DTSU and GX programs address critical gaps in Japan's innovation ecosystem by focusing on high-impact technologies and sustainability. However, certain complementary measures could enhance their effectiveness, such as: (i) Expanding access to global markets for GX startups to scale their technologies internationally; (ii) Fostering closer collaboration with universities and research institutes to improve technology transfer; (iii) Streamlining regulatory frameworks to support faster deployment of green technologies.
- Programs such as the DTSU and its specialized extension in the GX field, represent a strategic approach to fostering innovation while addressing critical environmental challenges. Continuous adaptation and scaling of the initiatives will be vital to meet Japan's long-term innovation and sustainability goals.

- Program details: The program is structured into three phases, each lasting approximately 2 to 4 years, with an additional 1.5 to 2 years allocated for fundraising between phases. NEDO offers flexible subsidies covering eligible expenses: up to two-thirds for Phases 1 and 2, and either two-thirds or half of expenses for Phase 3. Before progressing to the DTSU and DTSU in the GX phases, applicants can participate in three preparatory courses. Phases 1 (Seed-stage Technology-based Startups, STS) and 2 (Product Commercialization Alliance, PCA) focus on practical R&D to advance innovation. Phase 3 (Demonstration development for Mass Production, DMP) supports scaling up for mass production. Applications can be submitted for any phase; however, each applicant may only apply for the phase that best aligns with their company's current stage. Applicants are responsible for determining the appropriate phase based on the most advanced business operations or research and development activities within their organizations. Applications remain open until 2027.

Details of the 3 phases are as follows.

	Phase 1	Phase 2	Phase 3
Target	Startups engaged in R&D, prototype production, and market testing, but not yet offering a finalized product or service, which aim to validate problemsolving hypotheses. By the end of this phase, they should deliver a solution addressing a specific problem for an initial target market.	Startups focus on generating revenue by identifying initial and mainstream markets, solving target customer problems, and developing scalable business models. By the end of this phase, their product or service should address customer needs in both initial and mainstream markets while sustaining revenue generation.	Startups aim to achieve significant revenue by targeting mainstream markets, solving customer problems, and developing scalable business models. This phase requires establishing a mass production system or conducting demonstrations for business scaling. By its conclusion, the product or service should address major market needs, meet commercial production requirements, ensure sustainable revenue, and be ready for mass production by the next funding round.
Expenses covered by NEDO	Up to 2/3 of subsidy-eligible expenses (total maximum subsidy: 300 or 500 million yen)	Up to 2/3 of subsidy-eligible expenses (total maximum subsidy: 500 million yen or 1 billion yen)	Up to 2/3 of subsidy-eligible expenses for GX or 1/2 for DTSU upon certain conditions. (total maximum subsidy: 2.5 billion yen)
Support	Startups focus on the R&D of foundational	Startups work on developing prototypes	Startups conduct mass production demonstrations

	technologies and prototype development, including feasibility studies to guide technology develoment toward commercialization. Venture capital (VC), corporate venture capital (CVC), and business operators offer both investment and hands-on support to start-ups, aiding in their growth and development.	and initial production technologies while conducting feasibility studies to target mainstream markets. VC, CVCs, business opera-tors, and financial institutions offer investments, foster business partnerships, and implement various strategic initiatives.	by designing, manufacturing, and operating production and inspection equipment essential for developing and validating mass production technologies. VCs, CVCs, business operators, and financial institutions offer investments, foster business partnerships, and implement various strategic initiatives.

- Information source: https://www.nedo.go.jp/english/activities/activities_ZZJP_100250.html

Review of Korea's Policy: 'Deep tech Incubator Project for Startup'

- Policy brief and/or major goal: This project aims to promote the development of deep tech startups (so-called 'super-gap startups') that can achieve competitive advantages based on technological competence within 10 technology/industry fields in the global markets.[58] The super-gap technology/industry fields are formally specified in the project and they are consistent with the Korean National Plan for High-Tech Industry Development and the National Plan for Strategic Technology Promotion. The projects target deep tech startups that have a longer period of R&D, technology commercialization (including prototype test or certification), and scale-up than other (regular) startups. The project is implemented via two public programs: Deep tech Incubator Program for Startups ('DIPS') and Deep tech Tech Incubator Program for Startups ('Deep tech TIPS').
- Policy targets or scope: startup companies (those which have operated for less than 10 years) operating in the 10 selected deep technology (or related industry) fields
- Period for the policy support: This project aims to explore more than 1,000 deep tech startups for five years (2023-2027) and provide a range of appropriate support, customized to meet the needs of the startups.
- Organizations and financial budgets/investments for the policy design and implementation: The Ministry of SMEs and Startups (MSS) and the Korea Institute of Startup and Entrepreneurship Development (KISED, a legal and public agency of the MSS) are in charge of policy design and execution, respectively. Total budgets and investments

[58] The 10 fields cover: system semiconductors; bio or health; future mobility; environment or energy; robotics; AI or big data; cyber security or network; aerospace; maritime technology; future nuclear reactors; quantum technology.

(including matching funds invested by private entities) for deep tech startups will be 2 trillion Korean Won (1.48 billion US Dollars) during the five years.

- Criteria to select policy targets: (a) DIPS – startups that have superior core technology-based product and innovative business model in the 10 deep tech fields and maintain the potential of high growth (scale-up) through technology commercialization in the global market; (b) Deep tech TIPS – startups that have technology or product belonging to the 10 deep tech fields, superiority in both technological and market aspects, and have already received an investment of 300 million Korean Won (231,000 US Dollars, 1 USD = 1300 Korean Won) from the TIPS program's operator (accelerators, venture capitals, etc.).
- Means for support and/or related detailed information: 'DIPS' has selected approximately 150 to 230 startups, and 'Deep tech TIPS' has selected approximately 120 to 150 startups every year since 2023. The selected startups for 'DIPS' can receive financial support for technology commercialization covering up to 600 million Korean Won (USD 462,000) for three years and for technology development covering up to 500 million Korean Won (USD 385,000) for two years. The selected startups for 'Deep tech TIPS' can receive financial support for technology development covering up to 1.5 billion Korean Won (USD 1.15 million) for three years and for non-technological support (e.g. commercialization, international marketing, etc.) up to 100 million Korean Won (USD 77,000) for one year. The amount is based on the matching investments by the government and selected company (early-stage startup)/TIPS operator (government: company/TIPS operator = 70%: 30% up to 83%: 17%). The support amount can also differ across firms, depending on the firm's application proposal and initial and yearly assessments. Specifically, these supports cover technology advancement, prototype-making and testing, collaborations with other organizations (e.g., large or medium-sized firms, universities, public research/supportive institutes, etc.), business model development, international marketing or export initiation, promotion of fundraising from the domestic and international accelerators (ACs) and venture capitals (VC), etc. Regarding 'Deep tech TIPS', the selected firms can be located at the startup-clustered workplace ('TIPS Town').
- Policy performance: 'DIPS' and 'Deep tech TIPS' have selected and supported about 380 and 270 startups since 2023. The MSS provided the selected startups with both primary support via the public program and additional SME-related support (e.g. lowering interest rates for bank loans, certifications, export services, etc.). The performance of the two programs has not been formally assessed due to the short period of policy implementation (i.e. the project has been executed since 2023).
- Other considerations: The project was initiated to enhance the impacts of high-technology startups and government support on the startups through specifying the explicit link with the national plans for strategically prioritized technologies and industries with deep impacts in terms of both market (commercial) and societal aspects. This approach aims to harness the strengths of the Korean entrepreneurial ecosystem for deep tech startups (e.g. strong industrial bases, high levels of national R&D intensity (GERD), technology and knowledge creation, etc. (refer to Section 2.2. in Chapter 2). In

addition, the project was designed to complement existing policy or related public programs that support high-technology or innovative startups and to overcome the programs' limitations in effectively promoting deep tech startups. The DIPS and Deep tech TIPS have not only succeeded in existing public programs ('Innovative Startup Package' and 'Regular TIPS')[59], but also complemented them in several dimensions by considering the features of deep tech startups. For example, regarding the age of targeted startup firms, the two programs extended the maximum (upper limit) age of startups: from 7 years to 10 years. This extension was implemented due to the fact that, compared to regular startups, deep tech startups require longer periods for technology development, commercialization, and scale-up (refer to Section 1.1 in Chapter 1). Regarding the extent of financial support, these programs increased the period and amount of financial support matched by the private investor's pre-investment in early-stage startups in the Deep tech TIPS scheme: from a maximum of 500 million Korean Won for 2 years per company (regular TIPS) to a maximum of 1.5 billion Korean Won for 3 years per company (Deep tech TIPS). This increase in funding takes into account the additional investment scale and time that characterize deep tech startups (refer to Section 1.1 in Chapter 2). Regarding the government's policy design, the TIPS program has been divided into a regular track (which receives 80% of funding) and a Deep tech track (which receives 20%).[60] Many private operators of the previous TIPS program and other private investors were reluctant to actively invest in the deep tech startups requiring greater time and scale in harvesting the returns, due to both technology and market risks, compared to other startups with only market risk. Creating a Deep tech track in the TIPS program helps address difficulties which lead to 'market failure', such as cases where private entities under-invest in deep tech startups, or invest less than the socially required level (refer to Sections 1.1 and 1.2 in Chapter 1).

- Information sources:
  The Korean Ministry of SMEs and Startups – Press Releases[61];
  The Korea Institute of Startup and Entrepreneurship Development – Public Programs[62];

[59] The TIPS, which started in 2013, is a unique program in that the TIPS private operators (mostly ACs and VCs) choose and first invest in early-stage firms, and then the government selects and supports some of the startups later through matching funds according to the selection criteria. By contrast, the prior Korean public programs for startups tend to focus on providing subsidies to the startups selected by the government. That is, the TIPS has been regarded as the first approach to tackle existing public programs' problems (so-called 'government failure'; a lack of private information on startups' market potentials and scalability) in Korea.

[60] The share of Deeptech track in the TIPS program (20%) is appropriate to reflect on the recent share of VC investment in deep tech and related industry fields in total VC investments and the increasing importance of deep tech startups in total startups in Korea (Kim, 2023).

[61] Press release on Nov 3rd, 2022: available at https://www.mss.go.kr/common/board/Download.do?bcIdx=1036959&cbIdx=244&streFileNm=95a2d7b8-a9b1-470e-acb8-b0cda4b3a40d.pdf; Press release on May 12th, 2023: available at https://www.mss.go.kr/site/eng/ex/bbs/View.do?cbIdx=244&bcIdx=1041622&parentSeq=1041622; Press release on January 9th, 2024: available at https://www.mss.go.kr/site/smba/ex/bbs/View.do?cbIdx=86&bcIdx=1047192&parentSeq=1047192

[62] Information on the DIPS 1000+ Project: available at https://www.kised.or.kr/menu.es?mid=a10205180000 ;

Kim, J. H. (2023). Overview of DeepTech Startups and Supportive Policies. KIET Issue Paper Series, No. 2023-06. August 2023 (in Korea).[63]

Review of China's Policy: 'Promoting the Innovation and Development of Future Industries'

- Policy brief and/or major goal: The Chinese government's seven departments, including the Ministry of Industry and Information Technology (MIIT), announced implementation opinions on 'Promoting the Innovation and Development of Future Industries' in January 2024. This policy includes support related to deep tech startups (e.g., small and medium-sized enterprises or high-tech ventures in the 'future industries'). Future industries cover six areas (manufacturing, IT, materials, energy, space, and health) as priorities for China's industrial policy.[64] The policy aims to grasp the opportunities of a new round of scientific and technological (S&T) revolution and industrial transformation, accelerate the development of future industries within the main competitive battlefield (namely the manufacturing industry), and support the promotion of new-style industrialization. The policy sets up five key tasks: (i) comprehensively layout future industries; (ii) accelerate technological innovation and industrialization; (iii) create iconic products; (iv) strengthen industry entities (i.e., industry main body); (v) enrich application scenarios. The fourth task is especially important to the support of deep tech startups.
- Policy targets or scope: By 2025, this policy is expected to help China achieve "comprehensive development in the future industry technology innovation, industry cultivation, and security governance, with some areas reaching the international advanced level and the industry scale steadily increasing." Then, the comprehensive strength of future industries will be significantly enhanced, with some areas achieving global leadership by 2027. For the policy's fourth key task (i.e., strengthening industrial entities) the following goals are defined: (a) cultivating high-level enterprises; (b) building an entrepreneurial ecosystem. For the former goal, it is important to build incubation bases for innovative small- and medium-sized enterprises (SMEs) in future industries, nurturing professional, meticulous, specialized, and innovative new SMEs (i.e., deep tech startups), high-tech enterprises, and "little giant" enterprises in future industries. Regarding the latter goal, it is necessary to build an ecosystem for the integrated development of firms of all sizes (i.e., large, medium, and small enterprises), as well as the collaborative innovation of the upstream and downstream of the industrial chain.
- Period for the policy support: 2024 to present (ongoing)
- Organizations and financial budgets/investments for the policy design and implementation: Ministry of Industry and Information Technology (MIIT)

Information on the Innovative Startup Package: available at https://www.kised.or.kr/menu.es?mid=a20204090000 ; Information on the Tech Incubation Program for Startups (TIPS): available at https://www.kised.or.kr/menu.es?mid=a20204040000

[63] https://www.kiet.re.kr/research/paperView?paper_no=790

[64] Refer to the appendix for details of six future industries.

- Means for support and/or related detailed information: The policy has assurance measures, such as (i) strengthening overall coordination; (ii) increasing financial support; (iii) strengthening security governance; (iii) deepening international cooperation. In relation to financial support, deep tech startups will greatly benefit from increased investment from funds such as the National Development Fund for Small- and Medium-Sized Enterprises, and from capital investment in earlier and small projects and hard S&T.
- The support will be integrated with the existing incentives for tech startups. For example, to encourage technology innovation, the government offers reduced 15 % CIT (corporate income tax) rates for high-tech and new technology enterprises (HNTEs) and for advanced technology service enterprises (ATSEs). China has also provided super deductions on R&D expenses for technology SMEs (TSMEs).[65]
- Policy performance: n.a. (This policy launched in 2024.)
- Other considerations: This policy's implementation is associated with the government's '14th Five-Year Plan for National Economic and Social Development and Long-Range Objective for 2035'. As one of the basic principles and development goals, this policy emphasizes the ecosystem collaboration approach – e.g. by creating and advancing industry ecosystems, including large firms, SMES, and startups, thus deeply integrating a diverse range of chains for innovation, product capital, and talent. This policy is also related to the government's previous policies for tech startups (e.g. Demonstration Bases for Mass Entrepreneurship and Innovation). In 2015, the Chinese government announced a program to establish 'Demonstration Bases for Mass Entrepreneurship and Innovation,' which aims to foster innovation and entrepreneurship by optimizing the policy system for innovation and entrepreneurship and building a number of low-cost, convenient, and open "maker spaces" or incubators. The plan called for creating new service platforms that can effectively meet the needs of the public for innovation and entrepreneurship and have strong professional service capabilities. It also encouraged the cultivation of angel investors and VC institutions, and called for easier access to and use of investment and financing channels.[66]
- Information sources: The Chinese Ministry of Industry and Information Technology – announcement and its translation in English[67];

Review of Brunei Darussalam's Policy: 'Digital Economy Master Plan 2025'

- Policy brief and/or major goal(s): This policy is not directly related to the support of deep tech startups, but indirectly associated with developing infrastructure or bases promoting deep tech startups.[68] This masterplan, established in 2020, aims to steer the country's

[65] Refer to the appendix for details about deduction on R&D expenses for TSMES and other enterprise types.

[66] China Briefing, China Startup Landscape - Industries, Investment, and Incentive Policies, May 2023 (https://www.china-briefing.com/news/china-startup-landscape-industries-investment-and-incentive-policies/?form=MG0AV3)

[67] https://zwgk.mct.gov.cn/zfxxgkml/kjjy/202401/t20240131_951102.html (in Chinese); https://cset.georgetown.edu/wp-content/uploads/t0582_future_industries_EN.pdf (in English)

[68] In Brunei Darussalam, 'start-up' refers to a registered business entity which has been operating for not more than 5 years

investment in the development of a Digital Economy, which will give guidance to policies and initiatives, facilitate growth through improved efficiency, and promote good governance.

- Policy targets or scope: In addition to the overall digital transformation in the country, this policy has strategic trust, including 'Industry Digitalization' which aims to create opportunities for innovation, to chart key efforts, and to develop digital transformation plans for each industry sector. Specifically, the industry specializations focus on factors related to SMEs or startups. For example, the policy focuses on (a) undertaking a comprehensive industry awareness programme across all stakeholders with a particular focus on MSEMS (including startups) and on (b) driving the adoption of Industry 4.0 technologies through training for key technology solutions and collaboration with key industry partners.
- Period for the policy support: 2020-2025 (five years)
- Means for support: Under this Masterplan, several initiatives have the potential to support deep tech startups. (a) Brunei Innovation Lab: Under the Masterplan's strategic enabler of 'R&D and Innovation in Digital Technologies', support for the direct focal point for the start-up ecosystem is considered. (b) PENJANA: Under the Masterplan's strategic thrust of 'Industry Digitalisation', a funding scheme is considered to help MSMEs adopt digital transformation and technology. (c) MSME Tech Clinic Program: Under the Masterplan's strategic thrust of 'Industry Digitalisation', it provides a consulting program to help MSMEs adopt the appropriate technologies for their businesses
- Policy performance: Brunei Innovation Lab's innovation-specific support reached a milestone with the contribution to the startup ecosystem. Since its establishment in 2022, the Lab has driven innovation-related initiatives to support the creation of startups and the development of the techno-preneurs ecosystem through nationwide hackathons, capacity-building programmes, prototyping programmes, and public awareness initiatives towards the use of emerging technologies. The Innovation Lab has invested efforts to strengthen its presence across industries, institutes of higher learning, and the general public, seeking to place itself as a catalyst supporting the development of innovative products and services across the landscape.
- Information sources: relevant information provided by the SC; public information on the Digital Economy Masterplan and related initiatives (e.g. Innovation Lab and Penjana funding)[69]; related research conducted by the International Monetary Fund (IMF).[70]

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and has a business model designed to be highly scalable usually by leveraging on technology to create innovative products and/or services.

[69] Information on the Master plan: https://www.mtic.gov.bn/DE2025/documents/Digital%20Economy%20Masterplan%202025.pdf; Information on the initiatives: https://digitalbrunei.bn/initiatives/; https://www.innovatebrunei.com/

[70] International Monetary Fund (IMF), *Digitalization in Brunei and Singapore*. IMF Staff Country Reports Vol. 2023 Issue No. 347, October 2023: https://www.elibrary.imf.org/view/journals/002/2023/347/article-A005-en.xml?ArticleTabs=fulltext

Review of Cambodia's Policy: 'Techo Startup Center'

- Policy brief and/or major goal(s): This organization is an incubator and accelerator supporting technology-based startups.[71] It offers acceleration and incubating programs, including training programs, mentoring, technical assistance and acceleration services to startups. It is located in the Royal University of Phnom Penh in an area of 6,720 square metres. It was established in 2019 by the Ministry of Economy and Finance (MEF) to encourage the creation and growth of start-ups by enhancing entrepreneurship and innovative capabilities through its support programmes.
- Policy targets or scope: It targets a diverse range of tech startups in several fields such as digital technologies, agriculture technology/sector, finance technology (fintech)/sector, and so on. The Center focuses on 5 main areas: new business incubation (startup nurturing), community building, digital entrepreneurship, research and enterprise digital transformation.
- Period for the policy support: 2019-present
- Organization for policy design and implementation: The centre is backed by the Ministry of Economy and Finance (MEF).
- Means for support and/or related detailed information. The Center implements five major programs. (a) The 'Internship Program' targets university students who do not run a start-up but want to become part of the innovation process. Applicants can apply for internships as junior researchers or skilled workers for start-ups. (b) The 'Cultivation Program' provides qualified mentorship and enhances the entrepreneurship skills of start-ups during the formative stage from ideation to developing a concrete business model. (c) The 'Innovation Program' aims to turn intellectual property (IP)-based start-ups into viable businesses by developing their entrepreneurial skills, and helping them to exploit their IP. (d) The 'Investment Program' connects start-ups to the right investors within the Center's networks for seed funding and beyond. (e) The 'Accelerator Program' is designed to accelerate the development phase from a concrete idea to a prototype by providing substantial technical assistance to start-ups. The financial support differs across the startups, on average 5,000 US dollars (approximately 20 million Riels).
- Policy performance: The Center provided two key programs in 2023: (a) 'Digital Platform Accelerator' for a 16-week program designed to support digital startups that can offer innovative digital platforms for MSEMs to embark on digital adoption in their business operation; (b) 'Reverse Innovation' for a 20-week program focused on FinTech with an

[71] The government and other stakeholders have supported technology-based startups (so-called 'tech startups') in Cambodia. Issues regarding the tech startup and its entrepreneurship ecosystem is indirectly or broadly mentioned in several national or high-level policies such as 'Industrial Development Policy 2015-2025' and Science, Technology, and Innovation (STI) Roadmap'. These policies identify several priority technology areas and related sectors: for example, agriculture technology (AgriTech); modern production and engineering (including manufacturing); healthcare and biomedical technology (HealthTech); services economy and the digital economy with a focus on emerging technologies such as AI and spatial technologies; environmental technology (GreenTech or CleanTech). However, there is currently no separate and distinct policy for tech startups (especially, deep tech startups) in Cambodia.

aim to source key challenges and needs in the market through corporations, and to seek startups or innovators to solve them. Regarding the key results in 2023, the Center received 59 applications, selected 29 startups for boot camp, and fully supported 21 startups by providing 36 million Riels of prototype funding, 62.5 million Riels of pre-seed funding, and 220 million Riels in cash prizes. The Centre has provided a range of financial and non-financial support via accelerator programs to more than ninety startups since its establishment.

- Other considerations: As the hub in the ecosystem of tech startups in Cambodia, the Center is associated with 'Startup Cambodia', the National Program (launched by the MEF in 2021, including approximately 80 to 110 subprograms annually) which aims to empower local startups and foster a vibrant ecosystem in Cambodia. 'Startup Cambodia' has four program categories such as startup nurturing, community building and networking (including events and awards), digital platforms, and research and policy development.
- Information sources: The Center's website (https://techostart-up.center); Public reports on the Center, initiatives related to the ecosystem of tech startups[72]; News article from the Khmer Times.[73]

Review of Indonesia's Policy: 'AI National Strategy 2020 – 2045'

- Policy brief and/or major goal: Indonesia's AI National Strategy 2020-2045 is a guideline and roadmap for key stakeholders to leverage AI for economic and social development, identifying strategic issues and priorities for using AI.[74] It focuses on areas such as Ethics and Policies, Talent Development, Infrastructure and Data, as well as Industrial Research and Innovation.[75] The strategy also covers several policy areas or sectors, stipulated as national priorities, such as agriculture, education, health, innovation, public governance, science and technology, as well as transport.[76] While there is no dedicated section on startups, the document ultimately highlights the crucial role of startups in developing the

[72] Ek, S. and Vandenberg, P. (2022), *Cambodia's Ecosystem for Technology Startups*, Asian Development Bank (ADB) Report (https://www.adb.org/sites/default/files/publication/804931/cambodia-ecosystem-technology-startups.pdf);
Mapping Research and Innovation in the Kingdom of Cambodia, UNESCO Report (https://unesdoc.unesco.org/ark:/48223/pf0000383786);
Startup Cambodia Insight 2022 (https://api.techostartup.center/media/files/Startup_Cambodia_Insights_2022_4Uzqyvd.pdf);
Tech Startup Ecosystem in Cambodia 2022, Techo Startup Center (https://digitaleconomy.gov.kh/public/images/mediahub/Tech_Startup_Ecosystem_in_Cambodia_2022_Challenges_Opportunities__l6RPInh.pdf)
Techo Startup Ceter's Annual Review Report: *Year in Review 2023* (https://api.techostartup.center/media/files/Year_in_Review_2023_vKilaOF_VEYCOfU.pdf)

[73] July 5, 2025: https://www.khmertimeskh.com/501517887/techo-startup-centre-gives-30000-to-five-cambodian-startups/

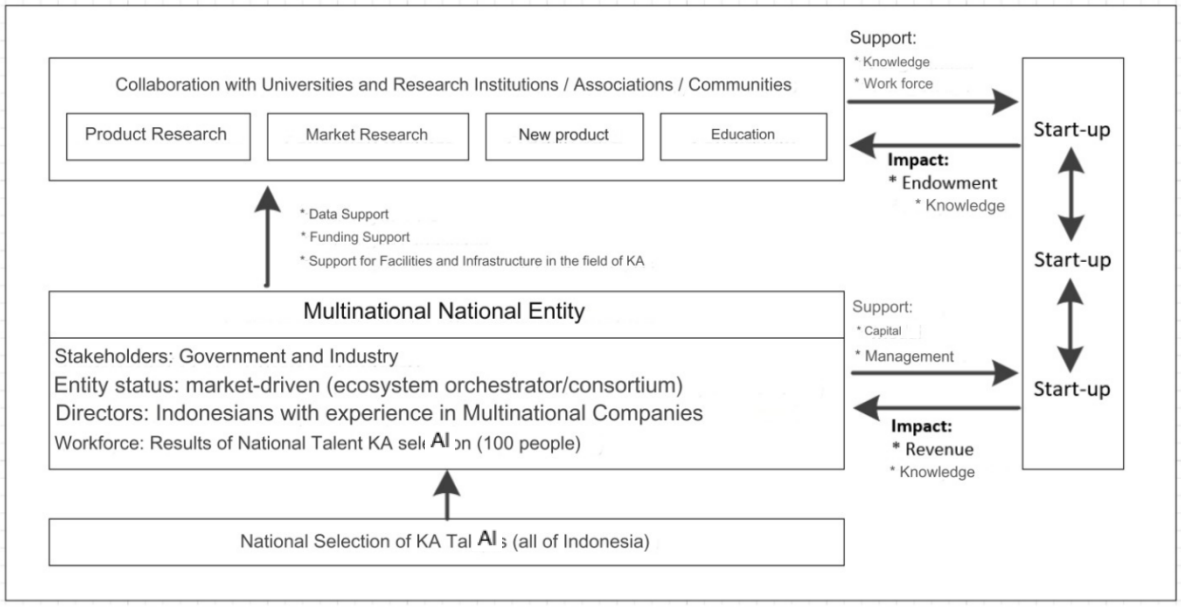
[74] AI Innovation. "Strategi Nasional AI di Indonesia." https://ai-innovation.id/strategi

[75] GIP Digital Watch. "The Indonesian National Strategy on Artificial Intelligence." https://dig.watch/resource/the-indonesian-national-strategy-on-artificial-intelligence

[76] *Ibid.*

national AI ecosystem. It asserts how startups can act as catalysts for innovation, bridging research with industry, generating economic and social benefits, and playing a key role in strengthening the national AI ecosystem through collaboration with stakeholders. The document, therefore, reiterates the importance of developing and establishing specific AI startup programs, positioning them not just as enablers, but also as key future objectives for the national AI strategy.

Figure 3.1 Support structure in AI National Strategy 2020-2045 in Indonesia



- Policy targets or scope: The strategy was designed to guide government institutions, ministries, and local authorities in formulating precise, effective policies that will drive the development and fully unlock the potential of the national AI ecosystem—including the creation of social and economic benefits through startups.
- Period of the policy support: Indonesia's AI National Strategy will be implemented over a 25-year period, from 2020 to 2045. It aligns with the bigger national development agenda that aims to position Indonesia as a developed country by 2045.[77]
- Organizations and financial budgets/investments for the policy design and implementation: The Ministry of Research and Technology, along with the National Research and Innovation Agency (BRIN) through the Agency for the Assessment and Application of Technology (BPPT), is responsible for overseeing the drafting process of Indonesia's AI National Strategy. Yet, the document itself is a product of collaborative efforts between government institutions, universities, communities, and industries—including startups. Meanwhile, an Innovation Centre for AI (PIKA) was established to implement the national strategy through eight Working Groups (WG), one of which is an

[77] SAFEnet. "Priorities and Challenges of Indonesia's Artificial Intelligence National Strategy (Stranas KA)." https://safenet.or.id/2022/05/priorities-and-challenges-of-indonesias-artificial-intelligence-national-strategy-stranas-ka/

institution named “Collaboration to accelerate Indonesian Artificial Intelligence innovation” (KORIKA).[78] Currently, no publicly available information exists regarding the allocated budget for implementing the national strategy.

- Criteria to select policy targets: Not applicable.
- Means for support: Since the document serves as a strategic reference for government agencies in shaping policies related to AI, its immediate impact on startups is limited, until it is translated into tangible policies or programs. Nevertheless, it sets an optimistic outlook for fostering the essential prerequisites for a robust AI ecosystem in the country. This includes initiatives to enhance digital infrastructure, promote local talent development, and secure the necessary funding to support growth.
- Policy performance: Nearly five years into its implementation, discussions have surfaced about revisiting and updating the AI strategy due to the rapid advancements in AI. It particularly entails the issue of generative AI’s emergence, and recognizes its potential risks, including increasing social tensions by spreading misinformation, violating intellectual property rights, and promoting discrimination. Moreover, no formal laws or regulations have been introduced to govern AI usage in Indonesia since the strategy was launched. The only related document is a non-binding, normative guideline on ethics and values, issued by the Ministry of Communications and Informatics (MoCI) in 2023.[79] The key elements concerning ethical and just usage of AI outlined in the national strategy also have yet to be integrated into existing key regulations, including those on data protection and privacy laws (PDP), data sharing and accessibility (KIP), as well as information and electronic transactions (ITE). Lastly, the most recent assessment from UNESCO also suggested updating the national AI strategy, as it lacks concepts such as proportionality, “do no harm,” and human oversight or accountability.[80]
- Other considerations: Selecting a policy that oversees or regulates deep tech startups in Indonesia is particularly difficult for two reasons. The first is the absence of an official definition and, consequently, recognition of what a ‘deep tech’ is, while the second obstacle concerns the fact that Indonesia does not have any Act that specifically regulates startups in general. Due to the lack of formal recognition for deep tech, discussions around its potential to contribute to the realization of the SDGs in Indonesia have also lagged. An investigation of various policies, documents, and programs related to SDGs in Indonesia[81] reveals that while the government acknowledges the critical role of technology in achieving sustainable development, they do not clearly specify the types of technology in focus. In most cases, only digital technology is highlighted in specific, and

[78] *Ibid.*

[79] Herbert Smith Freehills. "Ethical Guidelines on Use of Artificial Intelligence (AI) in Indonesia”. https://www.herbertsmithfreehills.com/notes/tmt/2024-02/ethical-guidelines-on-use-of-artificial-intelligence-ai-in-indonesia

[80] Presentation on Indonesia Artificial Intelligence Readiness Assessment Report. https://docs.google.com/presentation/d/1WkVUQ10QDwwGPN4sUTw6gb1LF54kz2CW/mobilepresent?slide=id.p1

[81] UNICEF. "Roadmap of SDGs." https://www.unicef.org/indonesia/media/1626/file/Roadmap%20of%20SDGs.pdf
UNESCO. “Indonesia Artificial Intelligence Readiness Assessment Report.” forthcoming.

thus, existing policies or programs focus on digital startups only.

On the other hand, the AI Readiness Assessment Report from UNESCO revealed that Indonesia's highest exposure to AI comes from its startups, implying the existence of deep tech startups as they intensely use AI. The Ministry of Communications and Informatics (MoCI) of Indonesia further mentioned the existence of up to 200 startups which utilize AI in the country. Hence, reviewing the AI National Strategy to assess the startup ecosystem is increasingly relevant, given the overall global rise in AI adoption. ERIA's most recent White Paper on Start-Up mentioned that more than half of the new unicorns in 2023 and 20 percent of all venture capital funding raised in 2023 were in the generative AI and deep technology sectors.[82] It also underscores the contribution of Southeast Asian AI startups toward SDGs by helping people with disabilities and advancing healthcare services. Likewise, Indonesia's AI National Strategy explicitly acknowledges AI's potential to bolster the research and innovation sector in achieving the SDGs, striving to incorporate AI into the nation's future development agenda. The summary of the National Strategy is accessible through OECD's dashboard of AI Policy Observatory.[83]

Review of Lao PDR's Policy: 'Policy on Creating Business Environment for Deeptech Startups Establishment and Operation'

- Policy brief and/or major goal(s): This policy (plan) aims to promote (i) a solid understanding of the business environment for deep tech startups, (ii) human resource development to support the advancement of deep tech startups, scientific techniques, technology and innovation. Regarding the goals, related stakeholders and public organizations (e.g., Micro, Small and Medium Enterprise Promotion Agency (MSMEPA) for the Ministry of Industry and Commerce) aim to build capacity to lead the improvement of deep tech startups. In the long run, the policy will continuously improve the government's regulations and management for deep tech startup establishment and operation (namely, deep tech startup registry system), intellectual property, tax registry system, tax payment and business permit from sectoral authorities. It also aims to promote and create favourable conditions in various forms for deep tech startups' access to domestic and international markets. It will support the collaboration between government, education institutions, Investors, and business sectors for research and development (R&D), and its output transfer to appropriate deep tech startups to promote inclusive and green transformation (related to UN Sustainable Development Goal (SGD) 9).
- Policy targets or scope: This policy targets deep tech startups, including technology-based startups and micro, small and medium enterprises (MSMEs). The policy stakeholders also

[82] ERIA One ASEAN Start-Up White Paper 2024. https://www.eria.org/uploads/media/E-DISC-White-Paper/ERIA-One-ASEAN-Start-up-White-Paper-2024.pdf

[83] OECD AI Policy Observatory: https://oecd.ai/en/dashboards/policy-initiatives/http:%2F%2Faipo.oecd.org%2F2021-data-policyInitiatives-26968

include government ministries and agencies, (e.g., Ministry of Industry and Commerce, Ministry of Technology and Information, MSMEPA, etc.), education institutions, public and private investors (e.g. Lao Development Bank, venture capitals, etc.), business-sector partners (e.g., Lao National Chamber of Commerce and Industry, private incubators and accelerators, etc.), and NGOs.

- Period for the policy support: 2026-2030 (five years)
- Organizations and financial budgets for policy implementation: The implementor is MSMEPA on behalf of the Ministry of Industry and Commerce. Regarding budget, this policy including action plans will be proposed to the Lao government and development partners.
- Criteria to select policy targets: Initially, the criteria for selecting the proposed policy are based on the MSME Development Plan 2021-2025 which MSMEPA is currently implementing, while conducting interviews with regular startups and deep tech startups in Laos. However, the proposed policy needs an assessment and a task force team to review, develop and create the most suitable policy for supporting deep tech startups.
- Means for support: Under the MSME Development Plan 2021-2025[84] that MSMEPA is currently implementing, the policy will receive a grant, along with technical assistance programs intended to promote and support MSMEs and startups. However, there is a lack of specific grant and capacity-building programs that focus on deep tech startups in Laos.
- Policy performance: n.a. (The policy has not yet been implemented.)
- Information source: information provided by the SC

Review of Malaysia's Policy: 'Malaysia Startup Ecosystem Roadmap (SUPER) 2021-2030'

- Policy brief and/or major goal: The primary aim of the Malaysia Startup Ecosystem Roadmap (SUPER) is to position Malaysia as a premier start-up hub in Southeast Asia by 2030. The policy seeks to nurture 5,000 high-potential startups, focusing on scaling deep tech ventures to achieve global competitiveness by 2030. This longer goal includes nurturing 5 startups to achieve unicorn status by 2025. SUPER emphasizes building an innovative ecosystem that drives economic growth, enhances technology adoption, and addresses critical societal challenges. As reported by Startup Genome, the value of Malaysia's start-up ecosystem was estimated at RM67.4 billion (approximately USD16.1 billion) in 2021.[85]

  Specially, SUPER engaged with:

  - Government stakeholders, to foster alignment on aspirations and understanding of current and future initiatives to enhance the start-up ecosystem.
  - Startups, to identify challenges and collaborate on solutions tailored to their needs.
  - Investors, to understand key traits sought in startups and explore the means through

[84] This plan was launched by the Ministry of Industry and Commerce.

[85] Startup Genome. (2021). The Global Startup Ecosystem Report 2021 (GSER 2021): Asia Insights & Rankings. Retrieved from https://startupgenome.com/reports/gser2021

which government support can align with these priorities.
- Corporations, to examine collaboration priorities with startups and evaluate proposed interventions for feasibility and impact.
- Educational institutions, to gather insights on training programs and initiatives to bolster talent pipelines for startups.
- Startup communities and associations, to validate ecosystem challenges and refine proposed solutions through community input.
- Incubators/Accelerators, to assess strategies for capability development and resource enhancement.

SUPER is aligned with key national policies, including the Shared Prosperity Vision 2030, Malaysia Digital Economy Blueprint, National Policy on Science, Technology and Innovation 2021-2030, National Entrepreneurship Policy 2030, Industry4WRD: National Policy on Industry 4.0, National Fourth Industrial Revolution (4IR) Policy, and the 10-10 Malaysian Science, Technology and Economy (MySTIE) Framework.

- Policy targets and scope: The roadmap supports startups through various stages of growth, with a particular focus on increasing the number of unicorns and enabling significant exit opportunities. The roadmap places particular emphasis on "deep tech startups", which are defined as ventures leveraging advanced technologies, such as artificial intelligence, biotechnology, and IoT, to tackle global challenges. These startups are expected to contribute significantly to national priorities, such as sustainability, industrial advancement, and digital transformation. Malaysia uses this term to align with global innovation trends and distinguish these startups from other tech-enabled ventures. The focus on deep tech reflects the country's commitment to fostering science and technology-based innovation.
- Period for the policy: SUPER spans a comprehensive 10-year period from 2021 to 2030. This 10-year plan details 16 strategic interventions organized into five core thematic areas. Each intervention is designed to align seamlessly with existing national policies, ensuring consistency and effective implementation. The policy includes phased implementation strategies, with periodic reviews to adapt to evolving market conditions and start-up ecosystem needs. These phases ensure a steady progression from initial groundwork to scaling and sustaining growth for startups.
- Organizations and financial budgets/investments for policy design and implementation: The roadmap is spearheaded by the Ministry of Science, Technology, and Innovation (MOSTI) in collaboration with key agencies like MDEC (Malaysia Digital Economy Corporation). While specific budget figures may vary, funding is sourced from public and private partnerships, grants, and investment incentives. The roadmap underscores the importance of coordinated efforts among government bodies, industry players, and financial institutions to optimize resource allocation.
- Criteria to select policy targets: Startups supported under SUPER are evaluated based on several criteria, including the innovation level of their products or services, scalability potential, alignment with national strategic goals, and contributions to economic growth.

- Means for support and/or related detailed information: The SUPER initiative operates on two primary levers: expanding global market presence and developing strategic sectors. These efforts aim to achieve three key outcomes: fostering innovative and high-quality startups, scaling deep tech ventures, and driving overall ecosystem growth. To accomplish this, SUPER engages four critical stakeholder groups—governments, the private sector, educational institutions and accelerators, as well as startups and their communities. The initiative focuses on five ecosystem drivers: funding, talent development, innovation, market dynamics, and policies and regulations.

  The roadmap outlines a variety of support measures to foster start-up growth. These include:

  - Grants and incentives: financial support for R&D, prototyping, and commercialization.
  - Capacity building: talent development programs to equip entrepreneurs with essential skills.
  - Infrastructure access: co-working spaces, innovation labs, and testing facilities.
  - Investor matchmaking: connecting startups with venture capital and angel investors.
  - Networking opportunities: events and platforms to facilitate collaborations and partnerships.
  - Market entry support: assistance in entering regional and international markets.

  These measures aim to reduce barriers for startups while ensuring they have the tools and resources needed to thrive.

  Policy performance: Progress is tracked via key milestones, focusing on successful exits, funding raised, and technology commercialization. Although SUPER is relatively early in its implementation, it has already set a foundation for a thriving ecosystem by fostering collaboration among stakeholders. Initial achievements include increased funding for startups, the establishment of innovation hubs, and strengthened ties between academia and industry. However, challenges remain, including talent shortages and uneven access to funding across regions. Continued evaluation and adaptation will be crucial to achieving the roadmap's ambitious targets.
- Other Considerations: Our analysis identifies five key thematic areas that encompass the challenges and gaps within Malaysia’s start-up ecosystem: funding, talent, innovation, policies and regulations, and the market environment. SUPER reflects Malaysia’s recognition of startups as drivers of economic transformation. Key factors in its design include addressing the unique challenges faced by deep tech startups, such as high R&D costs and longer development cycles. The roadmap also emphasizes fostering an entrepreneurial culture, building global partnerships, and ensuring inclusivity within the ecosystem. To maximize its impact, SUPER could focus more on bridging regional disparities, expanding international collaboration, and continuously adapting to emerging technologies and market demands. Enhancing global partnerships, addressing talent shortages, and fostering a culture of innovation are critical for maximizing SUPER’s impact.

- Information source: government website for SUPER[86]

Review of Myanmar's Policy: 'Startup Challengers Program'

- Policy brief and/or major goal(s): This program helps promising tech ventures grow and accelerate. It aims to create and promote an environment for tech startups to thrive. The government plans to offer over $50 million in seed funding for startups across various sectors.
- Policy targets or scope: It targets innovative startups in various sectors and technology, including agritech, fintech, and e-commerce.
- Financial budgets/investments for the policy design and implementation: $50 million in seed funding
- Means for support and/or related detailed information: (1) seed funding for tech startups, (2) 7-year tax exemption on the startup's income and reduced import duties on essential equipment and machinery; (3) setting up incubation centres and co-working spaces in major cities to support entrepreneurs; (4) offering startups affordable office spaces, mentorship programs, and access to a network of investors and industry experts
- Policy performance: (1) The program has supported tech startups: e.g., Tez Tun (a digital payments platform that scored $1.2 million in seed funding from the Myanmar Startup Challengers program) and Ricult (an agritech startup that uses AI and IoT to boost crop yields, recently awarded a $500,000 grant from the Myanmar Startup Challenge Fund)[87]. (2) The Yangon Innovation Center (YIC), supported by the program, has hosted over 200 startups since its launch in 2019.[88]
- Other considerations: The ecosystem for tech startups has grown slowly but steadily in Myanmar. The government has made related policy initiatives and laws, such as the Myanmar Digital Economy Roadmap (MDER)[89], SME Development Policy,[90] Myanmar

[86] https://www.mosti.gov.my/wp-content/uploads/repository/penerbitan/2021/(SUPER)%20Malaysia%20Startup%20Ecosystem%20Roadmap%202021-2030.pdf

[87] RBF Mynamar is the 'Challenge Fund' to promote responsible business practices of Micro, Small and Medium Enterprises (MSMEs) in Myanmar. The main objective of RBF Myanmar is to "increase the competitiveness and responsible behavior of Myanmar enterprises" by providing partial grants to MSMEs for the implementation of projects with a potential to demonstrate 'Responsible Technologies/Business Practices'. RBF was established in August 2017 and has disbursed MMK 20.87 Billion. The Fund focuses on helping MSMEs demonstrate the 'business case' to invest in 7 responsible areas, such as Energy Efficiency, Water Efficiency, Waste Treatment & Recycling, Occupational Safety & Health, Food Safety, Managerial and Supervisory Skills, and Practical and Technical Skills. For further details, refer to https://rbfmyanmar.com/.

[88] The YIC was officially launched in July 2019 in the presence of several Union and Regional level government officials. It is an initiative by the Yangon Region Government to support the growth of the local startup and innovation ecosystem. For further details, refer to https://newsviews.thuraswiss.com/yangon-innovation-center-opened-state/.

[89] The MDER is a comprehensive strategic plan aimed at accelerating the growth of the digital economy in Myanmar. It emphasizes the development of digital infrastructure, innovation hubs, and skills training programs to support startups, including those in the deep tech sector. The roadmap encourages the integration of emerging technologies such as AI, blockchain, and IoT into various industries, creating an enabling environment for deep tech startups.

[90] While this policy is primarily focused on small and medium-sized enterprises (SMEs), it includes provisions to support tech-driven startups. The policy encourages innovation, access to finance, and market development for deep tech

Science and Technology Development Law)[91], and Technology Transfer and Innovation Promotion Act.[92] However, tech startups, including deep tech startups, still face a range of barriers in Myanmar: for example, limited access to advanced technology and infrastructure; inadequate funding and investment opportunities (e.g. limited interest from local and global investors because of a lack of proven investor returns); a limited pool of skilled workers (a lack of experienced founders and talent for tech-startups); regulatory uncertainty; insufficient intellectual property (IP) protection, challenges in market access; high cost of importing technology and equipment; fragmented ecosystem; cultural and mindset barriers; political and economic instability. In response to these barriers, the government has provided diverse supportive subsidies to tech-startups or tech-based SMEs (e.g. SME Development Fund, export promotion subsidies, training and skill development subsidies, technology transfer subsidies, etc.) but such support does not yet focus on deep tech startups significantly.

- Information sources: news articles;[93] information provided by the SC; public information on the SME Development Policy[94] and the Challenge Fund[95]

Review of Philippines' Policy: 'Innovative Startup Act'

- Policy brief and/or major goal(s): This law defines the base of national policy to promote the creation and growth of technology-based startups (tech startups).[96] It was enacted in 2019 to bolster economic growth and sustainable development by fostering startups based on technological innovation. The ISA focuses on programs and incentives to support the development of startups and startup enablers (including incubators, accelerators, and other supportive entities).
- Policy targets or scope: It targets innovative startups in various sectors and technology fields including manufacturing, agriculture, education, health, etc. (and their technology fields)[97]

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startups, recognizing their potential to drive economic growth and technological advancement in Myanmar.

[91] This law governs the development and regulation of science and technology in Myanmar. It provides a legal framework that supports research and development activities, with an emphasis on promoting innovation in high-tech and deep tech sectors. The law encourages collaboration between public and private entities to advance technological innovation.

[92] As of 2023, this act is in the proposal stage. It aims to facilitate the transfer of technology and promote innovation across various sectors, including deep tech. The act will provide guidelines for intellectual property rights, collaboration between research institutions and industry, and the commercialization of innovations.

[93] https://www.nucamp.co/blog/coding-bootcamp-myanmar-mmr-inside-myanmars-thriving-tech-hub-startups-and-success-stories
https://www.asiabiztoday.com/2024/02/20/myanmars-startup-ecosystem-the-last-frontier-in-asia-has-opportunities-everywhere/

[94] https://myanmar.gov.mm/documents/20143/8126610/sme+policy.pdf/9de1161b-e3b6-c246-6779-a1de27dd27de?t=1537510456463

[95] https://rbfmyanmar.com/

[96] Another landmark law is the Philippine Innovation Act (PIA). Two laws are related to each other. In this section, we focus on the review of ISA.

[97] The Philippines' National Innovation Council (NIC) identified 10 priority innovation areas in the 10-year National Agenda and Strategy Document (NIASD) under the PIA. The areas cover learning and education, health and well-being, food and

- Period for the policy support: 2019-present
- Organization for policy design and implementation: The steering committee for the ISA and related public programs is composed of the Department of Trade and Industry (DTI), the Department of Science (DOST), and the Department of Information and Communications Technology (DICT). The committee leads the implementation of the ISA.
- Means for support and/or related detailed information: (1) The ISA created the Philippine Startup Development Program (PSDP), which is a collection of programs, benefits (e.g. grants, subsidies, funding opportunities), and incentives. Under the program (PSDP), qualified startups and startup enablers can receive subsidies for the cost of registration and permit application, as well as for the use of facilities, office space, and equipment from government or private institutions. Moreover, startups are provided non-financial support, such as mentorship, IPR, participation in local and international startup events, mentorship, and network building. (2) The ISA also created the Startup Venture Fund (SVF), which matches investments made by selected investors in Philippine startups. The SVF is managed by the National Development Company (NDC), a state-owned company supervised by DTI. In 2021, the NDC allocated 250 million Philippine pesos (PHP) to the SVF for startups in the seed to Series B stage. (3) The ISA also provides for the establishment of Philippine startup ecozones where incentives are offered to startups.
- Other considerations: In addition to the ISA's Philippine Startup Development Program and consistent with the ISA, the DTI, DOST, and DIST have maintained their enabling policies to support tech startups. For example, Under DTI, the Competitiveness Innovation Group leads the implementation of the Inclusive Innovation Industrial Strategy, which aims to develop globally competitive and innovative industries, including small and medium-sized enterprises and startups. DTI has offered a number of programs for startups, including incubation and acceleration (IDEA and ADVANCE), internationalization (GAP and iLEAP) and creation of linkages (SMART Link), and funding (SVF) since 2020.[98] Along with the ISA, the Philippine Innovation Act (ISA) has also provided a range of support to tech startups.[99]
- Information sources: the related government (DTI) websites for ISA and PSDP;[100] a public

agribusiness, finance, trade, transportation and logistics, public administration, security and defense, energy, and blue economy and water.

[98] Incubation Development and Entrepreneurial Assistance (IDEA, since 2022); Accelerating Development Valuation and Corporate Entrepreneurship (ADVANCE, since 2022); Global Acceleration Program (GAP, since 2022), Strategic MSMLE and Startup Link (SMART Link, since 2020); Startup Venture Fund (SVF, since 2021).

[99] For example, the PIA provides for the establishment of an Innovation Fund to award grants to enterprises that create solutions with socioeconomic or environmental benefits in the 10 priority sectors. This fund will be used to support government agencies' programs in micro, small, and medium-sized enterprises (MSME innovation, regional innovation, strategic research and development (R&D), the establishment of innovation centers and business incubators, and other related activities. In addition, the PIA mandates a credit quota to promote lending to the startup. sector. Under the PIA, banking institutions are required to allocate at least 4% of their total loanable funds to innovation development.

[100] ISA: https://ecommerce.dti.gov.ph/wp-content/uploads/2020/11/IRR-of-RA-11337-Innovative-Startup-Act.pdf
PSDP: https://startup.gov.ph/history/

report including information on the ISA[101]

Review of Singapore's Policy: 'Startup Singapore (SG) Programs'

- Policy brief and/or major goal: Startup SG, established in 2017, was created to support Singapore's vibrant startup ecosystem both locally and overseas. Several initiatives for funding technology-based startups (tech startups) have been consolidated under the Startup SG umbrella administered by Enterprise Singapore (ESG). Specifically, two programs, "Startup SG Tech" and "Startup SG Equity" are directly related to support for deep tech startups. Startup SG Tech accelerates the development of proprietary technology solutions, and catalyses the growth of startups based on proprietary technology, while Startup SG Equity provides co-investment opportunities supported by a government investment fund, which catalyses private funding into early-stage deep tech startups by sharing the risk with private investors.[102] Thus, the Startup SG and its programs take an ecosystem approach, utilising collaboration or innovation hubs for tech startups.
- Policy targets or scope: Startup SG Tech focuses on startups based on proprietary technology. Proprietary Technology refers to a combination of processes, tools, or systems of interrelated connections, which may be derived from Research Institutes, Institutes of Higher Learning or Public Health Institutes.[103] Startup SG Equity targets both general and deep tech startups (but the investment cap of each startup is greater for deep tech startups). Two programs support innovative, Singapore-based technology startups characterized by having or proving bases of technology/knowledge commercialization (e.g., intellectual property) and scale-up potential (e.g., global market potential, attractiveness for private investors).
- Organizations and financial budgets/investments for policy design and implementation: (a) Startup SG Tech - SGInnovate which is an organization owned by the Singapore government.[104] (b) Startup SG Equity - SEEDS Capital, which is the investment arm of ESG, and SGInnovate, which manages co-investment modality
- Criteria to select policy targets: (a) Eligibility for Startup SG Tech – (i) Applicants should be

[101] Teves *et al*. (2022), The Philippines' *Ecosystem for Technology Startups*, Asian Development Bank (ADB) Report (https://www.adb.org/sites/default/files/publication/884641/philippines-ecosystem-technology-startups.pdf)

[102] Early-stage funding and risk-sharing are crucial for deep tech startups due to the high development cost of complex technologies and the longer time to market. For details on Startup SG Tech and Startup SG Equity, refer to the following: https://www.enterprisesg.gov.sg/grow-your-business/partner-with-singapore/innovation-and-startups/join-startup-sg

[103] Examples of proprietary technology: A robotics startup has developed a custom end effector with a visual programming system that allows it to handle delicate objects. While the robotic arm required in the prototype may be considered as an off-the-shelf component, the software portion of custom end effector with the visual programming system can be considered proprietary technology.

[104] SG Innovative supports the commercialization of emerging technologies and their application to solve some of world's most challenging problems. It also has its own diverse funding and accelerating programs and services (e.g. ecosystem hub and community services, job and talent services, etc.) to support deep tech startups.

startup companies[105]; (ii) Projects must be Proof-Of-Concept (POC) projects or Proof-Of-Value (POV) projects. POC projects are those at the conceptualisation stage, and the technical/scientific viability still needs to be proven. A POV project is one for which the company has a technically/scientifically viable concept (POC available), and it wishes to carry out further development of a working prototype, in order to validate the commercial merit of an established concept. (iii) Projects should fall under one of the following nine areas: Advanced Manufacturing or Robotics; Biomedical Sciences and Healthcare; Clean Technology; Information & Communications Technologies; New Industries; Precision Engineering; Transportation Engineering or Service; Food Science and Technology; AgriTech. (b) Eligibility for "startups" which develop or process "innovation"[106] under Startup SG Equity – (i) a Singapore-based company with core activities carried out within Singapore; (ii) a private limited company which has operated for less than 10 years, except in cases of subsidiary or joint ventures; (iii) the company has paid-up capital of at least 50,000 Singapore dollars (SGD). Startup SG Equity has differentiated between general tech and deep tech startups. General traits exhibited by deep tech startups include: (i) products are built around differentiated, and often protected technological or scientific advances; (ii) high barriers to entry; (iii) long commercialisation periods (typically more than 3 years).[107]

- Means for support and/or related detailed information: (a) The Startup SG Tech grant fast-tracks the development of proprietary technology solutions and catalyses the growth of startups based on proprietary technology and scalable business models. Startup SG Tech is a competitive grant that supports Proof-of-Concept (POC) and Proof-of-Value (POV) projects for the commercialization of innovative technologies. Companies may apply for POC or POV grants depending on the stage of development of the technology/concept. In addition, Startup SG Tech has been revised to provide successful applicants with greater ease of cashflow. (b) The Startup SG Equity scheme stimulates private sector investments into innovative, Singapore-based technology startups with viable intellectual properties and global market potential. As part of the Startup SG Equity scheme, the government will: (i) co-invest with independent, qualified third-party investors into eligible startups; and (ii) Invest in selected venture capital firms that will in turn invest into eligible startups, through a fund-of-funds approach. Startup SG Equity supports up to S$8 million for each deep tech startup (four times S$2 million for each general tech startup). Co-investment ratios (SEEDS Capital: co-investor) for deep tech

[105] Registered in Singapore within the past 10 years at time of grant application; At least 30% local shareholdings; Company is not a subsidiary of a corporate entity at point of incorporation; Company's group annual sales turnover is not more than $100 million or group employment size is not more than 200 workers; and Core R&D activities to be carried out in Singapore; Main applicant should be undertaking a significant role in the company. (i.e. should not be a mere shareholder.) Refer to https://www.startupsg.gov.sg/programmes/4897/startup-sg-tech/eligibility.

[106] Innovation refers to any one of the following: (i) Develops, produces or commercializes tech products, services or platforms; OR (ii) Holds a patent registered with an approved national IP institution; OR (iii) Has an ongoing research collaboration with a research institution.

[107] https://www.startupsg.gov.sg/programmes/4895/startup-sg-equity

startups are 2:1 up to the first S$1 million (for the 1st institutional round of financing, otherwise they are 1:1) from SEEDS Capital; 1:1 thereafter, up to S$4 million; 1:2 thereafter, up to S$8 million; 1:3 thereafter, up to S$12 million.[108]

- Policy performance: Two programs have contributed to making vibrant and dynamic ecosystems for tech startups. It is known that the ecosystem covers approximately 36,000 or more startups. Many of these tech startups most of which have formed strong research-innovation-enterprise (RIE) partnerships to build deep technology capabilities and access a skilled workforce and international networks of partners and markets.
- Other considerations: These SG programs are associated with the national R&D strategy such as the Research, Innovation and Enterprise (RIE) Plan which has been ongoing for five-year intervals since 2011 (i.e., RIE Plans 2015, 2020 and 2025). In addition to key implementing actors (Enterprise Singapore, SGInnovate, and SEEDS Capital), diverse stakeholders, such as investors (e.g., Temasek), universities (e.g., NUS, NTU, etc.), and government agencies (e.g., A*STAR) are engaged in these programs and in the ecosystem for deep tech startups. [109]
- Information sources: Startup SG Tech- https://www.startupsg.gov.sg/programmes/4897/startup-sg-tech; Startup SG Equity - https://www.startupsg.gov.sg/programmes/4895/startup-sg-equity; SGInnovate - https://www.sginnovate.com; RIE 2025 Plan - https://file.go.gov.sg/rie-2025-handbook.pdf; Report on Singapore's ecosystem for tech startups[110]; information from SC

Review of Thailand's Policy: 'The National Higher Education, Science, Research and Innovation Policy'

- Policy brief and background: Thailand announced a policy to promote and support Startup Thailand in 2016. Startups have been called "New Economic Warriors" in Thailand. The goal is to show Thailand's position and commitment to becoming a science-based economy by supporting technology and innovation, and inspiring the next generation of technology business entrepreneurs who have the potential to expand their business and create new markets (Scalable) and who can grow exponentially (High growth). Thailand's policies for deep tech startups aim to bolster the nation's position as a science-based economy by promoting technological innovation and supporting the next generation of entrepreneurs. The policies cover financial and infrastructural support, ethical innovation,

[108] Startup SG Equity provides more intensive and greater investment support for deep tech startups compared to general tech startups. For example, the investment cap for each startup is increased up to four times for deep tech startups. The co-investment ratio is wefurther specified to promote early-stage risk-sharing and investment for deep tech startups, compared to general tech startups, according to the financing round and fundraising amount. For details, refer to the following:
https://www.startupsg.gov.sg/programmes/4895/startup-sg-equity.

[109] https://news.nus.edu.sg/temasek-nus-and-ntu-to-invest-s75-million-to-support-deep tech-ventures/

[110] Pangarkar, N. and Vandenberg, P. (2022), *Singapore's Ecosystem for Technology Startups and Lessons for Its Neighbors*, Asian Development Bank (ADB) Report: https://www.adb.org/sites/default/files/publication/804956/singapore-ecosystem-technology-startups.pdf

and the transition to a knowledge-driven economy, ensuring global competitiveness.

- Policy goals and key pillars: The policy has qualitative goals: (i) ecosystem development: create a robust ecosystem that supports deep tech startups through collaboration between academia, industry, and government; (ii) sustainability: promote sustainable practices within deep tech startups to address environmental and social challenges; (iii) global competitiveness: enhance the global competitiveness of deep tech startups by fostering advanced research and development. The policy also has quantitative goals: (i) increase funding: allocate funding to deep tech startups, aiming for $USD500 million by 2027; (ii) the number of startups: establish 100 new deep tech startups within the policy period; (iii) patents and innovations: secure 200 new patents from deep tech startups to foster innovation.

  The policy goals can be specified in the original document as follows: (a) support deep tech startups: outline the financial and infrastructural support mechanisms; (b) secure financial Future: Discuss long-term financial stability plans; (c) knowledge-driven economy: detail efforts to transition to a knowledge-centric economy; (d) enhance productivity: highlight productivity-boosting technological advancements; (e) global competitiveness: develop strategies to strengthen global competitiveness.

  The policy's key pillars are economic security (measures to secure economic future through deep tech innovations), knowledge economy transition (facilitating a transition to a knowledge-driven economy), national capability and sovereignty (enhancing national capabilities), and ethical Innovation (promoting ethical innovation practices).
- Policy targets or scope: The policy targets research and development (strengthening R&D), intellectual property (enhancing IP regimes), funding access (facilitating access to funding), infrastructure access (enabling necessary infrastructure), regulations and standards (creating conducive regulations), human resource attraction (building capacity in human resources), procurement and adoption (promoting procurement and adoption of innovations), and policy Interlinkages (enhancing interlinkages between policies and programs). Regarding the policy scope, deep tech startups in Thailand are businesses that leverage advanced science and technology to develop innovative products and services, emphasizing significant scientific research and technological advancement.
- Period for the policy support: 2023-2027 (five years). The policy period is divided into two phases: Phase I (2023-2025) to focus on supporting pandemic recovery and Phase II (2026-2027) to emphasize sustainability.
- Organizations and financial budgets/investments for the policy design and implementation: The Ministry of Higher Education, Science, Research and Innovation (MHESI) is a primary body overseeing policy implementation. The financial budgets are 1,300 million USD (500 million in 2025, 400 million in 2026, and 400 million USD in 2027). Key implementing actors are the National Science and Technology Development Agency (NSTDA) to support R&D activities, the National Innovation Agency (NIA) to promote and support innovation in SMEs and Startups, the National Research Council of Thailand (NRCT) to support research in various scientific fields, and the Digital Economy Promotion

Agency (DEPA) to promotes and supports the digital economy and digital startup.

- Criteria to select policy targets: (a) Innovation and Technology – the targeted startups must utilize advanced science and technology, often requiring significant R&D. (b) Business Model – the startups should address market needs and have a clear customer base. (c) Scalability – the startups must have the potential to scale and grow, ready for investments or joint ventures. (d) Sustainability: the startup should promote sustainable practices and contribute to environmental and social well-being.
- Means for support and/or related detailed information: This policy has a diverse range of supports as follows. (a) Programs and Grants - Innovation List Programme (to promote local innovative products by ensuring high standards and priority in government procurement and Research Gap Fund Programme: (to address gaps in existing research by funding under-explored areas); (b) Grants - Government Grants (supporting R&D, prototype development, and critical activities) and Private Grants (providing additional funding support); (c) Tax Incentives, such as Tax Credits (for investing in R&D) and Tax Deductions: For expenses related to R&D; (d) Investor Matching for Venture Capitals (to provide funding and support in exchange for equity) and Angel Investors (individuals providing capital for equity); (e) Workplaces Support, including co-working spaces for (collaborative environments), incubators and accelerators (providing resources, mentorship, and funding), and Research labs (e.g. Facilities for R&D), and Technology Parks (i.e. areas fostering innovation and entrepreneurship)
- Policy performance: The policy has achieved performance in several aspects. It has increased funding in that federal support increased from 39.1 billion USD in the financial year (FY) 2020 to 43.2 billion USD in FY 2021. It has Enhanced R&D in terms of significant investments in use-inspired basic research. It has improved education quality by making progress toward education quality on par with developed countries. Finally, it has contributed to economic growth by fostering an innovation ecosystem and creating jobs.
- Other considerations: Key factors for the policy design are stakeholder engagement (involving diverse groups for well-rounded policies), funding and resources (securing adequate funding), alignment with National Goals (supporting broader national objectives), inclusivity (promoting diversity to foster innovation), infrastructure (to invest in modern facilities and technology). Successful outcomes for this Thailand Policy 2020-2027 will focus on manpower, research, and competitiveness.
- Information sources: https://www.nxpo.or.th/th/en/

Review of Viet Nam's Policy: 'Central Government's 844 Program (Program on Supporting the National Innovation Initiative)'

- Policy brief and/or major goal: On May 18th, 2016, the Prime Minister of Viet Nam signed Decision No. 844 approving the 'Program on Supporting the National Innovation Initiative' to 2025, in short the 844 Program. The program has four goals as follows: (i) creating a favourable environment for the creation and growth of startups; (ii) establishing and

improving the legal framework for supporting startups; (iii) creating a National Startup Portal; and (iv) supporting 800 entrepreneurship projects and 200 startups, of which 50 projects and startups raise at least USD 80 million through investment and acquisition.

- Policy targets or scope: The 844 Program supports startups and entrepreneurship support organizations (ESOs). The Program defines a startup as "an innovative company that is less than 5-years-old since the date of business registration, and has high-growth potential based on intellectual property, or new technology, or new business model."[111] ESOs include, but are not limited to, incubators, accelerators, networks of mentors, angel investor groups, VCs, and university-based innovation centres.
- Period for the policy support: 2016 to 2025 (10 years)
- Organizations and financial budgets/investments for the policy design and implementation: MOST's National Agency for Technology and Entrepreneurship Commercialization (NATEC) is the technical implementing agency of the 844 Program. The Government of Viet Nam provides the Ministry of Science and Technology with an implementation budget of 80 million USD.
- Criteria to select policy targets: Annually, NATEC consults with ecosystem players and experts to prioritize issues and problems the national ecosystem should address. NATEC then releases requests for proposals to all eligible organizations that are capable of solving the problems or implementing startup support programs. Shortlisted applicants present their technical proposals to a panel consisting of MOST officials and ecosystem development experts. If the technical proposals are approved, then the applicants will submit financial proposals to MOST. MOST often provides grants covering half of implementation expenses. The average grant is approximately USD 50,000 for an assignment or program executed within 12 months.
- Means for support and/or related detailed information: The 844 Program provides financial grants to ESOs. Startup entrepreneurs – as well as mentors and angel investors – can benefit indirectly from the 844 Program by attending training courses, capacity-building workshops, entrepreneurship events (such as hackathons, startup weekends, and pitch days), incubation programs, acceleration programs, mentorship programs, investment-readiness programs, and commercialization programs.
- Policy performance: By the end of 2023, the 844 Program has made the following achievements: (i) introduced entrepreneurship and innovation support into various national regulations - i.e., 939 Program by the Viet Nam Women's Union and 1665 Program by the Ministry of Training and Education - and helped 60 of 63 municipal governments develop municipal plans for supporting entrepreneurship and developments; (ii) coordinated with other ministries, particularly the Ministry of Planning and Investment and the Ministry of Finance, to issue regulations on supporting startups, such as Decree 38 (issued 2018 on investing in innovative SMEs), Decree 39 (issued 2019 on SME Development Fund), and Decree 94 (issued 2020 with incentives for domestic

[111] ASEAN-ROS Startup Ecosystem Study Report, 2021

organizations and individual foreigners working at the National Innovation Center); (iii) A national startup portal has been test-running at http://startup.gov.vn/; (iv) The number of startups that indirectly benefited from the 844 Program is not available.

- Other considerations: The indirect and holistic approach to developing the entrepreneurial ecosystem of innovation makes the 844 Program effective, efficient, and sustainable. However, there is a need to develop monitoring and evaluation systems to improve the transparency and efficiency of the 844 Program.

  The lack of quantitative indicators in the definition of deep tech startups prevents government agencies from offering the startup community direct financial and technical support. In addition, municipal governments and implementation agencies often confuse startups with small-and-growing businesses and conventional small-and-medium enterprises. Since innovation is considered the engine of economic growth, the extension of the 844 Program - proposed to the Prime Minister's Office - is expected to be more focused on technology-based innovation-driven startups, even deep tech startups.

  Lessons learned from the 10-year implementation and evolution of the 844 Program should be acknowledged. In the first years, a steering committee, which is a combination of government officials, influential ecosystem players, and ecosystem experts, defines priorities and activities for the next 12 months. The steering committee then establishes task forces for different components of the ecosystem - i.e., incubators & accelerators, investors, mentors, communication and networking events, and legal framework - to develop an annual agenda for each component. The agendas also result from dialogues between the task forces and ecosystem players.
- Information sources: Information is collected from the information portal of the 844 Program (https://en.dean844.most.gov.vn/)[112] and the steering committee's progress reports.

3.3. Closing Remarks

We have found and outlined differences and similarities in major policies supporting deep tech startups in the APT countries.

Regarding the differences, some countries, such as Singapore, Korea and Japan, have targeted policies and related programs (or initiatives) to support deep tech startups, which are different from those that pertain to general technology-based startups (tech startups). For such policies, these countries commonly specify the concept of deep tech startups (or related policy targets) and also prioritize several (around six to ten) technology areas which are important in terms of the nation's leading and future industries, innovation advantages,

[112] Additional information about the 844 Program is available at Pham, T. T. and Hampel-Milagrosa (2022), *Viet Nam's Ecosystem for Technology Startups*, Asian Development Bank (ADB) Report. https://www.adb.org/sites/default/files/publication/807121/viet-nam-ecosystem-technology-startups.pdf

and sustainable development with social impacts. For example, Japan's policy for deep tech startups targets specialized extension in green transformation (GX) fields beyond the deep tech fields. In China's policy, these technology areas are related to future industries regarding Industry 4.0 or the national economic development's goal. Moreover, programs for deep tech startups in Singapore, Korea and Japan are commonly designed to specifically target the startups being at the stage of Proof-Of-Concept (POC) or the stage of Proof-Of-Value (POV), and thus include phase-approach (i.e., providing differentiated support or flexible subsidies according to the phase), and to promote co-investment by both public organizations (i.e. government and on-behalf agencies) and private entities (i.e. firms, private investors) for risk-sharing. On the contrary, although many other APT countries also identified key areas (e.g., Agritech, Greentech, Edtech, Healthtech, Fintech, etc.) for tech startups, they have not designed unique policy means or specialized support suitable for deep tech startups. Compared to the leading countries (Singapore, Korea and Japan), several APT countries lack appropriate policy design and implementation.

It is also notable that the policies for deep tech startups in the four countries (Singapore, Korea, Japan, and China) are adapted from existing policies of tech startups, according to the features of deep tech startups (e.g., further impact, increased time and scale, investment, related to sustainability, risks for both market and technology, and difficulty/complexity of deep tech commercialization).[113] Furthermore, it is found that the deep tech startup policies are directly related to either the national industry plan or science and technology (S&T) strategy, and to nation-level investment in R&D or higher education as the basis of deep technologies. For example, the four countries' prioritized areas for support of deep tech startups are based on national plans or strategies. These countries' policies for deep tech startups also stress the importance of the development and enhancement of entrepreneurial ecosystem for the startups (i.e., a combination of technology/industry ecosystem and startup ecosystem; the role of deep tech startups in the deep tech ecosystem).[114] Finally, the importance of STEM talent and human resource development are identified in the deep tech policies. In summary, all these features show that not only do these countries (and their policymakers) with better-designed and implemented policies understand the concept and challenges of deep tech startups, but also that the countries have paid attention to bolstering the entrepreneurial ecosystem for deep tech startups persistently, and in turn have established a more advanced ecosystem than other APT

[113] For example, the programs for deep tech startups in Korea, Japan and Singapore commonly have a higher investment gap (approximately three or four times compared to general startup supports), an extended program period (up to three or four years for each phase), and a higher maximum for the age of the firms (up to ten years). The four countries' policies also consider a big impact (global scale-up beyond the domestic market) or grand challenges (contribution to solving economic and social issues) in the eligible project or startup-target selection.

[114] Policies and programs supporting deep tech startups in Singapore, Korea and Japan have increased the period and total amount of support and related investment for each startup to complement private investors' under-investment in deep tech startups and promote their long-term investment in the ecosystem. The policies and program also emphasize a variety of practical collaborations with the startups and ecosystem stakeholders in terms of co-investment, prototype tests, functional collaborations (e.g., R&D/design-manufacturing-marketing), and related market (or demand) expansion.

countries.

Regarding the similarities of policies in the APT region, in addition to the three countries (Japan, Korea, and Singapore), several countries have (a) indirectly supported deep tech startups based on national AI, Innovation, or R&D strategies (including STEM talent policy); (b) recognized the importance of such ecosystems; (c) executed programs suitable for their own SDGs. Examples of (a) are: Indonesia's AI National Strategy; Thailand's National Higher Education, Science, Research and Innovation Policy; Brunei Darussalam's Digital Economy Masterplan 2025; China's Promoting the Innovation and Development of Future Industries. Examples of (b) include: Malaysia's Startup Ecosystem Roadmap; Philippines' Innovative Startup Act; China's Promoting the Innovation and Development of Future Industries; Laos (Lao PDR)'s Policy on Creating Business Environment for Deep Tech Startups Establishment and Operation; Viet Nam's 844 Program. Examples of (c) are: Cambodia's Techo Start-up Center (Digital Platform and Reverse Innovation Programs); Myanmar's Startup Challengers Program.

In conclusion, the policies and entrepreneurial ecosystems for deep tech startups tend to be developed in parallel. Deep tech startups can neither be born nor achieve scale-up in a vacuum. They are part of, and operate and evolve in, the related ecosystem. They also develop as a result of bolstering entrepreneurship for deep tech startups. Designing and implementing policies for deep tech startups is certainly challenging in practice, but offers many benefits in the long run from the ecosystem perspective.

4. Analysis of Cases of Deep Tech Startups

4.1. Selection Criteria and Basic Information of the Startup Case

One or two representative cases of deep tech startups were selected for each of the ASEAN+3 (APT) countries. The study group (SG) members screened the startup cases by searching for appropriate startups operating alone or with support from the steering committee (SC). The startups were selected if they fulfilled both 'startup' and 'deep tech' criteria.

Startup criteria: the case companies were selected based on the following conditions.

- Age: 4 to 10 years old (The age criteria for startups can differ across the APT countries. This report sets this age condition by considering data availability – i.e., the possibility of limited data for early-stage startups.)
- Size: small and medium-sized enterprises (SMEs) except for large firms' subsidiaries (The SME criteria can differ across the countries.)
- Evidence or potential of high-growth and scale-up: (a) achieved positive sales for the last two years (preferably more than 15% of growth rates in total sales or employment for the last 3 years); (b) have a minimum viable product (MVP) or prototype versions of products or services (except for nascent or very early startups in the stages of seed and early development); (c) arrived at a fundraising stage of Series A up to D (track records are required for data collection) – the preferable condition is defined as either accumulated total funding amount of approximately 1 million US dollars (USD) or 3 million USD in market valuation.

Deep tech criteria: the case companies were selected based on the following components.

- 'Tech' component: (a) based on one emerging or advanced technology AND showing strong technological competence (e.g., core patents, technological superiority over competitors); (b) based on emerging or advanced technologies and their convergence/integration for practical business or consumer applications AND having a moderate technological competence - examples of convergence/integration: e.g., AI + semiconductor development; big data + agriculture tech; AI/big data + bio/healthcare; fintech development; energy/environment + another tech (e.g. advanced IT, materials, electric technologies, etc.); robotics + environment/logistics; etc.
- 'Impact' or 'SDG' component: tackling challenges regarding social, environmental, or business problems or related to sustainable development in each APT country (SDGs and related issues can differ across the countries, depending upon the country and industry context.)
- 'Novelty' component: novelty or disruptive features in the business or market approach (e.g., business model), problem-solving, or applications of technologies in the business or

market.

- 'Investment' component: requiring time and scale investment for the creation and growth of deep tech startups: (e.g.) investment in human capital, long period of prototype, startup funding, research and development (R&D).
- 'Ecosystem' component: the creation and growth based on the technology-related and market (industry)-related ecosystem; capitalizing on factors related to the entrepreneurial ecosystem (EE) including startups and complementary partners

Few appropriate cases of deep tech startups which fulfilled all five deep tech criteria were found in certain APT countries. In such cases, the startup cases were selected if the first two conditions ('Tech' & 'Impact') and one additional condition could be fulfilled at minimum. Meanwhile, some countries have a diverse range of deep tech startups. In these cases, startup cases were selected considering the country's major industries or technological fields with competitive advantages.

For the study of startup cases, the SG received the recommendation from the SC or searched for appropriate startup cases, if necessary, by drawing on the SG members' knowledge and expertise. The SG could (i) choose two startup cases recommended by the SC or (ii) choose one from the recommended cases and select another appropriate startup according to the above-mentioned selection criteria.

The following information for each startup will be collected and reviewed in the next section of this chapter:

- Basic profile: country; establishment year; founder(s), size in terms of total sales and/or employment; current stage (e.g., market entry, early growth, expansion or scale-up, going-to-the public (IPO) or M&A, etc.); major customers and business segments; the company's website.
- Underlying technologies and business model: novelty, requiring investment and market/technology tests.
- The company's ultimate goals and impacts: market or social aspects.
- Starting points: e.g., pain points or key value propositions to be resolved in the establishment stage; the firm's or founder's background organizations (e.g., university, public lab, large company, etc.)
- Growth path: how this company has grown since its establishment
- Recent performance for fast-growth or scale-up: (a) market performance – total sales, sales growth or employment growth for the last three years, or any evidence of scale-up (e.g. market expansion; (b) an increase of funding amount or market valuation - the amount of funding and market value at each funding (VC financing) stage; major investors.
- Embeddedness in the ecosystem for deep tech startups: e.g., collaboration or alliances with the ecosystem partners, factors of the ecosystem which benefit the startup, etc.

- Support from government policies, public programs or national infrastructure.
- Internationalization: offices in other countries, export volume, R&D collaboration with third parties located in another countries, etc.
- Other considerations: e.g., current challenges and/or barriers as deep tech startups; why this company can be regarded as the deep tech startup in the country; other notable things in the startup case.
- Information sources: cited or relevant information sources. At least one English information source is included for each case (e.g., the company's English website or news articles written in English).

For data collection and information gathering, the SG utilized diverse information sources: e.g., information received from the SC and complementation by the SG, information collected by the SG from the company websites, news articles, disclosed data from the startup and VC database (e.g. Pitchbook, Crunchbase, Growjo, etc.) and government websites, information from the startup's founder or CEO, and other public and private sources.

The SG selected one or two cases of deep tech startups in the country. The overview of the startups is presented in Table 4.1.[115]

Table 4.1. Cases of deep tech startups in the APT countries

Company Name	Country	Est. Year	Business or Tech Area	Impact and Market Performance	Major SDG(s)
Nextacloud	**Brunei Darussalam**	2015	Health care (blood donation and MedTech)	Saved more than 100K lives with digital solutions for both hospitals and donors; $ 1.15M funding	Health and Wellbeing (3)
Mindtrex	**Brunei Darussalam**	2019	Education and learning platform	Learning capability and infrastructure improved; 8K+ students in 116 schools; $ 330K funding	Education (4), Reduced Inequalities (10)
Chalatex	**Cambodia**	2021	Agritech (IoT and mobile app platform)	Pioneering agritech innovation for sustainable farming; agriculture digital transformation	Zero Hunger (2), Industry & Innovation (9)
Xurya Daya	**Indonesia**	2018	Solar energy solutions (IoT/AI-based	Reduced CO2 emissions; 179 solar projects and created 1K+ green jobs; $ 88M	Clean Energy (7), Sustainable

[115] The cases of additional deep tech startups (e.g. the third or fifth cases for each country or companies established before 2014) are presented in Appendix B.

			management)	funding	Cities (11)
Nodeflux	**Indonesia**	2016	Vision AI platform (surveillance analytics)	Image and vision data analytics solutions for social challenges; 150+ clients in 60+ cities; $ 12M funding	Industry & Innovation (9)
Wayha Sokxay Technology	**Laos (Lao PDR)**	2020	FinTech (insurance B2B SaaS)	Fraud detection, risk assessment, and the industry's digital transformation	Industry & Innovation (9)
Aerodyne Group	**Malaysia**	2014	Drone and data technology (industry solutions)	Increased productivity by digital transformation in several industries; $ 64.5M sales; $ 86M funding	Industry & Innovation (9), Decent Work (8)
Biogenes Tech	**Malaysia**	2015	Molecular diagnostics and genomics	Accurate and affordable diagnostics; $ 5.7M funding	Health and Wellbeing (3)
Frontiir	**Myanmar**	2014	Internet and data service	Low-cost high-speed internet in rural areas, tackling digital divides; $ 147M funding	Infrastructure (9), Sustainable Cities (11)
Expedock	**Philippines**	2020	AI-based work platform for international shipping	Increased operations efficiency in the global supply chain industry; $ 18.9M funding	Industry & Innovation (9)
Hydroleap	**Singapore**	2016	Wastewater treatment with electric solutions	Treated heavily contaminated water in sustainable and advanced ways; $ 4.4M funding	Clean Water (6); Climate Action (13)
Lumitics	**Singapore**	2017	Food waste management (AI-based waste tracker)	Reduced waste by up to 40%, costs by 8%, and CO2 emission in diverse sectors; $ 2.2M funding	Climate Action (13); Sustainable Cities (11)
Nano Coating Tech	**Thailand**	2022	Nano-tech solutions for solar panels	Enhanced efficiency and sustainability; growth has increased by 3 times in the last two years	Clean Energy (7), Industry & Innovation (9)
NT2P	**Viet Nam**	2020	Diagnostics and disease treatment (AI-based)	Personalized and affordable healthcare services, deployed in 50 hospitals; $ 8M valuation	Health (3), Industry & Innovation (9)
Fuwa	**Viet Nam**	2019	Organic, plant-based cleaning	Resolved waste, pollution, and related health problems;	Water (6); Responsible

			products (Bio Enzyme)	$ 1.5M sales and 20%+ growth for the last 3 years	Production (12)
DEEPX	**Korea (ROK)**	2018	AI semiconductor (on-device chip)	Improved cost efficiency and reduced energy consumption; $ 100M funding	Industry & Innovation (9), Climate Action (13)
Elice	**Korea (ROK)**	2015	Learning, education training platform	Solutions/services tailored to learners and teachers (1.8M users) in diverse sectors; $ 25.6M funding	Education (4), Industry & Innovation (9)
Synspective	**Japan**	2018	SAR satellite data platform	Disaster and risk management and environment monitoring; $ 258M funding	Innovation & Infrastructure (9), Climate Action (13)
QunaSys	**Japan**	2018	Quantum computing (industry applications)	Resolved critical issues in industry domains (e.g. chemical, CAE, finance, etc.); $ 23.7M funding	Industry & Innovation (9)
Horen	**China**	2015	Recyclable plastic packing (intelligent logistics)	Green supply chains and smart solutions for global sustainability; RMB 435M funding	Industry & Innovation (9); Climate Action (13)
Momenta	**China**	2016	Autonomous driving software	Safe, high-performance, and cost-effective for mobility and logistics; $ 1.4B funding	Industry & Innovation (9)

Note: Details on related UN SDG(s) are 1. No Poverty; 2. Zero Hunger; 3. Global Health and Well-Being; 4. Quality Education; 5. Gender Equality; 6. Clean Water and Sanitation; 7. Affordable and Clean Energy; 8. Decent Work and Economic Growth; 9. Industry, Innovation and Infrastructure; 10. Reduced Inequalities; 11. Sustainable Cities and Communities, 12. Responsible Consumption and Production; 13. Climate Action; 14. Life below Water; 15. Life on Land; 16. Peace, Justice and Strong Institution; 17. Partnerships for the Goals.

4.2. Analysis of Deep Tech Startup Cases in Each Country

This section summarizes cases of deep tech startups in each APT country. The startup cases in 'Plus Three' countries (Japan, Korea and China) are presented first, followed by startup cases in ASEAN countries, presented in alphabetical order by country name.

Review of deep tech startup cases in Japan

[A] 'Synspective' case (https://synspective.com/**)**

- Basic profile: Synspective designs, builds, and operates a fleet of Synthetic Aperture Radar (SAR) satellites to detect and understand environmental changes across the globe. Through its technology, the company delivers cloud-based solutions that offer analytics services using data science and machine learning, assisting government agencies and companies worldwide. By processing immense volumes of data and providing remote monitoring services, organizations can gain critical insights into disaster and risk management, environmental monitoring and protection, transportation and logistics, and security and intelligence.
- Underlying technologies and business model: Synspective uses "StriX" SAR satellites to collect real-time data and integrate it with big data sources. Using unique properties of radar, the satellites can monitor ground activity 24/7, regardless of atmospheric conditions. The SAR imagery data collected is then processed and analysed using machine learning to forecast upcoming trends, offering valuable insights and solutions.
- The company's ultimate goals and impacts: The primary mission is to create a more resilient society based on real data, particularly through improving disaster management and response, monitoring Earth's environment and climate change, and supporting sustainable infrastructure development and maintenance.
- Starting points: The core technology of the company originated from a Japanese government-led R&D initiative, ImPACT Program, which aimed to improve information-gathering capabilities for emergency responses. As one of the Program Managers, Professor Seiko Shirakasa of Keio University worked toward integrating SAR satellite research results into publicly-available data. Hence, he quickly moved to establish a company, and was joined by Motoyuki Arai as the CEO six months later in 2018.
- Growth path: Synspective first raised 10.9 billion Yen (JPY) in Series A funding in July 2019. The company's first SAR satellite "StriX-a" was successfully put into its target orbit in December 2020. Afterwards, the company launched more StriX units in the next two years, and was selected for the "J-Startup Impact" support program from the Ministry of Economy, Trade and Industry (METI). By June 2024, the company had raised a total of 28.19 billion Yen in funding, including the most recent grant of 7 billion yen in Series C funding from Mizuho Capital and JAFCO.
- Recent performance for fast-growth or scale-up: (a) Market performance – Synspective's has recently signed a contract to launch 10 Electron rockets between 2025-2027, signifying its expanding operations, and has launched 4 SAR spacecrafts at the time of this report. There is a general trend of increasing employment from 2022 to the present. (b) Funding and valuations – the company has raised 258.07 million USD over 8 rounds, with a Series C funding of 44.26 million USD in June 2024.
- Embeddedness in the ecosystem for deep tech startups: The company's core product, StriX, was developed through collaborative efforts between national agencies, private sectors, and universities—all key actors in the Japanese ecosystem for deep tech startups.

The company has always had deep engagements with the Japanese government, where they are not only often involved as participants in government programs aimed at high-impact ventures, but also as collaborators in projects with national agencies, as well as in government-funded initiatives from METI and JICA. Its partnerships extend to global firms (e.g.: Orbital EOS, Seiren Co., Ltd, Fujitsu Viet Nam, KSAT) to foster innovation and promote the utilization of SAR technology in addressing climate and disaster impacts.

- Support from government policies or public programs: Synspective has received supports from at least two Japanese government programs. The imPACT Program, a Japanese government-led R&D initiative to promote high-risk, high-impact scientific and technological innovation that will bring about major changes in industry and society, helped develop the core technology for the company's small SAR satellites. On the other hand, J-Startup Impact intensively provides support for the company to build momentum and raise awareness through public-private partnerships. Assistance is particularly provided through exhibitions at large-scale events in Japan and abroad, receiving local facilitation overseas, obtaining further opportunities for bidding, and participating in business matching events with private companies.
- Internationalization: In addition to its headquarters in Tokyo, Japan, Synspective has an office in Singapore. With experts and professionals from over 25 countries, the company also serves clients worldwide, including in Southeast Asia, Central Asia, South Asia, East Europe, Australia, and Central America.
- Other considerations: Synspective qualifies as a deep tech startup due to its advanced technologies like SAR imaging and machine learning for data analysis, developed through long-term (6 years from development to the first satellite launch), high-risk R&D efforts, and its focus on creating societal impact by addressing global challenges such as disaster response and environmental monitoring. Additionally, Japan's commitment to advancing disruptive technologies through various programs and significant R&D investment (2nd highest among the APT regions) has benefited the company, providing grants and support.
- Information sources: Company website in English (https://synspective.com/); Official Government Pages on Japan's Startup Policies [116]; Others[117]

[B] 'QunaSys' case (https://qunasys.com**)**

- Basic profile: QunaSys is a company offering software development for quantum computers, and consulting services on quantum technologies. Since its establishment in 2018, the company has offered 3 main services: 1) QURI, a web service that enables users to perform quantum chemical calculation; 2) SDQs, a forum to discuss the impact and

[116] https://www.meti.go.jp/english/press/2023/1006_006.html
https://www.jst.go.jp/impact/en/intro.html
https://www.meti.go.jp/policy/newbusiness/global_promotion.pdf
https://www.nedo.go.jp/english/activities/activities_ZZJP_100250.html
[117] https://spacenews.com/synspective-orders-10-rocket-lab-electron-launches/
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https://pitchbook.com/profiles/company/234150-04#overview

contribution of quantum technology on ESG; and 3) Chemical Research Solution (CRS), tackling challenges in chemical research and development through quantum chemistry calculation, LLMs, and data recording and management platforms.

- Underlying technologies and business model: Qunasys utilizes Quantum Computing to solve critical industry issues in the chemical domain. Specifically, they develop various quantum algorithms and compilers to translate industrial applications into quantum computational operations that can be used in future practical quantum hardware.
- The company's ultimate goals and impacts: QunaSys aims to broaden the use of quantum computers in society by conducting research and developing (R&D) software that enables users to easily use those algorithms.
- Starting points: The company was inspired by founder Tennin Yan's encounter with Prof. Keisuke Fujii, a leading expert in quantum computer research at Osaka University. Afterwards, he co-founded the company with Prof. Kosuke Mitarai, a graduate student at that time, who later served as the company's technical advisor.
- Growth path: Since the company raised capital in 2022 and 2023, it has launched key tools like the QURI Parts library and QURI SDK, while expanding internationally and contributing to major policy initiatives such as Japan's Q-LEAP and SIP programs. A key strategy for expansion lies in the company's effort to establish global partnerships with core players in the quantum computing industry ecosystem, such as universities, high-tech private enterprises, and Japanese national agencies/governments. In November 2024, the company ultimately raised JPY 1.7 billion in Series B2 funding, and secured a 500 million Yen commitment line that will be used to accelerate the business both in Japan and internationally.
- Recent performance for fast-growth or scale-up: (a) Market performance – while there is no data for the company's sales, growth is evident through its consistent employment growth, from 2021 to 2024, and its capability to open a subsidiary abroad. (b) Funding and valuation – total funds raised amounts up to $23.7M over 5 rounds, arriving at Series B2 funding, with investors from Japan-based VCs and PEs (i.e.: Mirai Creation Fund, Mitsubishi Electric, JIC Venture Growth Investments, Global Brain, ANRI, Sumitomo Mitsui Banking Corporation).
- Embeddedness in the ecosystem for deep tech startups: As Quantum Computing technology is still in development, QunaSys is continuously involved in joint R&D efforts with universities and private enterprises. To nurture the network, it launched QPARC, a Japanese consortium to study the applicability of quantum computers. They also helped establish a standard online education system for quantum talent development under the Q-LEAP program from MEXT. The institution's New Promotional Policy for Quantum Science and Technology (Photonics and Quantum Technology) also allows QunaSys to be one of the key focuses for government initiatives supporting startups.
- Support from government policies or public programs: QunaSys was selected to receive support from the Japanese government's programs, such as Q-LEAP and SIP Programs. Q-LEAP is an R&D program to achieve advances in economic and societal goals by taking

advantage of quantum technology. Meanwhile, the Strategic Innovation Promotion Program (SIP) is a national program to realize science and technology innovation through cross-ministerial and cross-disciplinary management. The proposed budget for FY2023 is 28 billion yen for 14 issues to be addressed over 5 years.

- Internationalization: While QunaSys is headquartered in Tokyo, Japan, it recently took a strategic step towards expanding its presence in the European market by opening its first subsidiary in Copenhagen, Denmark. The company has also established partnerships with global institutions in countries such as Taiwan and Canada.
- Other considerations: QunaSys qualifies as a deep tech startup as it employs a particularly advanced technology that is under development, Quantum Computing. Even after more than four decades since quantum computing was first proposed, predictions suggest that at least another 20 years will be required before fault-tolerant quantum computers can be implemented in society. However, at this time, tangible implementation and impacts remain yet to be seen. The ecosystem needs to be built from scratch and a prolonged process of trial and error is inevitable, making the Japanese government's support to the sector particularly pivotal for growth.
- Information Sources: Company website in English (https://qunasys.com/en/); Official Government Pages on Japan's Startup Policies [118]; Others[119]

Review of deep tech startup cases in Korea

[A] 'DEEPX' case (http://deepx.ai**)**

- Basic profile: This company was established in February 2018. It designs AI-specialized semiconductors (on-device AI chips), such as NPUs (Neutral Processing Units), which can fulfill low-power efficiency and high performance for products and services using AI technologies. DEEPX is especially concerned with developing advanced and efficient semiconductors for AI-powered IoT devices. The company's sales are expected to grow fast within the next several years, as the company has completed development and testing of prototype products, and recently signed several contracts for scale-up production, after which these products will be provided to ten global companies. Before establishing the startup, founder-CEO (Lokwon Kim) received a Ph.D. from Stanford University, and worked for global IT companies in the U.S.
- Underlying technologies and business model: This company is one of the top-level companies that design AI semiconductors, and is the first startup which has developed

[118] https://www.jst.go.jp/stpp/q-leap/en/index.html
https://www.jst.go.jp/stpp/q-leap/pdf/q-leap_pamph2024_en.pdf
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[119] https://thequantuminsider.com/2024/11/02/qunasys-expands-quantum-reach-with-partnership-sdk-release-and-11-1m-series-b2-funding-round/
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https://qforum.org/en/committees/quantum-computer
https://pitchbook.com/profiles/company/452818-54#timeline

NPUs in South Korea. Unlike CPUs (Central Processing Units) or GPUs (Graphic Processing Units), NPUs play critical roles in AI-based functions and data processing (e.g. deep learning, IoT related to edge devices). GPUs have been used as alternative products for AI-based data processing, but have revealed lower qualities in energy usage (electric power) and advanced functions. Compared to competitors' products, DEEPX's NPUs have competitive advantages in terms of price (approximately 10%), power efficiency, technology performance (more than 10 times), and customized solutions. The company has more than 200 patents for technological advances.

- The company's ultimate goals and impacts: It seeks to provide 'AI for Everyone and Everywhere' by helping diverse customers (e.g., firms in manufacturing and service sectors, public organizations, etc.) better utilize the benefits of AI technologies and applied services based on the on-device AI chips. Its products and services can contribute to sustainability by using less energy while providing greater technology benefits.
- Starting points: The founder CEO began the startup to resolve the inefficiency and related problems of existing CPUs and GPUs in AI-powered data processing and advanced functions. The founder recognized the existing products' limitations and the importance of effective integration (i.e. optimization) of hardware and software while working for leading global companies, including IBM, Broadcom, and Apple.
- Growth path: This company has arrived at the stage of preparation for scale-up (mass production beyond the stage of prototype test). It developed an initial product via technology commercialisation through persistent investment in R&D for the first three years. DEEPX also improved them via prototype tests applied to diverse end-products (e.g. robots, smart cameras, smart factors, etc.) by collaborating with large companies (e.g. Hyundai-Kia Motors, POSCO DX, LG Uplus, etc.) in Korea for the next several years, and formed a partnership with Samsung Electronics (foundry) for the production of chips since 2022.
- Recent performance for fast-growth or scale-up: (a) Market performance – this company first obtained sales of 811 million Korean Won (810.7 thousand US dollars, 1 US Dollar= 1300 Korean won) in 2022. (b) Funding and valuation - total fundraising from investors amounts to 136.1 billion Korean Won (USD 104.7 million), arriving at funding Series C, from Korea-based VCs and PEs (e.g. Capstone Partners, Skylake PE, Aju Investment, BNW Investment, etc.) and a large company (Hyundai-Kia Motors). The company's market valuation is estimated at approximately 700 billion Korean Won (USD 538.5 billion).
- Embeddedness in the ecosystem for deep tech startups: It collaborates with diverse large companies (e.g. Samsung Electronics, Hyundai-Kia Motors, POSCO, LG, etc.) to test its products and technology applications by drawing on the national competitiveness in the semiconductor, manufacturing, and IT industries as well as that in the digital infrastructure. It also received early-stage support due to its location at a government-backed startup cluster (i.e. the Center for Creative Economy, backed by the Ministry of SMEs and Startups).
- Support from government policies or public programs: selected as a leading company at

the Fabless Challenge Competition to support semiconductor startups (backed by the Ministry of SMEs and Startups) in 2022; Program of Technology Development for Next-Generation Semiconductors (the Ministry of Science and ICT's program) in 2021.

- Internationalization: It started its business in Korea but has targeted global customers around the world. Hence, it opened a US office in 2018 at the establishment stage. It also received international awards such as the CES Innovation Awards in 2024. It has conducted globalization activities by seeking a range of collaborations with global companies in Taiwan, China, the U.S., and Europe.
- Other considerations: This company can be considered one of the leading deep tech startups in Korea. It has key features regarding deep tech startups, including its AI-oriented technology basis (effective integration of hardware and software technologies), considerable time gap and required investment between the establishment stage and the first sales in the market (i.e., persistent and big-scale R&D investment since its establishment despite few sales; test and upgrade periods), and a focus on both market and societal impacts. It benefited from the Korean ecosystem for deep tech startups in the IT and manufacturing industries for semiconductor design, and technology tests and applications through strategic alliances with a diverse range of large firms in these industries. The birth and growth within the ecosystem have helped this company improve product-market fitness in the proof-of-concept (PoC) process of applying deep technologies to commercialized ends and practices.
- Information sources: Company website (http://deepx.ai); news articles regarding CEO interviews, initial business story, recent market expansion, government support, and VC fundings;[120] others (articles in global media and VC information)[121]

[B] 'Elice' case (https://elice.io/en**)**

- Basic profile: This company was established as 'Elice' in November 2015. The company's name was changed to 'Elice Group' in July 2022. This company provides all-in-one digital learning platform and educational training solutions that empower teachers and learners with AI-driven technology. Specifically, it allows the teachers and learners to utilize a customized virtual platform for online learning (e.g., software/algorithm coding) via AI-based training, feedback, assessment, and education-specialized cloud services. This is at

[120] July 12, 2019: https://www.startuptoday.kr/news/articleView.html?idxno=24212
April, 7; 2021: https://deepx.ai/%EA%B2%8C%EC%8B%9C%ED%8C%90/?mod=document&pageid=1&uid=56
July 27, 2022: https://www.mss.go.kr/site/smba/ex/bbs/View.do?cbIdx=86&bcIdx=1035088
April, 24, 2023: https://biz.chosun.com/it-science/ict/2023/04/24/MHU4GGIIYBDJXMMYQDAUDPDYU4/
August 2, 2023: https://zdnet.co.kr/view/?no=20230801143918
June 6, 2024: https://www.thelec.kr/news/articleView.html?idxno=28416
Augst 8, 2024: https://www.thelec.kr/news/articleView.html?idxno=29560
October 25, 2024: https://www.e4ds.com/sub_view.asp?ch=2&t=0&idx=19853

[121] https://pitchbook.com/profiles/company/466596-82#overview
May 9, 2024: https://www.forbes.com/sites/johnkang/2024/05/09/korean-ai-chip-startup-raises-80-million-round-led-by-ex-samsung-executives-private-equity-firm/,
https://techcrunch.com/2024/05/09/ai-chip-startup-deepx-secures-80-5m-series-c-at-a-529m-valuation/

the growth stage: total sales are 32.8 billion Korean Won (25.2 million USD) in 2023 (about three times the previous record of 9.8 billion Korean Won in 2021), and its business is expanding into the Asian-Pacific regions (e.g., Southeast Asian countries and the U.S.) beyond the Korean domestic market. It holds approximately 1,800 clients (including large firms, SMEs, universities, and public organizations) and has 1.3 million users. The founder-CEO (Jae-Won Kim) graduated from the KAIST graduate program in Computer Science after working for global IT companies in the U.S. and Canada.

- Underlying technologies and business model: This company is the first education startup in South Korea that has implemented AI technologies in education for its training programs and platform. It has novelty in both underlying technology and business model. It provides AI-based training solutions (e.g., digital content, programs, assessment, and feedback) customized to learners and teachers. For example, teachers could assess learners' algorithms and make concrete and timely feedback by harnessing AI technologies.
- The company's ultimate goals and impacts: It aims to improve education and training efficiency and enhance digital transformation by applying AI technologies to education.
- Starting points: Co-founders began the startup to resolve the inefficiency of manually marking undergraduate students' coding exams and homework (i.e., the time required to offer feedback to learners) when they were graduate students at the KAIST. It also received early-stage financial support (seed money) from a KAIST-based entrepreneurship organization, and tested prototype service at KAIST.
- Growth path: The company first obtained sales in 2017 (i.e., no sales for the first 2 years after its establishment) via early-stage investment in technology and business development. It achieved enormously fast growth and scale-up since then by proving its initial technology-based service (AI-powered education content, solutions, and learning platform) and business model (mutual and timely feedback among teachers and learners; customized programs according to the learning pattern and progress) in the market. Recently, the company has expanded its business segments into AI data centres and cloud services, which are specialized in online and virtual learning, beyond its initial service. It started from B2C but has covered both B2B and B2C businesses. It has expanded its business in the US and Asia-Pacific region since 2022.
- Recent performance for fast-growth or scale-up: (a) Market performance - the average growth rate in total sales for the recent three years (2021-2023) is 110% and the average growth rate for the prior three years (2018-2021) is approximately 200%; (b) Funding and valuation - total fundraising from investors amounts to 33.3 billion Korean Won (25.6 million US Dollars), arriving at funding Series C, from the Korea-based VCs (e.g. Altos Ventures, Korea Development Bank, etc.) and a Singapore-based VC (Vertex Growth).
- Embeddedness in the ecosystem for deep tech startups: It collaborates with diverse private and public organizations to test its early services and secure customers based on the nation's competitiveness in the IT sector and digital infrastructure. It received early-stage timely support from an IT-oriented accelerator (D2SF) backed by Naver (one of

Korea's largest IT companies). It also built strategic alliances with online and offline education companies in Korea.

- Support from government policies or public programs: Global TIPS (the Ministry of SMEs and Startups' program) in 2024; Global IT Future Unicorn (the Ministry of Science and ICT's program) in 2021.
- Internationalization: It opened a US office in 2022 and a Singapore office in 2023. It secured funding from a major global VC (Vertex Growth, a Singapore-based VC affiliated with Temasek) in 2024. It has initiated globalization activities by seeking a range of collaborations with international education/learning companies and universities in the Asia-Pacific regions (e.g. the U.S. and ASEAN countries).
- Other considerations: This company can be considered a deep tech startup because of its features such as AI/big-data technology basis, the time gap and the required investment between the company start and the first sales in the market (i.e., lasting investment during the initial two years without any sales; testing and upgrade periods), and seeking a societal impact. It benefited from the Korean ecosystem for deep tech startups through appropriate support from private entities such as a deep tech accelerator backed by a large IT company, which enhanced product-market fitness in the proof-of-concept (PoC) process of applying deep technologies to commercialized ends, and government supports.
- Information sources: Company website (https://elice.io/en); news articles regarding CEO interviews, initial business story, recent market expansion, and VC fundings;[122] others (news release of a global VC that invested in this company)[123]

Review of deep tech startup cases in China

[A] 'Horen' case (https://www.horengroup.com/)

- Basic profile: HOREN (Shanghai Horen Smart Technology), founded in 2015 by Liao Qingxin, provides transport products and develops platforms designed to provide smart transport solutions for enterprises in transport-related industries. With its comprehensive integration of software and hardware technologies, it has established itself as a trusted provider of green supply chain circular services for numerous manufacturing enterprises. It has 500 employees and generates annual sales of RMB 600 million. Its customers include renowned Fortune Global 500 companies and leasing service providers such as Wanhua Chemical, Cargill, Haier Group, Honeywell, Siemens, Schneider, L'Oréal, Bosch, Midea, Haitian, COFCO, and CHEP. Underlying technologies and business model: HOREN

[122] June 23, 2023: https://jmagazine.joins.com/forbes/view/338026;
Oct 12, 2021: https://www.chosun.com/economy/smb-venture/2021/07/20/FYT5HVNV35CJNPQJG3RKOV35EI/
January 17, 2024: https://www.kedglobal.com/korean-startups/newsView/ked202401170014
January 19, 2024: https://zdnet.co.kr/view/?no=20240129105704
Aug 22, 2024: https://www.chosun.com/economy/smb-venture/2024/08/12/HXKX5ZNANRGFHJX2VZFDOB4724/

[123] https://pitchbook.com/profiles/company/233233-57#timeline
January 29, 2024: https://www.vertexgrowth.com/news/elice-inc-raises-krw-20b-series-c-round-from-global-investors-to-accelerate-apac-expansion/

has emerged as a leader in addressing various technical challenges related to recyclability, including lightweight and foldable IBC recycling technology and zero-residue irrigation and drainage technology. By combining AI, cloud computing, and big data, HOREN has independently developed an integrated software and hardware AIoT+SaaS intelligent recycling management cloud platform. This platform creates a full-link recycling service system that encompasses everything from box usage to box management.

- The company’s ultimate goals and impacts: HOREN is committed to creating a shared recyclable packaging asset pool. Through its circular service platform and nationwide circular service network, it seamlessly integrates packaging into production and daily life, much like water and electricity. This innovation transforms packaging into a new type of public infrastructure in ecological civilization, facilitating the transition away from traditional disposable packaging. HOREN enhances production efficiency and carbon emissions performance by leveraging zero-carbon circular technology throughout the entire industry chain. It also aims to reduce overall carbon emissions by 100 million tons.
- Starting points: The Chinese manufacturing industry consumes approximately RMB 760 billion worth of disposable packaging annually. Notably, disposable packaging accounts for more than 95% of this total. This results in about 30 million tons of solid waste pollution each year. In the context of the global sustainability concept, global packing industry enterprises worldwide increasingly recognise the need to "green" their supply chains and "reduce costs while increasing efficiency." The founder officially entered the intelligent recyclable packaging industry in 2015. He led his team to gain independent control over China's patented technologies in bulk liquid recycling, establishing green recycling service networks and facilities for industries such as non-hazardous chemicals, food and beverages, and pharmaceutical manufacturing.
- Growth path: Since its founding, HOREN has upheld a commitment to “driving independent innovation”. It has steadily increased its investment in research and development, progressing through three major stages. (i) “independent intellectual property rights innovation” (from 2015 to 2018, prioritized R&D) - 959 global patents 116 patents in China; (ii) “circular sharing business model innovation” (from 2018 to 2020, focused on innovating its circular sharing business model) - launched the "Box Sharing" brand in 2017, officially offering circular sharing services to the Chinese market and established offline circular service outlets and other infrastructure, including central warehouses and forward warehouses, as well as upstream and downstream service outlets across the country; (iii) “digital platform ecosystem innovation” (since 2021) - launched a digitalization strategy that integrated IoT software and hardware with AI, big data, and other technologies to create an AIoT+SaaS cloud management platform, established a "Hundred Networks, Thousand Stations" operational service platform, integrated and productized multidimensional data for service to successively launch a circular management SaaS system and intelligent online box usage services for the industry.
- Recent performance for fast-growth or scale-up: It acquired 20.7% global market share

and 50.2% national market share in 2022. It raised RMB 436 million and got a valuation of RMB 2 billion in the last round on June 9th, 2023. It has also gained increased attention and recognition from green capital with key investors (e.g., Zhongguancun Technology Leasing, Green Capital, Ling Capital, Vertex, and Seven Seas Capital.)

- Embeddedness in the ecosystem for deep tech startups: Under the guidance of the International Cooperation Center of the National Development and Reform Commission, HOREN, in collaboration with the Beijing Institute of Green Finance and Sustainable Development, initiated a research project on the "Zero-Carbon Circular Economy." This project aims to further unlock the development, investment, and innovation opportunities within China's zero-carbon circular economy industry in the context of carbon peaking and carbon neutrality. HOREN is committed to providing customers with innovative solutions for logistics and packaging recycling by deeply integrating with Siemens's extensive "ecosystem" resources. It is also a member of the China ESG Alliance, which strives to continuously integrate high-quality ecological resources and enhance joint innovation. In collaboration with partners such as Lingang Group, Zhongguancun Science and Technology Lease, and Cyber-Entrepreneur, HOREN has jointly launched the "Zero-Carbon Circular Entrepreneurship Initiative" to search for global entrepreneurial partners in the zero-carbon circular industry, and offers empowerment to eligible and outstanding entrepreneurial teams or individuals through accompanying mentorship.
- Support from government policies, public programs or national infrastructure: HOREN receives support from both national and regional policies. The "14th Five-Year Plan for Modern Logistics Development" states that logistics enterprises should be encouraged to strengthen green, energy-saving, and low-carbon management. It also emphasizes the enhancement of R&D of new green logistics technologies and equipment. In addition, it promotes the use of recyclable packaging, aims to reduce excessive and secondary packaging, and facilitates the reduction and reuse of packaging materials. In addition, the Shanghai Municipal Government has issued several policies to support the development of manufacturing-based services and green producer services. These policies include the "Special Funds for the Development of Producer Services and Service-Oriented Manufacturing in Shanghai," the "Action Plan for Targeting New Tracks and Promoting the Development of Green and Low-Carbon Industries in Shanghai (2022-2025)," the "Action Plan for Accelerating the Promotion of Green and Low-Carbon Transformation in Shanghai (2024-2027)," and the "Action Plan for Promoting Industrial Services to Empower Industrial Upgrading in Shanghai (2024-2027)."
- Internationalization: HORAN has branch offices in Rotterdam (the Netherlands), Birmingham (UK), Tennessee (USA), and Tokyo (Japan). International sales of HOREN surpassed USD 100 million in the past three years. The company also has R&D collaborations in the UK with ALLpaQ Group and One51 ES Plastics Ltd. The first is to develop a 500L capacity bulk liquid Intermediate Bulk Container (IBC) semi-cubic OF500 to meet the stringent filling and transportation needs of pharmaceutical, life science, and biotechnology companies. The second is to incorporate China's standardized, intelligent,

and high-quality smart recyclable packaging technology.

- Other considerations: Through years of market practice, Horen has discovered that China's intelligent industrial recyclable packaging technology and services have globally leading advantages. Particularly in the context of the "Belt and Road" initiative, the Southeast Asian market presents significant potential and opportunities. However, these emerging markets lack mature platforms to showcase corporate brands and technologies. Therefore, Horen seeks to organize and conduct related promotional activities.
- Information sources: information provided by the SC; company website (https://www.horengroup.com/); others[124]

[B] 'Momenta' case (https://www.momenta.ai/en)

- **Basic** profile: Momenta Global Limited is a developer of a developer of intelligent driving technologies and software for autonomous driving. It was founded in September 2016 led by Cao Xudong, a former scientist at Microsoft Research and formerly executive director of R&D at Chinese deep-learning and computer vision company SenseTime.[125] it currently has more than 500 employees. Momenta's clients include major companies in the automobile industry such as SAIC Motor (one of the "big four" car manufacturers in China), Toyota, Bosch, Audi, and Mercedes-Benz. Nvidia and Qualcomm are also partners of the company, in addition to General Motors China and BYD.
- Underlying technologies and business model: Momenta sells car software to automakers. The company develops deep learning capacities (so-called "brains")for automotive software and hardware. Its software is fed with large amounts of data which are needed in particular for the development of self-driving cars which can achieve end-to-end intelligent driving and navigate through challenging road conditions. Momenta's model, already mass-produced and delivered to leading automakers, is designed to handle various challenging driving situations, significantly reducing driver workload while improving traffic safety. The founder Ceo (Cao Xudong) led the team to develop fundamental technologies for autonomous driving based on deep learning, such as environmental perception, semantic HD maps, and data-driven path planning. The company has developed many solutions across multiple scenarios, including autonomous driving for highway, parking, and urban scenarios. Based on deep learning and vision-based technology, Monenta's products are high-performance, cost-effective, and easily mass-produced.
- The company's ultimate goals and impacts: Momenta's vision is to reduce up to one million traffic fatalities, reduce driving time by 100%, and double the efficiency of logistics and mobility within ten years.
- Starting points: Before starting Momenta, the founder was a scientist at Microsoft

[124] https://pitchbook.com/profiles/company/185553-28#overview, https://www.dealstreetasia.com/stories/horen-bags-funding-347760

[125] https://www.chinamoneynetwork.com/2017/07/25/nio-capital-leads-46m-round-in-autonomous-driving-technology-firm-momenta

Research Asia, where he worked on computer vision technologies that were applied in products like Bing and Xbox. He also served as the executive director of research and development at SenseTime, a leading Chinese company in deep learning and computer vision. Cao Xudong's vision was to develop advanced autonomous driving technologies using deep learning, semantic HD maps, data-driven path planning, and environmental perception. His expertise and strategic planning helped Momenta quickly gain recognition and investment, propelling the company to unicorn status within just two years.[126]

- Growth path: Momenta became the first Chinese unicorn in the field of self-driving cars after General Motors invested $300 million in the company at a valuation of more than $1 billion in 2021.[127] Previously, Momenta managed to raise $500 million from investors including SAIC Motor, Toyota, Mercedes-Benz, IDG Capital, GGV Capital, Blue Lake Capital, Shunwei Capital, and Cathay Capital. Momenta unveiled its first mass-produced intelligent driving model on 29th September 2024, at the Global Intelligent Vehicle Summit held in Hefei, Anhui province.[128] The large model integrates perception and planning into a deep-learning framework, offering an end-to-end solution to address long-tail challenges.
- Recent performance for fast-growth or scale-up: Momenta's robotaxi service, Momenta GO, started pilot operations in 2020. By 2024, they plan to deploy the service on a large scale and operate profitably, in a partnership with Qualcomm.[129] The company has raised a total funding $ 1.4B over several rounds from Chinese and international investors. Mercedes has chosen Momenta as its ADAS supplier in four models to be launched in China from 2025 to 2027 and is discussing internally whether to use Momenta software in more Chinese models beyond 2027. Mercedes also intends to invest a further US$75 million (S$100 million) in Momenta, and may invest more as a cornerstone investor in Momenta's initial public offering, scheduled in the first quarter of 2025.[130]
- Embeddedness in the ecosystem for deep tech startups: Momenta has benefited from the ecosystem of autonomous driving technologies and their product applications (e.g. robo taxis). It has grown by collaborating with local and international automakers (e.g. SAIC, Mercedes-Benz, GM, Toyota, etc.), and related ecosystem stakeholders (e.g. Bosch, BYD, Qualcomm, etc.) for its R&D, technology applications and tests.
- Support from government policies, public programs or national infrastructure: n.a.
- Internationalization: operated in Stuttgart (Germany) and Toyota City (Japan)
- Other considerations: n.a.

[126] https://www.innovatorsunder35.com/the-list/xudong-cao/?form=MG0AV3

[127] https://techcrunch.com/2021/09/23/gm-invests-300m-in-chinas-first-self-driving-car-unicorn-momenta/

[128] https://www.chinadaily.com.cn/a/202409/30/WS66fa189fa310f1265a1c5b5c.html

[129] Momenta and Qualcomm Announce New Intelligent Driving Solutions for Advanced ADAS and AD Functions Built on Latest Generation Snapdragon Ride Platform https://www.telematicswire.net/momenta-qualcomm-unveil-advanced-driving-solutions/

[130] https://www.reuters.com/business/autos-transportation/mercedes-use-momenta-software-4-models-accelerate-china-comeback-sources-say-2024-11-29/

- Information sources: company website (https://www.momenta.ai/en); others[131]

Review of deep tech startup cases in Brunei Darussalam

[A] 'Nextacloud' case (https://nextacloud.com/**)**

- Basic profile: Nextacloud, established in 2015, is a software development company specializing in MedTech solutions. Its flagship mobile app, 'Bloodkad', is a comprehensive platform designed to enhance blood donation management and support healthcare providers in delivering efficient services.
- Underlying technologies and business model: Bloodkad utilizes AI-driven insights, data analytics, and gamification to engage blood donors, optimize donation processes, and provide hospitals with essential support. The company's business model comprises subscription plans for healthcare institutions, enterprise solutions, and e-commerce integration for healthcare products.
- Company goals and impacts: The company's goal is to empower healthcare systems by promoting sustainable blood donation practices and improving public health outcomes. Bloodkad's impact is evident in its ability to streamline hospital operations and engage donors, ensuring consistent blood supply while enhancing donor health.
- Starting Points: This company developed 'Bloodkad' in response to the challenges faced by hospitals in managing blood donations. The company identified a need for a digital solution that supports both hospitals and donors. The founder, Agus Muslim, had a background in cybersecurity and experience as a programmer. He transitioned into entrepreneurship to bridge the gap between healthcare and technology through innovative solutions.
- Growth path: Since its launch of Bloodkad, this company has achieved nationwide adoption in Brunei Darussalam, being implemented in multiple hospitals. The company has also received recognition through regional awards,[132] further validating its approach and impact.
- Recent performance for growth or scale-up: Through the Bloodkad platform, the company continues to expand, backed by endorsements from government healthcare institutions. It claims to have saved more than 100,000 lives through the product platform, and has surpassed over 2 million in revenue. It is currently raising an additional USD 1.15 million to enhance and scale the Bloodkad platform as the company pursues market expansion across Southeast Asia.
- Embeddedness in the ecosystem: The company and its platform service (Bloodkad) are deeply embedded in Brunei's healthcare ecosystem through partnership with the Ministry of Health. This collaboration serves as a proof of concept, allowing the company

[131] https://en.wikipedia.org/wiki/Momenta; https://pitchbook.com/profiles/company/172222-03; https://tracxn.com/d/companies/momenta/__NfzRgUgM6GIdxAUZddxeZXdlYVPpgJldt8daZH8PFQ4/funding-and-investors#summary

[132] The company received awards as follows: ASEAN Impact Challenge and IGINITE Entrepreneurship Challenge in 2015; Global Game Exhibition G-Star and Young Social Entrepreneurs in 2016; Asia Pacific ICT Alliance (APCITA) and Brunei ICT Awards (BICTA) in 2016 and 2017; Startup@ASEAN and ASEAN+3 Young Entrepreneurs in 2017; Most Promising Digital MSME by ASEAN Business Awards in 2019. (https://nextacloud.com/nextacloud-story/)

to refine its platform and scale its operations effectively.

- Support from government policies/infrastructure: The public-private partnership with the Ministry of Health has been instrumental in the company's growth, providing the company with essential support and infrastructure to integrate Bloodkad into the national healthcare system. This partnership highlights the government's commitment to innovation in healthcare.
- Other considerations: One of the challenges this company is currently addressing is scaling beyond Brunei's borders while ensuring the company's solutions remain sustainable and effective in larger markets. This company is actively seeking partnerships and investment opportunities to expand its impact regionally.
- Information sources: Company website in English (https://nextacloud.com); information provided by the SC; news articles[133]

[B] 'Mindtrex Academy' case (https://mindtrexacademy.com/**)**

- Basic profile: Mindtrex, established in 2019, is a game-based learning platform designed to enhance learners' competencies while rewarding them for their progress. Its programs have shown remarkable results in various schools in Brunei districts. In one case, a low-income school in Tutong saw a 30% increase in students meeting grade-level literacy benchmarks after using Mindtrex as their learning tools. Teachers noted not only improved scores but also increased student engagement and confidence. The company also encourages community and parental involvement, offering resources and insights that help parents support their children's literacy at home. By fostering a collaborative approach, it addresses literacy issues holistically.
- Underlying technologies and business model: This company provides a fully integrated student management and learning platform (the "Platform"). The Platform includes diagnostic tools for parents, teachers, and schools to assess students' learning needs and identify areas where additional support, such as face-to-face learning clinics, courses, and tutoring, can enhance students' literacy and numeracy skills. Other features of related technologies are adaptive learning technology, data analytics, and engaging multimedia content.[134] This company has a subscription-based business model (BM) focused on K12 education.[135]

[133] September 14, 2018: https://www.bizbrunei.com/2018/09/this-youth-startup-hopes-to-drive-brunei-blood-donation-bloodkad-nextacloud/
October 27, 2022: https://thebruneian.news/2022/10/27/imagine-inks-agreement-with-nextacloud/

[134] Regarding adaptive learning technology, the company's platform employs adaptive learning algorithms to personalise instruction for each student. For data analytics, the system collects and analyses data on student performance in real time, allowing educators to track progress and identify areas needing additional support. This data-driven approach enhances instructional decision-making. For the engaging multimedia content, the company incorporates a variety of engaging multimedia resources, including interactive games and activities, to keep students motivated and enhance their learning experience.

[135] The company typically operates on a subscription model, where parents and schools pay for access to its platform. This recurring revenue model provides a stable income stream. Its BM is specifically designed for K-12 education, allowing for a targeted approach to literacy intervention that aligns with curricular standards and educational goals.

- Company goals and impacts: This company's core mission is to prioritise the early mastery of literacy and numeracy skills, laying a strong foundation for the development of more advanced skills through innovative digital solutions. The company improved its service, and impacted over 8000 students from 116 schools in K12 market throughout Brunei by enhancing their foundational skills in literacy and numeracy, by improving the accessibility and affordability of its services in comparison with conventional tuition schools.
- Starting Points: As pain points, co-founders (Khairi Metussin and Rianov) identified a growing trend that excessive screen time on platforms like YouTube, along with reliance on autocorrect and text-speak, is weakening literacy and numeracy skills, particularly in children's mother languages. As key value propositions, they assessed students' learning needs and identified areas where additional support with the use of AI and Diagnostic tools (such as face-to-face learning clinics, courses, and tutoring) can enhance their literacy and numeracy skills. The founders started Mindtrex with an aim to boost exam results by offering an easily-accessible assessment platform. As more users took advantage of the platform, Mindtrex discovered that early development for children had been impacted due to early digital exposure. [136]
- Growth path: [Product Expansion] Mindtrex started with foundational literacy programs and has expanded its offerings to include more comprehensive literacy solutions, catering to various age groups, market segments, and skill levels. [Market Reach and Partnerships] It has broadened its reach by partnering with relevant stakeholders and established institutions such as the Ministry of Education, DARE, AITI, BIBD, and TAIB, as well as with schools in districts across Brunei Darussalam and internationally. The company is currently entering the Singapore market through a collaborative effort with Merkle3, with an aim to enhance learners' literacy skills in their mother language (e.g. Malay and Mandarin). [Data-Driven Insights] The incorporation of analytics and assessment tools has allowed schools to track student progress effectively, leading to higher adoption rates among educators seeking evidence-based solutions. [R&D] Ongoing research has supported Mindtrex hybrid programs, demonstrating effectiveness in improving literacy skills, which has attracted more educational institutions. [Integration, including M&As] Mindtrex has also grown through strategic acquisitions, enhancing its technology and expanding its product suite.
- Recent performance for growth or scale-up: [Market Performance] Mindtrex has reported strong sales growth year to year, especially during and after the COVID-19 pandemic, as schools increasingly sought digital learning solutions. Many parents adopted Mindtrex, leading to increased user engagement and higher revenue. [Funding and Acquisitions] The company has successfully secured seed funding of USD 330,000 from an angel

[136] The company currently focuses on foundational literacy skills through adaptive technology that assesses students' abilities and tailors activities accordingly. For example, in under-resourced schools, it has been implemented to help struggling readers improve their skills. By using data-driven insights, teachers can identify areas where students need additional support and target interventions effectively.

investor, which has played a crucial role in developing the comprehensive architecture of its educational solution and validating its market potential. Additionally, it has formed strategic partnerships with various educational institutions, enabling further product enhancement and expanding its market reach. This combination of initial investment and collaborative efforts has positioned Mindtrex for continued growth and innovation in the edtech sector. [Market Expansion] The company has expanded its footprint internationally, entering new markets in Singapore as the first step before entering global market.

- Embeddedness in the ecosystem: It is integrated into the startup ecosystem through collaborative partnership, feedback and iteration, and adoption of data technology.[137]
- Support from government policies/infrastructure: This company has received a range of support from government policies and infrastructure: funding and grants, educational policies promoting literacy, investment in digital investment structure, and research and data access. This support plays a crucial role in the company's growth.
- Other considerations: government policies and infrastructure can play a crucial role in supporting the growth of edtech companies like Mindtrex. By providing funding, promoting literacy initiatives, investing in technology infrastructure, and facilitating teacher training, governments can create an environment that fosters innovative educational solutions. However, in Brunei, Edtech has not yet been prioritised as a key area for development. As a result, startups in the region, including those in the edtech space, often need to explore alternative income streams and bootstrap their operations to ensure survival. The local startup ecosystem is largely influenced by agencies such as Brunei Economic Development Board (BEDB) through Enterprise Development (DARe) and the Authority for Info-communication Technology Industry (AITI), which provide some support but may not target the specific needs of edtech companies. This landscape challenges edtech startups to be resourceful and innovative in their approaches to growth and sustainability.
- Information sources: Company website in English (https://mindtrexacademy.com); information provided by the SC

Review of deep tech startup case in Cambodia

[A] 'Chalatex' case (https://chalatex.com/**)**

- Basic profile: Chalatex is an agritech smart technology company providing a fully integrated IoT and Mobile Application platform to help Cambodian Farmers reduce

[137] Mindtrex has made partnerships with educational institutions, school districts, and organisations focused on literacy and education. The partnerships facilitate real-world testing of their products and provide valuable feedback for ongoing improvement. The company has also fostered strong relationships with educators and users to create feedback loops that inform product development. This approach ensures that their solutions address real classroom challenges and improve student outcomes. In addition to the partnerships, feedback and iteration, Mindtrex utilizes data analytics to track user engagement and learning outcomes. The data not only helps refine the products but also demonstrates efficacy to potential partners and investors.

irrigation costs. It was established in 2021. Along with reducing irrigation costs, this company's technology helps to increase crop yields and mitigate against adverse weather and climate conditions.

- Underlying technologies and business model: This company is innovating and developing IoT solutions and mobile application platforms to help farmers who seek to improve efficiency. In addition to technologies, it provides important agricultural products and services, affordable pricing, and trustworthy consultants.
- The company's ultimate goals and impacts: Chalatex aims to pioneer agritech innovation for a sustainable farming future in Cambodia. Specifically, it has impacted innovation and sustainability in the industry and communities by helping farmers reduce workloads, reduce water usage, and adapt to modern and smart technologies in the agriculture industry.
- Starting points: The co-founder CEO (Sokkim Neak) and founding team members began the startup to leverage smart technology to drive positive change in the agricultural sector, with a focus on smart irrigation through the startup's core initiative. With a bachelor's degree in information technology & engineering from the Royal University of Phnom Penh and additional expertise in Digital Marketing from Tux Global Institute, the founder has utilized both technical knowledge and business acumen to establish this promising startup business.
- Growth path: This company has expanded its technology and service areas – e.g. monitoring soil moisture and temperature levels, managing smart irrigation systems remotely through mobile devices, and setting crop irrigation schedules.
- Recent performance: This company is in an early stage. It won the 1st Best Digital R&D of the Year 2023 Award for CAM-Science from Cambodia Digital Awards, sponsored by the Ministry of Digital Technology of Cambodia.
- Embeddedness in the ecosystem for deep tech startups: It has collaborated with farmers and related organizations for more effective product implementation and improvement.
- Support from government policies or public programs: It has been supported by the National Incubation Center of Cambodia (NICC), which supports the incubation and growth of startups, and SAAMBAT (Sustainable Assets for Agricultural Markets, Business and Trade) program, which supports improvement and upgrading of key rural infrastructure to increase market participation and employment for rural households.
- Information sources: Company website (https://chalatex.com/); news article;[138] others[139]

Review of deep tech startup cases in Indonesia

[A] 'Xurya Daya' case (https://xurya.com/**)**

- Basic profile: Xurya Daya Indonesia is an Indonesian clean energy startup specializing in

[138] https://cambodianess.com/article/cambodian-student-overcomes-challenges-to-succeed-in-vietnam

[139] https://dgf.gov.kh/archives/224709;
https://www.fao.org/digital-villages-initiative/asia-pacific/agritech-founders/startup-leaders/sokkim-neak/en

solar energy solutions through rooftop solar power systems. Founded in 2018, it operates in major cities including Jakarta, Bekasi, Semarang, Surabaya, and Medan, with an estimated workforce of more than 100 employees. The company offers a "one-stop solution" for industry players to transition to solar energy, providing services ranging from feasibility studies, installation, operation, and maintenance. With 196 rooftop solar projects operating, Xurya serves more than 70 SMEs and large companies from various industries like textile and food manufacturing, logistics, retail, and hospitality. The company stated that it has received investments totaling more than $88 million to date, from global investors such as Norwegian Climate Investment Fund, British International Investment, Swedfund, AC Ventures, Mitsui & Co, Surya Semesta Internusa, and East Ventures' Growth Fund.

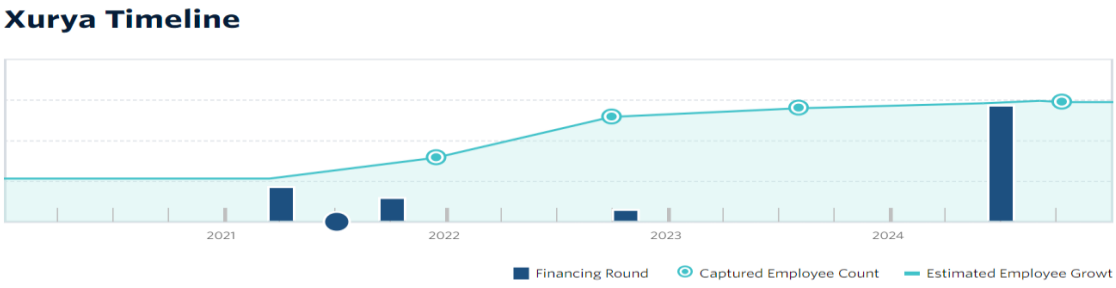
- Underlying technologies and business model: Xurya is the first Indonesian company to offer rooftop solar panels as Hardware-as-a-Service (HaaS) via a lease scheme that does not require upfront costs or investment, incentivizing industries to transition to clean energy while reducing the burden of high installation expenses. The company continues to innovate by using the Internet of Things (IoT) and Artificial Intelligence (AI) for remote solar operations and implementing machine learning for the management of solar power systems.
- The company's ultimate goals and impacts: Xurya aspires to lead in technology and solutions for sustainable and clean energy. By pioneering affordable, innovative, and reliable renewable energy solutions, the company aims to support the national energy transition goal of achieving net zero emissions (NZE) by the year 2060. Additionally, the company also seeks to contribute to SDGs No. 7, 8, 11, 12, and 13 by reducing carbon emissions, creating green jobs, and promoting responsible energy consumption. Official statements claim that their solar systems have reduced carbon emissions by 152,000 tons of CO2 per year and have generated more than 1,600 green jobs.
- Starting points: Xurya was founded by Edwin Widjonarko, Eka Himawan, and Philip Effendy to address challenges related to solar energy adoption in Indonesia, as the transition often requires high installation costs. Widjonarko holds a PhD in Material Physics from the University of Colorado Boulder and has worked on third-generation solar cell research projects for the National Renewable Energy Laboratory in Colorado. He recognized the economic potential of solar power when the US Department of Energy sought to decrease the cost of solar power systems to $1 per watt. He discussed the possibility of starting a solar power business in Indonesia with longtime friend Himawan, who was working at a hedge fund in the US at that time, handling alternative energy investments. Yet, despite the increasing investment in this field, solar power was still quite expensive in 2007. Both Eka and Edwin continued to work in the energy sector in – Edwin focused on research in solar power, while Eka gained experience funding power plants through his work at Barclays.[140] By the time the cost of solar modules in Indonesia

[140] https://climateimpactinnovations.com/urgent-energy-needs-in-southeast-asia/

decreased to almost $1 per watt in 2016, further discussions about business models and local intricacies influencing business took place. Eventually, Effendy, who was an investment associate at East Ventures, joined the venture as the VP of Operations, while Himawan became the MD.

- Growth path: Xurya started by offering a novel Hardware-as-a-Service (HaaS) model for solar rooftops through a lease scheme. Over time, the company integrated IoT and AI into its remote solar monitoring and operating systems. Xurya has successfully installed over 170 solar projects across Indonesia, contributing to substantial carbon emissions reductions and creating more than 1000 green jobs, and is continually expanding. It has yet to enter the residential market due to existing government regulations, which make home solar installations less economical.
- Recent performance for fast-growth or scale-up: By 2022, Xurya had completed the installation of over 100 rooftop solar projects, with 86 operational and 32 under construction. In 2023, the number of operational projects increased to 150. As of March 2024, there are 172 operational projects and 34 more under construction.[141] [142] [143] Growth is also measured from the generated clean energy, which stood at 589.713.411 kWh in 2022 and grew to more than 166 million kWh per year by 2023. Data from Pitchbook suggests that the company has consistently grown, both in valuation and employee count.[144]

Figure 4.1 Timeline of Xurya Daya Indonesia



The company managed to acquire investments totaling $88 million from 2021-2024. In July 2024, Xurya secured $55 million in funding led by the Norwegian Climate Investment Fund, administered by Norfund, with participation from British International Investment, Swedfund, and AC Ventures. Previously, the company raised $11.5 million during an extended Series A round in 2022 from Mitsui & Co and Surya Semesta Internusa, and $21.5 million in its first funding round in December 2021, led by East Ventures' Growth

[141] https://xurya.com/News/hingga-akhir-tahun-2022-xurya-berhasil-melakukan-ekspansi-bisnis-dan-meningkatkan-instalasi-plts-atap-untuk-industri-45
[142] https://xurya.com/News/kinerja-gemilang-di-tahun-2023,-xurya-lanjutkan-misi-menghijaukan-indonesia-71
[143] https://xurya.com/tentang-kami
[144] https://pitchbook.com/profiles/company/277098-76#timeline

Fund.[145]

- Embeddedness in the ecosystem for deep tech startups: Collaboration has long become one of Xurya's core strategies in sustaining their business. They have actively built networks and fostered collaboration with government institutions, educational institutions, and private sectors. One of the most recent partnerships with PLN Icon Plus, a subsidiary form the state-owned electric company, grants Xurya access to their infrastructure and distribution network, enabling sharing of knowledge, technology, and resources. In addition, regulatory and licensing support are available to facilitate quick and effective implementation of renewable energy projects.[146] Xurya is also an active member of the Indonesian Solar Energy Association (AESI) which has provided multiple training of trainers (ToT) programmes in the field of solar energy.[147] Lastly, the company strives to strengthen university-industry linkages by collaborating with universities in order to develop talents and skills in solar energy.
- Support from government policies or public programs: There is limited publicly available information on Xurya's specific procurement process. However, some of their technology partners, including a few Chinese companies, are mentioned. Given the need to import advanced components such as solar panels, Xurya likely benefits from Indonesia's participation in the ASEAN-China Free Trade Agreement (FTA), which allows for import duty exemptions of up to 100% for solar modules purchased from China.
- Internationalization: It currently operates exclusively within Indonesia, with offices located in major cities including Jakarta, Bekasi, Semarang, Surabaya, and Medan. However, its Managing Director affirmed its goal to enhance competitiveness on a global scale and to expand their business beyond Indonesia.[148]
- Other considerations: Xurya's main challenge entails the lack of support from the government. Inconsistent regulations create an unfavourable environment for renewable energy businesses to expand. For instance, the government previously allowed households to export surplus electricity to the state, with the benefit of reducing electric bills. This incentive encouraged the installation of solar power systems in residential areas, making them both cost-effective and environmentally friendly. However, since the export ban in 2022, installing solar panels has become less economical for homeowners, as they will no longer enjoy the same financial savings. There has also been little support and/or incentives for deep tech startups in clean energy to scale up. A survey by New Energy Nexus Indonesia in 2023 suggested that over 50 % of cleantech startups have

[145] https://xurya.com/en/News/renewable-energy-start-up,-xurya,-announces-major-funding-from-domestic-and-foreign-investors-85

[146] https://xurya.com/en/News/xurya-collaborates-with-pln-icon-plus-aims-the-growth-of-renewable-energy-usage-in-indonesia-61

[147] https://xurya.com/en/News/renewable-energy-start-up,-xurya,-announces-major-funding-from-domestic-and-foreign-investors-85

[148] https://technode.global/2024/07/01/indonesias-xurya-raises-55m-in-funding-led-by-norwegian-climate-investment-fund/

never received government incentives.[149] The same survey found that these startups particularly seek R&D funding — which becomes problematic as Indonesia's GERD is among the lowest compared to other APT countries.

[B] 'Nodeflux' case (https://www.nodeflux.io/**)**

- Basic profile: Nodeflux is the first and largest Indonesian vision AI company in Jakarta. The company was first established in 2016 as a Big Data startup and has expanded in developing deep learning computer vision to provide intelligent Video Analytics solutions. By 2021, Nodeflux had a market valuation of $20 million and employed 75 people.[150] It is also expected to grow 7.8% annually. Around 60% of its business comes from government institutions,[151] such as the Indonesian National and Regional Police and local governments in major cities like Jakarta and Bandung. Notable projects include security enhancements for events such as the 2018 Asian Games, the IMF-World Bank Summit in 2018, the G20 2020, and the ASEAN Summit 2023, through its facial recognition technology. Nodeflux raised Series A funding from East Ventures in 2018, following seed investment from Indonesian smart city solutions provider Qlue in 2017. MDI Ventures, Digitaraya, Magpie, and Prasetia Dwidharma are several other investors who have invested in Nodeflux.[152]
- Underlying technologies and business model: Nodeflux uses deep learning and computer vision to process information on recorded footage. Its flagship product, VisionAIre, is a computer vision integration engine designed to perform machine vision operations with robust, flexible deployment, and modular analytics.[153] It encompasses two core functions. The first is "Surveillance Analytics as a Service", which enables real-time or snapshot-based image processing using selected analytics tools. The second is "eKYC Solutions", designed to automate identification and authentication processes integrated with primary data providers. These products provide solutions for Smart City and Governance, especially for monitoring traffic violations, calculating the volume of passing vehicles, detecting illegal parking, detecting flooding at air gates, detecting the density of rubbish in rivers, and monitoring public facilities — ultimately contributing to the SDGs in building resilient and sustainable urban communities. Nevertheless, these AI-enabled solutions are also applicable to sectors like financial services, transportation, telecommunication, and facility maintenance.
- The company's ultimate goals and impacts: it is more oriented towards market leadership, positioning itself as a key player in the application of AI for real-world solutions and propelling the country's technological advancement. It seeks to integrate AI solutions into more cities and expand partnerships with governments and industries. Its strategy underlines sustainability, in which business growth is supported by continuous R&D

[149] https://newenergynexus.id/wp-content/uploads/2023/09/Clean-Energy-Technology-Startups-in-Indonesia-How-the-Goverment-can-help-the-Ecosystem.pdf
[150] https://www.abc-pf.org/data/report/206.pdf
[151] https://dailysocial.id/post/nodeflux-profitabilitas-ekspansi
[152] https://pitchbook.com/profiles/company/222254-02#data
[153] https://www.nodeflux.io/products

innovation and a robust business model.

- Starting points: Nodeflux was founded in 2016 by two graduates of Bandung Institute of Technology (ITB), Meidy Fitranto and Faris Rahman. Meidy is a seasoned business analyst and manager with experience working in supply chain management roles at two oil and gas companies from 2010 to 2014. Faris, on the other hand, has a background in developing applications focused on providing HR and accounting solutions for Indonesian businesses. He also gained experience working with the multinational company KBR Inc. and founded a short-lived venture called Travellist-tour. Since Nodeflux was first established as a Big Data startup, Meidy and Faris initially did not intend to focus on intelligent video analytics. Yet, they grew to recognize its potential to offer solutions for numerous social challenges and to further revolutionize how clients monitor, understand, and measure their surroundings.
- Growth path: Nodeflux has grown notably since its inception in 2016 as a big data startup, evolving into one of Indonesia's leading AI vision companies. It has not only acquired certification from the National Institute of Standard and Technology (NIST) as a face recognition vendor, but also become the first Indonesia-based company to join the Nvidia Inception Program. However, publicly available data suggests that since securing Series A funding from East Ventures in 2018, Nodeflux has not received any additional external funding. Accordingly, statements from the company's leadership affirm that despite setbacks due to the COVID-19 pandemic, it has achieved profitability by 2019 and has since operated solely on its own generated revenue. As of now, it serves over 150 clients across various industries in more than 60 cities, provinces and border posts, with over 20,000 CCTVs installed and analytics implemented. Yet, Nodeflux continues to face challenges in their business, including the lack of AI talents in Indonesia, insufficient infrastructure capable of supporting AI model operation, and limited bandwidth. This propels the company to develop "AI on the Edge" that enables the operation of AI model and technology without an internet connection — allowing usage in excluded, less developed areas.
- Recent performance for fast-growth or scale-up: Over the past three years, it has grown by expanding its partnerships with organizations like the National Police, as well as with state-owned enterprises such as PLN Icon Plus and Jasa Marga, further enhancing their VisionAIre platform for smart city and surveillance applications. Yet, there is no publicly available data on the exact number of sales or the financial value of each project. A plausible explanation for this could be that Nodeflux's products are now listed in the government's e-catalog for procurement, and since most of their clients are government institutions, the details of sales are not publicly disseminated.
- Embeddedness in the ecosystem for deep tech startups: Nodeflux is one of the industry players that was involved in the development of Indonesia's National AI Strategy Framework 2020-2045. Not only did they contribute to the document's substance, but representatives from the company also became members of the Working Group for its implementation, specifically in the areas of Talent Development, Ethics and Policy,

Industrial Research and Innovation, as well as Priority Areas and Quick Wins. Their participation ultimately allows them to advocate for policies or programs that are beneficial to developing a national ecosystem for AI as necessary for technological advancement and flourishing businesses in the sector. Moreover, Nodeflux's commitment to developing the national's AI ecosystem is apparent through its collaboration with universities on research and development activities, producing tangible results such as scientific articles and hardware prototypes, while also conducting lectures to educate audiences about AI technology.

- Support from government policies or public programs: (1) Nodeflux was a participant in an incubation and acceleration program from a state-owned telecommunication company, Telkom Indonesia. The program, Telkom Indigo, aims to nurture digital startups and foster innovation by providing an end-to-end development process for startups. Each year, Indigo offers up to $140k in funding for successful participants. (2) Nodeflux participated as one of the startup delegations in the Archipelageek event organized by the Creative Economy Agency of the Republic of Indonesia, which took place at the SXSW Creative Industries Exhibition in 2019. The program provided opportunities for Nodeflux to network with industry players and showcase and promote their products to the global market.
- Internationalization: Nodeflux's operations are still limited within Indonesia despite its consistent achievement of generating profit. Nevertheless, an interview with the company's Chief Product Officer in 2022 revealed a plan to expand business to India, Singapore, the US, and Europe in the near future.[154] They are in the process of market identification, focusing on determining the most effective distribution channels for the company's products.
- Other considerations: The main challenge lies in the lack of awareness of AI models, and the limited capacity to operate AI models in Indonesia. As part of the Working Groups for the Implementation of the AI National Strategy 2020-2045, Nodeflux has continuously advocated for improvements in human resources and infrastructure development. Nodeflux is committed to developing AI products using locally sourced talent, but the necessary skills for AI remain scarce in Indonesia. Several reports highlight issues such as inadequate digital competencies in the education curriculum and insufficient government support for developing local talent. This problem is worsened by concerns regarding potential job displacement due to AI. Operating AI models also requires advanced digital infrastructure, including high-speed internet. Unfortunately, Indonesia is ranked 83rd in the world for mobile speeds and 116th for fixed broadband speeds as of September 2024.[155]

[154] https://dailysocial.id/post/nodeflux-profitabilitas-ekspansi

[155] https://www.speedtest.net/global-index/indonesia

Review of deep tech startup case in Laos (Lao PDR)

[A] 'Wayha Sokxay Technology' case (https://wayha-sokxay.tech**)**

- Basic profile: This company was established as Wayha Technology in 2020 and integrated into the Sokxay Group Company in 2022. The founder is Dr. Savath Saypadith. It offers a diverse range of IT services with AI-powered digital (and specialized software) solutions tailored to customer needs. It's an early-stage startup with a size of 15 employees.
- Underlying technologies and business model: Major customers are firms seeking digital transformation. The company develops software platforms primarily for the insurance industry, with additional work in the retail and logistics sectors. Technologies developed by the company include AI and machine learning for claims fraud detection and risk assessment, deep learning models for underwriting and predictive analytics, and scalable cloud-based databases for managing insurance policies, claims, and customer data. By merging cutting-edge technology with a deep understanding of the client's needs, this company aims to deliver ICT solutions that redefine industries and set new benchmarks for excellence. For example, it provides B2B SaaS (Software as a Service) such as specialized software for insurance companies to optimize operational efficiency, reduce fraud, and automate claims processing. Key value propositions in the business model are (a) leveraging AI to enhance claims fraud detection, streamline risk assessment, and reduce operational costs; (b) enabling insurance companies to operate more efficiently and with greater accuracy. These ensure faster claims processing, minimize fraudulent activities, and improve overall customer satisfaction.
- The company's ultimate goals and impacts: This company strives to drive digital transformation, empowering businesses and individuals in the country. The company's market goals are to (a) become a leading provider of deep tech solutions in the insurance industry in Southeast Asia, and (b) expand services to other emerging markets in the region. The company also seeks social impacts related to sustainable development goals (SDGs): (a) increasing access to affordable and reliable insurance services in underserved areas; (b) improving customer experience and satisfaction by automating claims processes and speeding up resolution times.
- Starting points: The founders began the startup with a commitment to utilize technology and innovation to provide impactful solutions via ICT software (including digital and data) solutions. Specifically, pain points that the founders addressed in the insurance industries were inefficiencies in claims processing and underwriting, high manual effort for fraud detection, and slow customer response time and limited access to insurance in rural areas. The founder has academic and practical backgrounds, including a PhD in AI and computer vision and nearly 10 years of experience as a software developer. His expertise includes anomaly detection, GANs, and deep learning technologies, which form the backbone of Wayha Sokxay Technology's AI-driven solutions in the insurance industry.
- Growth path: The company has grown through expanding its customer base and developing AI-powered solutions for the insurance industry.
- Recent performance for fast-growth or scale-up: The company is in its early growth phase,

with ongoing development of AI-powered insurance platforms. Future potential includes scaling across the Southeast Asian market.

- Embeddedness in the ecosystem for deep tech startups: The company collaborates with public and private R&D institutions to leverage technological advancements in AI and insurance operations.
- Support from government policies or public programs: Like other deep tech startups, this company can benefit from Laos' growing focus on digital transformation and AI through collaborations with the Ministry of Industry and Commerce and the Ministry of Technology and Information.
- Internationalization: The company operates no international offices yet, however plans for regional expansion are in place.
- Other considerations: This company has several challenges and barriers, such as securing external investment to scale beyond current operations. The insurance market in Laos is still adopting digital solutions. The company should also align its AI advancements with industry capabilities while educating the market. Limited access to high-performance computing hardware hinders the company's training and deployment of AI models, which slows innovation. Finally, the local AI talent pool is small, making it difficult to scale AI projects, which can be one of the barriers to this company's scale-up. To resolve the problem, this company will need to attract international talent or foster the development of local skills.
- Information sources: Company website (https://wayha-sokxay.tech); information provided by the SC.

Review of deep tech startup cases in Malaysia

[A] 'Aerodyne Group' case (https://aerodyne.group/**)**

- Basic profile: Aerodyne is a DT3 (drone technology, data technology, and digital transformation) enterprise solutions provider, established in 2014. Its autonomous drones employ advanced technologies that allow them to carry out operations without human intervention, such as cloud computing, computer vision, artificial intelligence, machine learning, deep learning, and thermal sensing. A key sector for this startup is agricultural intelligence, which helps farmers boost yields and reduce costs; security and surveillance, simplifying the monitoring of large areas; asset management, ensuring infrastructure maintenance; and logistical innovations, such as delivering to remote and hard-to-reach areas.
- Underlying technologies and business model: Aerodyne utilizes an AI-driven, collaborative, swarm, nested drone system. The data collected by drones is then processed by AI-based proprietary software to offer actionable insights. Its nested drones return to automated stations for data download and autonomous recharging for subsequent missions.
- The company's ultimate goals and impacts: The company aspires to lead the global tech

curve in the use of drone data and AI-powered analytics to resolve complex industrial challenges, enabling organizations to rapidly scale, digitally transform, and increase productivity.

- Starting points: Kamarul Muhamed, a founder of Aerodyne Geospatial Sdn Bhd, shot a documentary in 2009 which required aerial shots of Egypt, Turkey and Russia. Instead of renting a helicopter, the founder opted to use drones, despite drones being a relatively new technology at the time. Although Kamarul and his team have been using drones to provide such services since 2009, it was only in 2015 that Aerodyne was formally incorporated into the company.
- Growth path: When first established in 2014, the business grew by word of mouth. But when the founder introduced a service that used drones for project reporting and monitoring, the business took off. The company first received $2 million Series A funding in 2019 from Chiba Dojo Drone Fund II Investment Limited Partnership. While growth was stunted when the COVID-19 pandemic hit, the company survived and further grew to receive a $30 million Series B funding from Malaysian ventures in 2022, enabling it to further expand its operations across the globe.
- Recent performance for fast-growth or scale-up: (a) Market performance – Revenue growth reached 77%, with total revenue of $64.5 million in Q4 2023, up from $36.4 million in Q4 2022. (b) Funding and valuations – Aerodyne has raised a total funding of $86.1M over 6 rounds, arriving at Series B funding. Investors include prominent national and international entities such as Petronas Ventures, Real Tech Global Fund, Kobashi Holdings Co., Ltd., Meranti ASEAN Growth Fund, and Kumpulan Wang Persaraan (KWAP). The company's most recent valuation stands at $257.3M.
- Embeddedness in the ecosystem for deep tech startups: Aerodyne actively collaborates with the government to support digital transformation, using Cyberjaya and the Multimedia Super Corridor (MSC) as test beds for drone technology, with backing from agencies like MDEC and MOSTI. The company also partners with local and foreign universities, funding drone-based R&D and trainings, as well as internships, working with Young Malaysian Engineers (YME) to empower youth in STEM fields.
- Support from government policies or public programs: Headquartered in Cyberjaya, Aerodyne operates within MSC, a special economic zone designed to foster IT-driven innovation and digital economy growth. Companies meeting MSC Malaysia Status requirements can benefit from tax incentives. In 2022, MSC status attracted RM5 billion in investments, split between domestic and foreign sources, and is projected to create 7,763 jobs. The company is also under the Global Acceleration Innovation Network (GAIN) program of the MEDC. Through Business Support Ecosystems and business matching sessions, the program aims to enable high-potential Malaysian-headquartered tech companies to compete on the global stage. Since 2016, a total of 70 GAIN companies have brought in new contracts worth more than US$1.2 billion.
- Internationalization: Aerodyne currently has a presence in 25 countries, with two corporate HQs (Cyberjaya and Dubai) and six Regional Offices (Washington DC, Rome,

New Delhi, Perth, Rio de Janeiro, Santiago de Chile). The company has also established strategic partnerships with various global enterprises and institutions in countries such as Italy, Japan, Austria, Switzerland, Germany, and the Scandinavian region to expand its market reach.

- Other considerations: Aerodyne qualifies as a deep tech startup due to continuous R&D efforts to develop its technology. When first founded in 2014, they focused on aerial cinematography, but they later diversified to geospatial intelligence, and recently integrated AI into their technology. By utilizing drones, they helped clients to reduce carbon emission in the process of collecting aerial data and information, and they also facilitated timely responses to natural disasters (as from 2015's flood case in Kelantan and Terengganu).
- Information sources: company website (https://aerodyne.group/); official government page[156]; report, news, articles, and others[157]

[B] 'Biogenes Technologies' case (https://www.biogenestech.com/**)**

- Basic profile: Biogenes Technologies is a Malaysian-based startup in the field of molecular diagnostics and genomics. They have developed an end-to-end platform built on a digital backbone that enables aptamer design, synthesis, and wet-lab validation across different market segments, including education, research, agriculture, diagnostics, therapeutics, and pathology. It was established in 2015.
- Underlying technologies and business model: Key technologies include printed nano-coated sensors, immobilization of DNA probes and aptamers (synthetic antibodies), as well as in-silico design and validation of new aptamers. Through them, the company provides cutting-edge solutions, products and services to customers from both the research and commercial sector.
- The company's ultimate goals and impacts: To make accurate diagnostics affordable and available to everyone around the globe, regardless of wealth and age, creating an alternate ecosystem in the diagnostics and drug development industry. It also aims to increase the commercialization of test kit technology using aptamers.
- Starting points: Biogenes was founded to address the difficulties involved in developing drugs and diagnostics in SEA. Such difficulties arise due to a lack of access to raw materials, the need for expensive technologies, and the lack of companies outside of the USA, EU, and China which focus on such development. Despite difficulties due to lack of

[156] https://www.mida.gov.my/industries/services/other-services/other-services-multimedia-super-corridor-msc/

[157] https://www.adb.org/sites/default/files/institutional-document/826606/adou2022bp-digital-entrepreneurship-asia-malaysia.pdf
https://www.techinasia.com/aerodyne-raises-30m
https://www.tatlerasia.com/lifestyle/gear/kamarul-muhamed-aerodyne-drone-technology
https://theedgemalaysia.com/article/cover-story-aerodyne-ushers-age-drones
https://www.forbes.com/sites/malaysia-digital-economy-corporation/2023/11/15/reaping-gains-from-malaysia-digital/
https://alternatives.pe/company/MTI2NDc2NFA=
https://pitchbook.com/profiles/company/226652-77

funding, the business started to take off when the COVID-19 pandemic hit. In 2022, Biogenes became the first company in the world to take computer-designed aptamers to clinical trials., These trials, which are ongoing at the time of this report, aim to enable on-site detection of Strep B and Sepsis within 30 minutes.

- Growth path: Biogenes was first awarded a grant from a Malaysian venture, PlaTCOM, to kickstart the business in commercializing genomics and genetics technologies. In the next years, it then collaborated with universities across the country to deepen R&D efforts on commercial genomics. Before Biogenes focused its efforts on producing biosensor diagnostic kits for COVID-19 during the pandemic, it received an undisclosed amount of seed investment from Antler S.E.A. It last received a Series A funding of $5.7 million from Pembangunan Ekuiti Sdn Bhd (PESB) in January 2023.
- Recent performance for fast-growth or scale-up: a) Market performance – There is consistent growth in the company, measured through employment rate, both before and after a financing round in 2023. A statement by the co-founder in 2024 also affirmed that the company is cash flow positive, despite limited funding. b) Funding and valuations – Biogenes has raised a total funding of $5.7 million over 2 rounds, arriving at Series A funding. Investors include global venture firms, such as Antler, and Malaysian ventures, such as PlaTCOM and PESB. In 2023, the company's valuation stands at $28 million.
- Embeddedness in the ecosystem for deep tech startups: The Malaysian start-up specializes in developing and commercializing diagnostic solutions for healthcare, agriculture and biology by collaborating with universities and research institutions to accelerate R&D towards commercialization. The collaboration provides access to experimentation, technologies and materials, empowering Malaysian R&D to perform well commercially. In addition, Biogenes has recently been appointed as one of the members of a task force, namely the Food, Safety and Quality Working Group under the Academy of Sciences Malaysia. The task force aims to foster collaboration between industry-academia, government agencies, and private companies to improve food safety in Malaysia.
- Support from government policies or public programs: Biogenes received various supports from the Malaysian government. It was the first startup to complete NTIS Sandbox Fund 1 from MTDC and MRANTI, validating its COVIDSENS rapid test kit with RM250k funding in November 2020. Launched under Malaysia's PENJANA recovery plan by MOSTI, the NTIS Sandbox seeks to promote innovation by relaxing regulatory requirements. In addition to support from MTDC and MOSTI, Biogenes also received CIP Accelerate funding from Cradle Fund for its APTSENS digital COVID-19 test kit in 2021. Most recently, the company also received an approved grant of RM5.5 million (around US$1.2 million) through the NTIS 3 project, where $750k of the grant will be provided by the MTDC.
- Internationalization: When the company received a $5.7 million Series A funding in January 2023, the company announced intentions to expand its sales outreach in Southeast Asia, especially in Indonesia and the Philippines. Regardless, there has been no further update on this proposed expansion.

- Other considerations: Biogenes is currently in funding Series A, with access to capital remaining as the main pain point for the company. As a comparison, Biogenes is underfunded by a factor of one tenth compared to the lowest-funded biotech startups in the USA. This reflects a trend among Asian VCs who appear hesitant to invest in sectors requiring long development timelines. Asian life sciences startups also face tough competition from their better-funded counterparts in the USA, EU, and China, with funding gaps of 10x to 30x.
- Information Sources: company website in English (https://www.biogenestech.com/); others[158]

Review of deep tech startup case in Myanmar

[A] 'Frontiir' case (https://www.frontiir.com/**)**

- Basic profile: This company is a provider of affordable high-speed internet to underserved regions using fibre optic and satellite solutions, bridging the digital divide in rural and remote areas. It offers affordable digital access and information services, and helps overcome the digital divide. It was established in 2015 and is now a leading internet service provider in Myanmar.
- Underlying technologies and business model: This company has a network developed with unique proprietary technology and network access gateway architecture with an optical transport network. It provides customers with low-cost high-speed broadband internet services.
- The company's ultimate goals and impacts: Frontiir's mission to provide affordable digital access was achieved with the launch of Myanmar Net brand internet services in Myanmar, which now provides high-speed broadband internet services to 2 million users in Myanmar for as little as US$ 0.13 per day.
- Starting points: The co-founders (MIT doctorates and business experts) identified the opportunity to enter Myanmar's underserved internet service provider (ISP) market using proprietary Wi-Fi technology.
- Growth path: The company has offered and expanded high-end fibre internet services to enterprises and mobile internet access through its Wi-Fi mesh and fibre networks to consumers. Now it has the largest network coverage amongst the ISP players in Myanmar due to the fast-to-market roll out of street by street ("SBS") wireless networks in Yangon and Mandalay after the first investment in June 2016. It has raised $147 million.
- Recent performance for fast growth and scale-up: This company increased the number of

[158] https://vulcanpost.com/814354/biogenes-technologies-malaysia-biotech-funding-sandbox-grant/
https://www.linkedin.com/pulse/interview-biogenes-technologies-founder-adrian-joseph-dr-terence-2xnvc/
https://tracxn.com/d/companies/biogenes-technologies/Gaql8QWdlH8j-ojmVSg_HIzdp2Iy8J9n4VesK1sGgYM/funding-and-investors#funding
https://themalaysianreserve.com/2024/08/01/biogenes-technologies-commercialisation-pathways-for-innovative-researchers/#google_vignette
https://pitchbook.com/profiles/company/462043-27#overview

subscribers by 700% over the last four years, resulting in it becoming the largest ISP in the country. This startup has grown into a company employing a few thousand employees across several cities.

- Embeddedness in the ecosystem for deep tech startups: Since the liberation of Myanmar telecoms sector in 2014, internet use has rapidly increased from 6 million users in 2014 to almost 22 million users in 2019. Frontiir launched Myanmar Net internet services in 2015, and is the only service provider which serves lower-income customers, with low-cost unlimited broadband internet. It has collaborated with stakeholders of internet infrastructure, covering IT, education, and healthcare service sectors in Myanmar. Frontiir also implemented a high-speed inter-campus network between the three main Technology and Computer Studies Universities in Yangon, further developing the capacity of these higher learning institutions. In the healthcare sector, it established videoconferencing facilities for the Yangon Regional Teaching Hospital in 2018, enabling health professionals to receive ongoing training from experts in countries such as Japan, India, the UK, and Singapore, as well as consult cases with experts in other countries.
- Support from government policies or public programs: This company has benefited from US and UK government support. In 2016, It received the OPIC (Overseas Private Investment Corporate), which is a loan offered by the US government's development finance institution for the expansion of its broadband network. This loan financed the costs of (a) capital expenditures for utility pole Wi-Fi access points, (b) deploying a fibre optic network, (c) purchasing international bandwidth capacity contracts, and (d) data centre infrastructure. The project covers $ 40 million for the 9-year term with a 2-year grace period. In 2019, the company received $ 30 million investment from the UK CDC (Commonwealth Development Corporation), which is the UK government's development finance institution, to expand the internet network and infrastructure.
- Information sources: company website (https://www.frontiir.com/); news article;[159] others[160]

Review of deep tech startup cases in Philippines

[A] 'Expedock' case (https://expedock.com**)**

- Basic profile: This company, established in 2020, provides AI-powered automation services in the supply chain and logistics business. It uses AI technologies to read paperwork and invoices to categorize them and help visualize the automated work process in the international freight industry. It is streamlining operations for key players

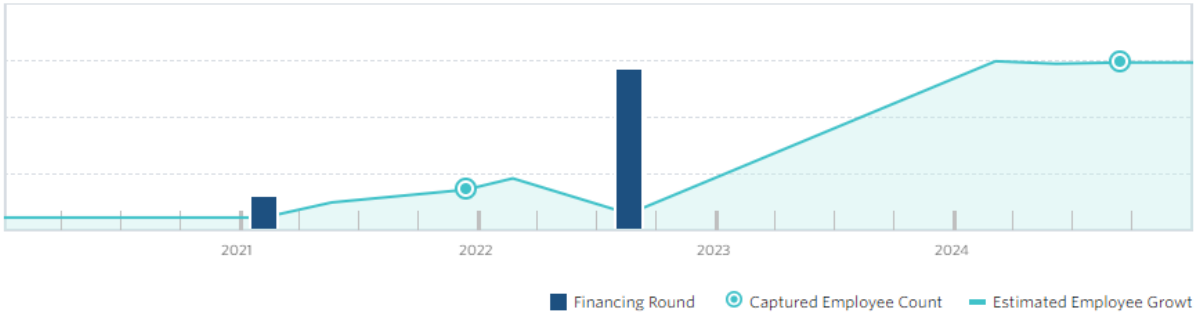
[159] https://www.irrawaddy.com/news/burma/frontiir-receives-30m-investment-uks-cdc.html
https://www.privateequitywire.co.uk/opic-makes-usd250m-investment-telecom-tower-infrastructure-project/;
https://www.frontiermyanmar.net/en/us-development-agency-loans-250m-to-aid-telecommunications/

[160] https://www.dfc.gov/sites/default/files/media/documents/9000093363.pdf
https://www.crunchbase.com/organization/frontiir;
https://www.norfund.no/investment/frontiir-direct-co-investment-with-mofii/
https://pitchbook.com/profiles/company/104045-32

in the global supply chain.

- Underlying technologies and business model: This company's technology aims to eliminate inefficiencies by automating manual processes, and connects all physical and digital data sources into one platform. The company's technology allows its artificial intelligence (AI) platform to categorize documents, even those with unfamiliar formats. Hence, it expedites the international delivery of thousands of freight containers every week. It also improves supply chain visibility for the operations of both customers and the company. The company is also able to reduce clients' operational expenses by up to 90%, by eliminating data extraction and data entry work for airway bills, bills of ladings, and invoices, and thus decreases turnaround time to about one tenth of the original time required.
- The company's ultimate goals and impacts: This company supports SDG 9 (Industry, Innovation, and Infrastructure) by improving industrial processes. The company's vision is to eliminate the time and complexity of connecting and reconciling disparate data sources by digitizing the global supply chain with best-in-class technology for thought leadership and innovative solutions. The company aims to drive growth and value to supply chain services by reconciling disparate data, which can reduce inefficiency in the industry, and allow logistics companies to focus on making other impactful decisions.
- Starting points: The company has three co-founders: King Alandy Dy (CEO), Jeff Tan (Chief Operations Officer), and Jing Young (Chief Product Officer). King was an AI researcher who came from a family of shippers and worked as a machine learning (ML) engineer at Shopee (the No. 1 e-commerce company in Southeast Asia). Before starting this company, Jeffe managed the operations of one of the largest forwarders in the Philippines for three years. Jig previously oversaw product strategy and growth for a supply chain financing startup (from Series A to B). Like King, he is also a second-generation freight forwarder. Therefore, the co-founders well understood the challenges facing the international shipments industry.
- Growth path: The company has grown by expanding its customer base and developing AI-powered solutions through collaboration with global and local partners. It is working with some of the largest global supply chain companies, such as Wayfair, ClearFreight, Jusda, and Ascent.
- Recent performance for fast-growth or scale-up: The company achieved successful and continuous funding records reflecting its growth and future potential – 1.38 million USD for seed funding in 2020; 4 million USD for pre-A funding in 2021; 13.5 million USD for series A funding in 2022. Major investors are global angel investors (e.g. Ali Partovi, Claus Moldt, etc.) and venture capitals (e.g. Insight Partners, Motion Ventures, Decent Capital, etc.) associated with tech giants (e.g. Facebook, Uber, Airbnb) and partnered with supply chain industries (e.g. LBS Express, Walmart, eBay, etc.). Along with the funding records it has high growth rates in market performance – (estimated) total sales of $22 million and a total of 133 employees; the recent employment growth rate is approximately 20%.

Figure 4.2 Timeline of Expedock



- Embeddedness in the ecosystem for deep tech startups: The company has benefitted from the supply chain industry's persistent and bulk growth (especially, fast growth since the COVID pandemic).
- Internationalization: This company has a U.S. office. Its major customers are global companies in the U.S., Europe, and Asia.
- Information sources: company website (https://expedock.com); information provided by the SC; news articles[161]; public information on the company[162];

Review of deep tech startup cases in Singapore

[A] 'Hydroleap' case (https://hydroleap.com/**)**

- Basic Profile: This company develops advanced wastewater treatment technology designed to replace expensive chemical treatments with a smart electrical treatment for wastewater. It is a deep tech startup addressing industrial wastewater challenges with sustainable electrochemical solutions. It specializes in delivering cost-effective and environmentally friendly water treatment technologies, helping industries meet stringent environmental regulations and sustainability goals. Its technology focuses on the treatment of high-suspended solid, high oil, and heavy metal-contaminated wastewater, enabling clients to take advantage of water recycling services using electrical and membrane treatment systems. It was established in 2016 by Mohammad Sherafatmand. It raised $4.4 million in funding in 2023. Hydroleap's business segments cover industrial wastewater treatment in sectors such as manufacturing, data centres, food and beverage (F&B), mining, and palm oil production.

[161] February 4, 2021: https://e27.co/ai-powered-supply-chain-solutions-firm-expedock-bags-us4m-led-by-early-backer-of-facebook-airbnb-20210204/
February 10, 2021: https://www.bworldonline.com/technology/2021/02/10/343930/ai-startup-raises-4-million-in-seed-round-partners-with-lbc-express/
August 10, 2022: https://techcrunch.com/2022/08/10/expedock-cinches-series-a-to-grow-its-freight-paperwork-management-platform/

[162] Forbes: https://www.forbes.com/profile/expedock/;
Pitchbook: https://pitchbook.com/profiles/company/435155-86;
Growjo: https://growjo.com/company/Expedock

- Underlying technologies and business model: The company's solutions rely on proprietary electrochemical processes, such as electrocoagulation and electrooxidation, which remove pollutants without using chemicals. Their systems are highly automated, reducing manual intervention by up to 95% while lowering operational costs by approximately 30%. The solutions are tailored for industrial applications, including cooling tower water recycling, palm oil effluent treatment, and high-volume F&B wastewater. The company has successfully demonstrated its technology's efficiency across diverse sectors.
- The company's ultimate goals and impacts: In market aspects, it provides scalable, sustainable wastewater solutions that reduce operational costs and improve water reuse efficiency. In social aspects, it supports global water conservation efforts while addressing the environmental challenges of industrial waste. In environmental aspects, it targets reducing industrial carbon footprints by replacing chemical treatments with clean technologies.
- Starting points: The founder and founding teams recognized that industrial clients often face high costs and inefficiencies in conventional wastewater management methods, particularly in sectors with complex effluent streams. Hydroleap's key value proposition is to deliver easy-to-deploy, energy-efficient water treatment solutions that minimize chemical use and optimize operational efficiency. In addition, this company is supported by deep tech ecosystems such as Enterprise Singapore and various private investors.
- Growth Path: In 2016, Hydroleap was founded with a focus on sustainable water management. For the period 2018-2020, it deployed pilot systems for wastewater treatment in the F&B and palm oil sectors. In 2021, it gained recognition with commercial implementations in manufacturing and cooling towers. In 2023, It secured $4.4M in Series A funding to fuel international expansion in APAC. Recent funding provided by Mitsubishi Electric and Real Tech Holdings has enabled expansion in Australia, Japan, and Indonesia.
- Recent Performance for fast-growth or scale-up: (a) Sales growth - Hydroleap has experienced steady growth driven by increasing adoption of sustainable technologies across industries. (b) Employment growth: it has expanded teams in R&D and business development to support global market entry. (c) Expansion into various sectors - cooling tower water recycling (providing efficient treatment systems for cooling towers, reducing water discharge by up to 70%); palm oil effluent treatment (introducing solutions to treat challenging wastewater from palm oil production, addressing regulatory demands); data centres (supporting water-intensive operations in data centres by enabling higher levels of water reuse); F&B wastewater management (helping F&B manufacturers optimize effluent treatment and reduce costs).
- Embeddedness in the ecosystem for deep tech startups: The company has made partnerships with international partners and governments, including the Victorian State Government in Australia, to expand its impact. It works closely with research institutions and regulatory bodies to refine and adapt its technologies. It benefited from support under Enterprise Singapore and the Singapore Green Plan 2030 initiatives. It actively participates in deep tech accelerators and sustainability-focused industry groups. Its

funding is also backed by industry leaders such as Mitsubishi Electric and government-linked organizations in Singapore.

- Internationalization: Hydroleap is expanding its footprint across APAC, particularly in Australia, Japan, and Indonesia. The company is leveraging its proprietary technology to address complex wastewater challenges globally, emphasizing adaptability to various industrial needs.
- Information Sources: company website (https://www.hydroleap.com); news articles from Business Times (https://www.businesstimes.com.sg) and Tech in Asia (www.techinasia.com); others[163]

[B] 'Lumitics' case (https://lumitics.com/**)**

- Basic Profile: This company provides food waste management solutions designed to help chefs and restaurant managers optimize their kitchens. The company provides waste tracker AI-based image recognition technology to accurately recognize food items, enabling users to track food waste seamlessly.
- It was established in 2017 by Rayner Loi (CEO) and Keshav Sivakumar. Major customers and business segments are hospitality, food and beverage (F&B) industries, airlines, cruise ships, hospitals, and schools. Its flagship product, 'Insight', is an AI-driven food-waste tracker that uses image recognition and weight sensors to monitor discarded food. The device integrates into commercial kitchen workflows, providing real-time data to help clients reduce waste by up to 40% and lower food costs by 3-8%.
- Underlying technologies and business model: This company combines proprietary image recognition technology and weight sensors to track food waste, ensuring both insights and benefits for customers. It generates actionable insights on waste patterns, enabling better inventory management and cost savings.
- The company's ultimate goals and impacts: Lumitics aims to help clients reduce food waste and operational costs. It also promotes sustainability by addressing the global challenge of food waste. In environmental aspects, it targets to reduce CO2 emissions associated with food production and disposal.
- Starting Points: The founders found inefficient manual food-waste tracking in commercial kitchens. To resolve the pain points, the company provided a key value proposition – seamless, data-driven waste management solutions for diverse food production environments. For its background support, it was incubated at BLOCK71 Singapore and supported by NUS Enterprise.
- Growth path: After the establishment in 2017, it launched its flagship product, "Insight" in 2019. It has actively expanded its client base, including partnerships with major hotel chains and F&B businesses during the period 2020-2024.
- Recent performance for fast-growth or scale-up: (a) sales growth - continued scaling through successful market penetration and partnerships; (b) employment growth –

[163] https://pitchbook.com/profiles/company/185175-73; https://www.crunchbase.com/organization/hydroleap

continued expansion into regional markets has created new roles; (c) expansion into various sectors – hospitality (working with hotel chains to reduce buffet line food waste); airlines and cruise ships (implementing waste-tracking solutions in high-volume kitchens); hospitals and schools (supporting efficient waste monitoring in institutional settings); (d) funding – Lumitics has raised over S$1 million (approximately $2.2 M in total) in funding. It has also received funding from sources such as Temasek Foundation Ecosperity and Enterprise Singapore. With over S$557K raised in its seed round, the company has focused on scaling operations and expanding regionally.

- Embeddedness in the ecosystem for deep tech startups: It works with hospitality and food service leaders to refine solutions. It has made partnerships by collaborating with diverse organizations like the National University of Singapore (NUS) Diversey and Green Eco Technologies. It has received grants from Singapore's public and private innovation programs and ecosystem support (e.g. NUS Enterprise and BLOCK71 Singapore). It has also benefited from funding by government-linked organizations.
- Internationalization: Lumitics aims to expand regionally across Asia, with plans to adapt its technology to broader industries like fast food and educational institutions. Its innovative solutions demonstrate scalability and adaptability in tackling a global issue.
- Information sources: company website (https://www.lumitics.com); news articles from Tech in Asia (www.techinasia.com) and the Business Times (https://www.businesstimes.com.sg); others[164]

Review of deep tech startup case in Thailand

[A] 'Nano Coating Tech' case (https://en.nanocoatingtech.co.th/)

- Basic profile: This company is a deep tech startup established in 2022 under the NSTDA Startup Program. It originated from a research team at the National Nanotechnology Center (NANOTEC), which has been innovating in nano-coating technology since 2012. The company specializes in nanotechnology solutions for solar panels, building maintenance, and other industrial applications. Collaborating with over 10 distributors nationwide, the company delivers cutting-edge products designed to enhance efficiency and sustainability. With a compact team of six highly skilled professionals, the company is recognized for its innovative contributions to the energy and construction sectors.
- Underlying technologies and business model: The company uses cutting-edge nanotechnology, employing nanoparticles to create advanced coatings that enhance solar panel efficiency, extend the lifespan of building materials, and reduce maintenance costs. These coatings are water- and dust-repellent, form invisible nano-thin layers, and comply with international safety and environmental standards. Tailored for diverse industrial applications, including construction and textiles, they improve energy absorption and durability while remaining eco-friendly and non-toxic. Operating on a B2B model, the

[164] https://pitchbook.com/profiles/company/277460-47#overview; https://www.crunchbase.com/organization/lumitics

company provides customized solutions, technical support, and easily removable coatings for solar panels, ensuring long-term client satisfaction and strong industry partnerships.

- Ultimate goals and impacts: It is driven by a mission to advance sustainability, energy efficiency, and industrial innovation. The company aligns its goals with global Sustainable Development Goals (SDGs), particularly SDG 7 (Affordable and Clean Energy), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 13 (Climate Action). By promoting the adoption of renewable energy technologies, such as its high-performance solar panel coatings, Nano Coating Tech helps reduce carbon emissions and supports clean energy transitions. The company also enhances industrial infrastructure by improving the durability and efficiency of construction materials, textiles, and household products through its innovative coatings. These efforts not only reduce maintenance costs and environmental impacts but also create a foundation for more sustainable and resilient industries, benefiting clients, communities, and the environment.
- Starting points: Nano Coating Tech was co-founded in 2022 by Dr. Tanyakorn Muangnapoh and Dr. Pisist Kumnorkaew, leveraging their expertise in nanotechnology and material science to address gaps in renewable energy and construction industries. Originating from a research team at the NANOTEC under NSTDA, they had been innovating nano-coating technologies since 2012. With targeted funding and strategic partnerships, they developed advanced coatings to enhance solar panel performance, protect infrastructure, and reduce inefficiencies. These efforts positioned the company as a leader in sustainable solutions for energy and industrial applications.
- Growth path: The company began with small-scale projects in Thailand, expanding its reach by collaborating with leading energy companies in Viet Nam. By 2024, the company had over 50 corporate clients in Thailand and had positioned its products for regional growth. Its innovative nano-coatings are tested at large-scale facilities, including solar plants in Viet Nam, showcasing its capabilities as a regional leader in solar technology. Additionally, the company was selected for international programs such as the HKSTP Idea Landing Programme in Hong Kong and the UOB GreenTech Accelerator 2024 in Singapore, focusing on construction coatings, further enhancing its market presence.
- Recent performance for fast-growth or scale-up: In 2024, Nano Coating Tech achieved notable growth in Thailand and Viet Nam. Revenue grew from THB 1.8 million in 2023 to THB 6 million in 2024, demonstrating steady progress toward its five-year target of THB 100 million. This growth is fuelled by strategic partnerships, international collaborations, and the proven effectiveness of its coatings across diverse environmental conditions, solidifying its position as a key player in sustainable technology solutions.
- Embeddedness in the ecosystem for deep tech startups: The company is deeply integrated into regional and international innovation ecosystems, actively participating in prestigious programs such as the HKSTP Idea Landing Programme in Hong Kong, UOB FinLab's GreenTech Accelerator in Singapore, the Viet Nam Innovation Summit in Viet Nam, and the Taiwan Innotech Expo in Taiwan. The company leverages its roots in the NANOTEC to enhance its R&D capabilities and develop cutting-edge solutions. By

collaborating with universities, trade associations, and industry leaders, the company fosters innovation and nurtures talent in nanotechnology and renewable energy. Furthermore, its active engagement in industry trade associations solidifies its presence and influence in the deep tech and clean energy sectors. These collaborations enable the company to stay ahead of technological advancements and maintain a competitive edge in global markets.

- Support from government policies or public programs: The company benefits significantly from Thailand's innovation-driven policies, which support startups through grants and funding programs. Key achievements include a THB 4.07 million grant from the National Innovation Agency (Public Organization) for renewable energy R&D and a THB 1.67 million grant from the Young Startup Program under the Ministry of Higher Education, Science, Research, and Innovation. The company also takes advantage of regional trade agreements, such as the ASEAN-China FTA, to facilitate cost-effective procurement of advanced materials, further supporting its growth. However, challenges remain, such as the limited government incentives specifically aimed at scaling clean technology startups, which the company continues to advocate for through its industry and policy engagements.
- Internationalization: The company has established a strong foundation for international expansion, with trials and collaborations in Viet Nam and active participation in regional showcases in Singapore, Hong Kong, and Taiwan. These initiatives not only demonstrate the company's global ambitions but also pave the way for partnerships with international energy providers, real estate developers, and industrial players. By positioning itself in key markets across Southeast Asia and beyond, the company aims to scale its operations and reinforce its role as a regional leader in nanotechnology and sustainable innovation.
- Other Considerations: Nano Coating Tech faces challenges common to many deep tech startups, including raising awareness about the unique benefits of nano-coating technology and navigating regulatory barriers in emerging markets. Limited public understanding of nano-coating's potential to improve energy efficiency, reduce maintenance costs, and enhance sustainability creates a need for robust customer education initiatives. Additionally, regulatory frameworks in some regions may slow the adoption of innovative technologies, requiring the company to engage with policymakers and industry stakeholders to advocate for supportive policies and incentives. In addition, the company emphasizes customer education through targeted outreach, industry events, and pilot projects to demonstrate the efficacy and cost-effectiveness of its solutions. By aligning its offerings with the needs of industries like renewable energy and construction, the company ensures its products provide clear, measurable value. The company exemplifies the potential of deep tech startups to transform industries by driving innovation and sustainability. Its commitment to advancing nanotechnology, coupled with its proactive approach to addressing challenges, positions the company for long-term success and growth in both domestic and international markets.
- Information Sources: National Science and Technology Development Agency (NSTDA);

NANOTEC, NSTDA

Review of deep tech startup cases in Viet Nam

[A] 'N2TP' case (https://n2tp.com/**)**

- Basic profile: N2TP Technology Solutions provides a precision-medicine-based healthcare ecosystem supporting hospitals and clinicians by offering insightful information tailored to the physiological characteristics of individuals. This approach aims to enhance patient care and treatment outcomes through personalized medical solutions. It was established in 2020 by 4 co-founders and has grown to ten employees. It is in the stage of market entry. Major customers are healthcare providers and research institutions.
- Underlying technologies and business model: It has developed a programmable biosensor that can be customized to detect various biomarkers for diseases like cancer and infectious diseases. Integrated with AI-driven data analysis, this biosensor provides fast, accurate results without the need for complex lab equipment. Its main products are portable, cost-effective in-vitro diagnostic (IVD) kits paired with a point-of-care device and an AI-powered platform. BM is centred around offering a free point-of-care diagnostic device coupled with a SaaS-based diagnostics platform, while generating revenue through the sale of test kits.
- The company's ultimate goals and impacts: Initially, this company is targeting the Asia-Pacific, Africa, and Europe regions, where there is high demand for early cancer detection, treatment monitoring, and reducing microbial resistance, and plans to expand globally. N2TP's innovations align with the UN SDG by offering affordable diagnostics that improve health outcomes, particularly in low-income countries (SDG 3). With low-cost, portable kits, this company ensures equitable access to healthcare (SDG 10) while strengthening sustainable healthcare infrastructure to address global health challenges (SDG 9).
- Starting points: Founders Nhung Duong, a pharmacist on N2TP's team, and Mr. Vu Dinh Hoa, Vice President of the National Drug Information & Adverse Drug Reaction Center, first met in high school. Recognizing the need for precision medicine in Viet Nam and ASEAN, they founded N2TP to develop solutions which aimed to help clinicians provide faster, more accurate diagnostics and treatment. The founding team includes Nhung Duong, a PhD candidate in Biotechnology at Hanoi University of Pharmacy with 7 years of experience in Biomedical Science and 4 years in Pharmaceutical Sales & Marketing; Tuan Do, a former Data Scientist at Experian with 7 years in Software Engineering and Data Science, and expertise in Scientific Computing and LC-MS analysis; Phong Ho, a Kyushu University graduate with experience in Applied Data Science, Software Engineering, and Strategy Analysis; and Vu Dinh Hoa, a Lecturer in Clinical Pharmacology at Hanoi University of Pharmacy, Deputy Manager at the DI and ADR National Center, and a key member of the TDM Association in the Asia-Pacific region.
- Growth path: Since its founding in 2020, N2TP has developed precision medicine solutions, including SmartDoseAI. This platform helps hospitals personalize dosage for

narrow therapeutic window drugs using therapeutic drug monitoring, Big Data, and AI. It's available at no cost for research and is deployed in about 50 hospitals across Viet Nam, including major state hospitals. SmartDoseAI has been featured in over 40 scientific articles and conferences for its efficiency and accuracy. In addition, N2TP is developing a programmable biosensor method that can be customized to detect various biomarkers for different health conditions. This biosensor is capable of quantifying key biomarkers, including RNA, ctDNA, DNA mutations, and pathogens related to infectious diseases. It is currently patenting this method in Viet Nam and the UK, planning to apply it to develop IVD kits for future registration in Europe and Japan. Additionally, N2TP focuses on identifying biomarkers for various health conditions such as chronic health diseases or mental health issues, while extending the biosensor's programmability to these biomarkers.

- Recent performance for fast-growth or scale-up: N2TP has established a robust network of approximately 50 hospitals across Viet Nam, encompassing both public and private institutions. This strategic advantage positions them favourably for conducting clinical trials, obtaining regulatory approval for the IVD kit as a medical device, and driving commercialization efforts. The company has already filed two patents in Viet Nam and the UK, with plans to file a PCT application and expand registrations to Europe and Japan in the next phase. On the regulatory front, N2TP is currently preparing pre-clinical data for the initial submission of kits. Additionally, it plans to construct an ISO 13485-certified manufacturing facility to support the biomanufacturing of kit components. In terms of funding, N2TP successfully raised capital in mid-2024 during Phase I of its pre-seed round, achieving a valuation cap of $8 million with investments from BKFund and AiViet Venture.
- Embeddedness in the ecosystem for deep tech startups: N2TP collaborates with hospital and university laboratories to drive R&D advancements. The company provides custom biosensors, chemical reagents, and its bioinformatics/AI/ML platform as a service to other laboratory-developed test (LDT) startups, fostering collaboration and innovation within the deep tech community. Additionally, N2TP purchases electronic components, nano-materials, and OEM printed circuit boards (PCBs) from deep tech manufacturers to support the development of its point-of-care diagnostic devices.
- Support from government policies, public programs or national infrastructure: N2TP is a member of the National Innovation Center (NIC), under Viet Nam's Ministry of Planning and Investment. NIC has supported this company with networking, funding, and partnerships, both locally and internationally, and provided free space for their laboratory and manufacturing facilities.
- Internationalization: N2TP is actively collaborating with a molecular biology laboratory at Kyushu University in Japan, led by one of their advisors, to advance their R&D initiatives. Additionally, the company is planning to establish a UK headquarters to support its international expansion.
- Other considerations: A major challenge N2TP faces is obtaining regulatory approvals such as CE marking and FDA clearance for its biosensor, which is costly and time-

consuming. To address this,N2TP is working with regulatory consultants and conducting clinical research in Viet Nam, Japan, and Europe. As demand grows, they plan to optimize processes using platforms such as CultureBiosciences' cloud lab to reduce COGS.

- Information sources: information provided by the CEO of N2TP (Ms. Nhung Duong); others[165]

[B] 'Fuwa Biotech' case (https://fuwa.com.vn/en/**)**

- Basic profile: This company develops bio-enzyme cleaning solutions from pineapple peels. It was established in 2019 by five founders with related industry experiences (management or STEM backgrounds. It aims to address issues of food waste and water pollution caused by traditional cleaners by making eco-friendly products from natural materials.
- Underlying technologies and business model: Fuwa Biotech leverages Eco Enzyme Technology, which is a complex solution produced by fermentation of organic waste (fruits, vegetables), sugar and water. Eco Enzyme is a multi-purpose cleaning liquid, and is a plant-based product, and thus is safer and more environmentally friendly than other chemical cleaners. The company's Eco Enzyme Application tackles existing problems and diverse issues, such as household cleaning, agricultural applications, green ecosystem building, wastewater and drainage Treatment, health and skin protection, etc.
- The company's ultimate goals and impacts: For market goals, it aims to become a leader in eco-friendly cleaning solutions in Viet Namese and other Asian markets. Regarding social impacts, its products lack many of the harmful chemicals found in traditional cleaners, reducing risks to human health such as skin inflammation. This company also has committed to eliminating up to 700,000 plastic bottles annually by promoting the use of eco-friendly cleaning products and refill stations. Fuwa transforms up to 1,000 tons of pineapple peel waste annually into high-value products, reducing agricultural waste and promoting a circular economy.
- Starting points: The company was founded to address pain points related to environmental pollution and health risks associated with chemical cleaning products. In particular, it aims to address environmental challenges related to pineapple peels. 100 K tons of pineapple peel waste is generated annually, leading to severe water pollution (100 liters of harmful substances per ton) and soil degradation (3 tons of nitrogen and 1.2 tons of phosphorus released annually). The founders set out to address this pollution, as it harms local ecosystems and agricultural productivity and affects farmers' livelihoods. The company also wanted to resolve health hazards from chemical products used in household cleaning products, including risks ranging from mild allergic reactions to severe conditions like cancer and reproductive disorders.
- Growth path: In 2019, the company developed semi-industrial scale production and

[165] Crunchbase: https://www.crunchbase.com/organization/n2tp-technology-solution;
Pitchbook: https://pitchbook.com/profiles/company/550963-54#overview;
https://swissep.org/our-impact/success-stories/how-one-startup-benefited-from-vietnam-s-ecosystem

established foundational sales and marketing strategies. For 2020–2021, it promoted distribution channels, developed homecare product sets, and built export-oriented factories. During the growth stage in 2022-2024, it achieved $4M in revenue in the Viet Namese market by launching new product lines (eco-friendly body care products) and investing in R&D. It expanded to key international markets (e.g. the U.S. and Germany).

- Recent performance for fast-growth or scale-up: Fuwa has achieved remarkable financial growth, with revenues increasing from $208K in 2020 to approximately $1.5 million in 2023, and targeting $2 million by the end of 2024. The company achieved a 40% increase in sales, rising from 91,500 units in 2022 to 124,700 units in 2023. It is partnering with well-established companies in other countries, specifically targeting the US, Germany and Korean markets. Notably, it secured an export contract of 250 K EUR in 2024 and another 750 K EUR contract in 2025.
- Embeddedness in the ecosystem for deep tech startups: For research collaborations and partnerships, the company benefits from strong collaborations with academic and research institutions. It is implementing various collaborative projects between the international (UK) and Viet Namese partners, such as the UK-VN HEP project, Researchers Links, and the GCRF project.
- Support from government policies, public programs or national infrastructure: For sustainability training and recognition, it actively participates in sustainability training programs, equipping the team with the latest knowledge and tools to drive green innovations. The company is in the global network of innovators in the green-tech space.
- Internationalization: Fuwa has an office in Germany and a growing presence in multiple countries (e.g., the U.S., Germany, China, Singapore, Australia, Canada, Korea, Malaysia).
- Other considerations: Deep tech startups like Fuwa require substantial capital investment to fund R&D, production expansion, and international market penetration. While Fuwa has secured initial funding, scaling up operations, expanding globally, and seeks further funding as it continues improving its technology. Fuwa requires continuous R&D to remain competitive and further improve the performance of Eco Enzyme technology.
- Information sources: information provided by the founder-CEO; Company website in English (https://fuwa.com.vn/en/)

4.3. Closing Remarks

We have reviewed examples of deep tech startups in the APT countries. They operate in diverse industries, including manufacturing, services, education, logistics, healthcare care, and environmental sectors. A majority of the startups harness Industry 4.0-related technologies, such as AI, big data analytics, robotics, advanced semiconductors, IoT, green/clean tech, and medical/biotechnology. Some startups also capitalize on other advanced technologies (e.g., materials (nanotechnology, organics, chemicals, etc.), quantum

computing, satellite, and autonomous technology) for industry applications and effectively integrate the technologies with Industry 4.0-related technologies to tackle economic value creation and sustainable development issues.

In relation to the impacts, deep tech startups in the APT countries tackle diverse challenges for sustainable development goals (SDGs).[166] The startups cover most SDGs: e.g., Industry, Innovation and Infrastructure (UN SDG 9), Affordable and Clean Energy (UN SDG 7), Quality Education (UN SDG 4), Global Health and Well-Being (UN SDG 3), Climate Action (UN SDG 13), Clean Water and Sanitation (UN SDC 6), Decent Work (including occupational safety and health) and Economic Growth (UN SDG 8) Responsible Consumption and Production(UN SDG 9), Reduced Inequalities (UN SDG 10), Sustainable Cities and Communities (UN SDG 11), Zero Hunger (2), and Partnership for the Goals (UN SDG 17).

In addition to the technological aspect and technology protection via patents, deep tech startups have commonly developed and improved their innovative business models for value creation and capture in the process of technology commercialization. Regarding the business model type, although the majority of deep tech startups focus on B2B, their business areas and models have moved toward the BC2 business (or vice versa). This tendency of deep tech startups in the APT countries is similar to business shifts in other developed countries (e.g., the U.S. and European countries) and in developing countries (e.g., India).

By analysing the cases of deep tech startups in the APT countries, we confirm that common features and challenges of the deep tech startups are associated with the factors of the entrepreneurial ecosystem for deep tech startups. First, it is notable that many co-founders of deep tech startups in the APT countries have STEM backgrounds, strong human capital (personnel who hold Master or Ph.D. degrees), and solid experience in related industries or technologies. Most co-founders started their businesses based on their prior work and industry experiences, for instance from universities or research institutes, or from spin-off collaborations with universities and companies. These background, knowledge, and experience features of deep tech startups' founders confirm the importance of 'talent and human capital' and 'technology, knowledge creation, and transfer' (ecosystem factors C and D in Chapter 2), which belong to major ecosystem factors for deep tech startups. Several startups in the ASEAN regions report that a lack of deep tech talent and human capital in their countries limits their growth and scale-up.

[166] We can find the major differences between general and deep tech startups from the findings of case analysis in the APT regions. First of all, compared to general startups, deep tech startups seek to resolve challenges related to sustainable development (SD) at the country- and international levels. In addition, regarding the SD, they strive for impactful transformation of industry or business domains to maximize their impact, beyond focusing only on the niche market, despite a high risk of market and technology at the early stage. That is, compared to general startups seeking private benefits, the products or services offered by deep tech startups could be regarded as having social benefits and spillovers in the country across the APT regions. This can justify why policymakers need to pay attention to the government's support for deep tech startups and risk-sharing between public and private entities for deep tech startups.

Second, most deep tech startups in our cases have raised more than 1 million USD in their funding, with some raising more than 10 million USD in funding. Considering their age (less than 10 years) and sales-growth stage (either the early growth or initial expansion stage), this funding amount might seem considerably high. However, the amount of external funding compared to the sale size reflects that deep tech startups require greater 'access to venture capital (VC) financing' and 'intensive and large-scale funding' (ecosystem factor B in Chapter 2) than regular startups. Several startups in the ASEAN regions report that ASEAN deep tech startups tend to be underfunded compared to the U.S. or European startups in the same sector due to lack of track records, limited markets of products or services, insufficient opportunities for investors' exit (i.e., return harvesting), or less internationalized financing markets.

Third, deep tech startups have grown through long-lasting or intensive collaboration with and timely support from other actors of the entrepreneurial ecosystem for the startups (e.g., corporate partners such as large firms and SMEs, universities, research institutes, public organizations, etc.). They have also benefited from the collaboration or support in the stage of early business/technology development, prototype test or market expansion. They also acknowledge the importance of governmental or public support (e.g. R&D grants, public programs, de-regulation, collaboration with public entities, etc.) to reduce risks related to markets and technology at the early stage. These features of deep tech startups show the importance of 'physical and non-physical infrastructure' and 'startup barriers and government regulation' (ecosystem factors E and F in Chapter 2). In particular, the startups reported that regulatory requirements in domestic and international markets and their differences are critical in the healthcare, bio/Meditech, and FinTech fields.

Finally, the extent, type and field of deep technology applications to the industry differ, depending on the country's major industry domain, market demands, and other issues (i.e., social concerns, levels of technological development, and focus on specific SDGs). For example, market needs for products and services provided by deep tech startups are influenced by the size and sophistication of private or public sector demands in the APT countries. The field/industry applications and implementations of deep technologies also depend on the nation's industrial bases and development. These factors support the findings that 'market and economic conditions' (ecosystem factor A in Chapter 2) are vital to the creation and scale-up of deep tech startups.

5. Policy Recommendations for Sustainable Development through Deep Tech Startups

Previous chapters have reviewed the deep tech startup's concept and the entrepreneurial ecosystem's indicators and analysed related policies and startup cases in the ASEAN + 3 (APT) countries. The following policy recommendations are drawn from the preceding review and analysis.

1. Harmonise and adopt a common definition of deep tech startups to facilitate policy-making, monitoring and evaluation as well as data collection.

Currently, there is a lack of common definitions and understanding of deep tech startups across the APT countries. The review of policy and programs to support deep tech startups and their ecosystems in Chapter 3 of this report highlights a great variety of concepts and definitions, and in some countries, even shows a generalized lack of categorization of deep tech startups. Promoting more coherent frameworks in the APT region would be an important step towards, first, data collection around deep tech startup trends and dynamics; and secondly, data collection for monitoring and evaluation purposes and evidence-based policymaking. As the promotion of deep tech startups in general and deep tech entrepreneurship in particular is becoming an increasingly important policy priority for the APT region, this lack of definitions, data, indicators and monitoring schemes hinders evidence-based policymaking across jurisdictions.[167] (See recommendation 10).

2. ASEAN+3 countries should develop and expand talent enhancement, attraction and circulation programmes for deep tech innovation and startup creation.

Talent and skills for deep tech (from digital technologies in general, to AI, robotics, agritech, biotech and healthtech, fintech and more) are crucial to accelerating the emergence of deep tech startup ecosystems in the APT region. At present, talent availability for deep tech is

[167] It is understandable that defining deep tech startups for policy design and implementation is not easy in practice. Even some ASEAN states have not differentiated between startups and SMEs for the policy. Policymakers should appreciate that policies for SMEs and/or general startups are sometimes ineffective to appropriately support deep tech startups. Regarding the practical criteria and target fields for the identification of deep tech startups, refer to the 'Startup' and 'Deep-tech' criteria proposed in Section 4.1 and those in Korea's, Japan's and Singapore's policy cases (i.e., DIPS, DTSU, Startup SG Tech, and Startup SG Equity programs) presented in Section 3.2 of this report. The basic criteria should be consistent with the common definition of deep tech startups even if a certain component in the criteria and target fields might be modified according to each country's situation and context (e.g. economic development, industry and technology aspects) and major SD issues.

distributed unevenly in the region, with some countries (in particular Japan, Korea, Singapore and the more developed regions of China) characterised by the abundance of highly skilled talent in the deep tech sectors, whereas other countries in the ASEAN lag behind. Moreover, tech-intensive universities and research institutions in the above-mentioned countries are more advanced and capable of training deep tech personnel and talent. To bridge these gaps, APT countries should develop and expand mechanisms to promote the circulation of talent amongst more and less mature deep tech ecosystems. For example, tertiary education exchanges should be developed with a particular focus on deep tech talent development programmes. Other measures include tech and entrepreneurship startup visa programmes that allow deep tech entrepreneurs to move more freely in the region to establish relevant connections and promote the circulation of new ideas and technology adoption. Additional measures include programs to attract or connect deep tech startups with relevant diaspora networks.

3. Enhance public-private matching fund and investment-readiness programs for deep tech startups, and tax incentives for investors in deep tech startups.

Deep tech startups rarely have access to bank financing in early stages, while venture capital (VC) funding is more likely available at later stages. A public-private matching (co-investment) fund for risk sharing will encourage VCs to invest in early-stage deep tech startups.[168] Public money does not need to be traded for equity. When a deep tech startup receives VC funding, the startup should be eligible to get a matching grant from public agencies.[169] In addition, an investment-readiness program can remove the gap between founders and investors by equipping financial literacy and matching the two as early as possible through idea exchanges and mentorship.[170] The investment-readiness program can be finished at a fund-raising camp or investment day where investment offers should be

[168] This type of co-investment would be beneficial to the ASEAN countries in which VCs and private investors inactively invest in or pay less attention to early-stage deep tech startups. It can also be harnessed to increase collaterals of commercial banks' loans for such startups. The key principle for co-investment with the aim of risk sharing is that the share of the government investment fund or a public development bank on the government's behalf should be much higher than the shares of private investors at the early stage with greater risk, while the public share should decrease gradually after the intermediate stage, or significantly at the mature stage with lower risk to prevent the crowding-out effect.

[169] The grant is just a portion of the VC amount – for example, 1 to 5 or 1 to 7. For VCs, with the same check size, the startup's valuation is simultaneously increased. For founders, this prevents them from being diluted too early. Last but not least, deep tech startups have a longer runway through the valley of death. Most, if not all, ASEAN states will face the challenge of defining deep tech startups when implementing this public-private matching fund. The cases of Korea's Deep-tech TIPS program and Singapore's Startup SG Equity program offer some insight regarding the matching fund scheme. Refer to Sections 3.2 and 3.3. of this report.

[170] Deep-tech startup founders are usually scientists and engineers who have experience developing technologies and products, but lack business development and financial management skills. Before financial professionals join their teams, the founders should learn how to communicate their financial needs to investors. On the other hand, business angels, even those who are familiar with startup investing, should be ready for high failure rates, long development cycles, regulatory and ethical considerations, and intellectual property challenges, in addition to market and technology risks.

placed, and ideally matching grants and tax incentives are committed. Finally, tax incentives for deep tech startups can not only promote prioritized industries but also compensate investors' risk premiums, as investing in deep tech startups may be perceived as riskier than supporting traditional startups.[171]

4. Expand the demand for deep tech startups' products or services by leveraging industrial and innovation bases and the public sector through public procurement and demand-driven innovation.

Market demand is a crucial ingredient for deep tech startups to establish and scale up via the demand-pulling process. The demand needs to be further expanded in the amount and quality to promote the startups in the APT countries. It can come from the private and public sectors, and sometimes from an integration of the sectors. For example, market demand can come from enabling deep tech startups to act as pioneers innovating in related industries in the private sector. Policies bridging gaps between the innovation (or industry) entrepreneurship ecosystems will ensure deep tech startups capitalize on industrial bases for their birth and fast growth.[172] The demand can also come from public sector clients, especially in the sectors of edutech, health/biotech and cleantech, through public procurement or application to public services. Supporting deep tech startups tackling the challenges for sustainable development in the sectors will be beneficial to both the startups and the public. Drawing on public procurement would be beneficial to stimulate the demand of deep tech innovation.

5. Strengthen the routes by which deep technologies can be transferred and commercialized through targeted collaborations for substantial impacts in the ecosystem.

Transferring technology (including technical knowledge and entrepreneurial mindset) from universities or public research institutes to the private sector is a key component in promoting the creation and scale-up of deep tech startups.[173] Policies which promote

[171] China's tax policies for venture capital (VCs) and angel investors investing in tech startups – enforced from January 2018 to December 2023 – are good lessons to learn and adopt.

[172] Policymakers need to help deep tech startups and related private investors draw on abundant demands in targeted industry and technology sectors with greater SD impacts to maximize public support benefits. Regarding this, it is notable that policies and programs supporting deep tech startups in Korea and Singapore, for example, specify nine to ten technology or industry domains to be prioritized. China's policy also specifies target industries to advance industry and innovation ecosystems beneficial to related startups. However, core industry or technology fields will differ across the APT countries, depending on the country's context and situations (e.g. SDG priority, industry competitiveness, economic development, etc.). Policymakers need to appropriately assess which specific domains can be prioritized for the greatest impact in their countries.

[173] Technology transfer should be flexibly conducted within the intellectual property right (IPR) framework that encourages innovation. The ASEAN countries need to check whether the IRP framework legally fosters the innovation activities of

general business creation and entrepreneurship (including startup policies not targeting deep tech) will not automatically lead to fostering deep tech startups. Deep tech startups can be focused on market-oriented outcomes or on the commercialisation of deep technologies with impacts in the vibrant ecosystem, as deep tech innovations cannot be easily linked to market returns in the short term due to time, scale and investment requirements. Furthermore, it is necessary to foster collaboration for knowledge exchange between the startups and corporate partners through prototyping or productization (POC or POV) stages in the industry value chains. Such collaborations should lead to win (startups) - win (existing firms), rather than winner-take-all situations, through a range of collaboration mechanisms and pathways with impacts in the ecosystem.[174]

6. Expand physical and digital infrastructure to foster innovation and enable startups to thrive in a competitive environment.

Regarding physical infrastructure, the establishment of co-working spaces, innovation hubs, and technology parks across various regions must be prioritized to enhance accessibility for startups. These facilities should be strategically located to reduce geographical disparities and offer essential resources like high-speed internet, testing or prototyping equipment, and collaborative workspaces. Furthermore, integrating cutting-edge digital technologies, such as IoT, AI, high-performance computing, and blockchain, and science-based engineering technologies, such as Nanotech, Biotech and Greentech, within these hubs will ensure startups have access to advanced tools necessary for scaling their operations and driving innovation.[175] In addition, intangible infrastructure, including entrepreneurial culture or public programs promoting public-private partnerships, is equally essential to address deep tech commercialization challenges.[176] Non-physical infrastructure, such as mentorship programs and workforce development initiatives, should complement physical infrastructure improvements.[177] The partnership and culture can also facilitate the transition of research

tech startups.

[174] For this to happen, policymakers need to maintain a well-functioning ecosystem in line with good competition policies and existing structure.

[175] We have found in the ASEAN regions that some deep tech startups operating in non-manufacturing sectors (e.g., knowledge services, healthcare, agriculture, aquaculture, logistics, etc.) have invested in building up physical and digital infrastructure by themselves in the early or initial scale-up stage without any government (or public) support, although their products or services have social impacts and tackle SDGs. Their self-investment in the infrastructure under financial constraints has lowered their profit returns, or increased the commercialization period, thus reducing attraction by private investors and VCs. These problems could be lessened by timely collaboration partnership between the government and deep tech startups in the physical infrastructure.

[176] Collaborative efforts between government bodies, private investors, and academic institutions can diversify funding sources and create tailored financial solutions like grants, tax incentives, and low-interest loans.

[177] Although many deep tech startups' founding members have strong STEM backgrounds, the STEM talent per se does not guarantee startups' commercial success such as higher market returns and scale-up. Tailored skill development programs focused on upskilling and reskilling the workforce in advanced technologies will ensure a steady pipeline of skilled talent for deep tech startups. Targeted skill-building programs are essential to equip the workforce with expertise

and development (R&D) from laboratories to market-ready products, accelerating the growth of deep tech startups.

7. Remove startup barriers and refine government regulations to provide an enabling environment for the entrepreneurial success of deep tech startups.

Streamlining government regulations further ensures startups operate efficiently. Regulatory processes must be simplified and digitized to alleviate administrative burdens on startups. Simplified frameworks for registering businesses, accessing funding, and protecting intellectual property (IP) will eliminate unnecessary hurdles. The startup barriers and government regulations can differ across the APT countries, depending on the country's situation, administration context, and social and legal system. For instance, in some countries with weak IP systems, strengthening IP protection mechanisms will not only safeguard innovations but also attract foreign investment by demonstrating a commitment to ethical entrepreneurship practices.[178] Creating an integrated digital platform for centralized policy support, funding opportunities, and regulatory guidance can also simplify the startup journey.[179] Additionally, aligning domestic regulations with international standards is essential for enhancing the global competitiveness of deep tech startups. Harmonizing policies on data privacy, cybersecurity, and environmental sustainability will enable deep tech startups to expand seamlessly into global markets.[180]

8. Foster international collaboration regarding deep tech startups and ecosystems across the APT countries for investment and networking among startups, VCs and supporters.

Specific programs or events can be considered to promote global collaboration in the APT regions. These international collaborations can help achieve more integration of markets that are good for startups because they have access to more consumers and investors. The network initiatives or events can be proposed. For instance, 'Deep tech Hubs Network' with

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in cutting-edge technologies. Such programs should align with market demands and emerging trends, emphasizing areas like AI, data science, renewable energy, and biotechnology. Policymakers should work with educational institutions and industry leaders to develop curricula that address both current and future industry needs, ensuring startups have access to a well-prepared talent pool.

[178] Streamlining IP registration systems and making them accessible through digital platforms can significantly reduce the time and cost involved in securing IP protections. This effort will encourage startups to innovate without fear of losing competitive advantages, fostering a culture of creativity and entrepreneurship.

[179] This platform should provide a one-stop solution for accessing resources such as grant applications, tax incentive details, regulatory compliance checklists, and mentorship directories. By reducing the complexity of navigating various systems, this initiative will enable startups to focus on core business activities and growth strategies.

[180] Consistent with the global standard, coordinated funding mechanisms and tax incentives that promote long-term sustainability will further solidify the ecosystem of deep tech startups, ensuring resilience and scalability in the ecosystem.

vertical focuses based on national competitiveness can stimulate international alliances by creating synergies among deep tech startups dedicated to their national domain/industry.[181] 'ASEAN+3 Deep Tech Tour' can provide opportunities for exploring new markets, learning new technology and industrial trends, and exchanging ideas that are helpful to deep tech founders. The tour is also an opportunity for peer learning and collaboration.[182] Lastly, 'ASEAN+3 Deep Tech Summit' can be suitable. This annual summit will be not only a gathering of the deep tech community – i.e., founders, policymakers, supporters, and experts – but can also attract international investors. The summit can start first as a part of ASEAN+3's well-known events.

9. Policymakers and business leaders should acknowledge and investigate further the relationship between deep tech startups and the SDG framework to promote innovation conducive to sustainable development.

There are many ways in which deep tech innovations and startups promote the agenda of SDGs.[183] Policymakers in the APT region should clarify and investigate this relationship in their respective countries and at the regional level to enhance policy initiatives and policy support. For example, a comprehensive mapping of priority deep tech areas for the SDGs could be conducted.[184] At present, a majority of policy initiatives for deep tech startups in the APT countries are not making explicit the relations between deep tech and SDGs, and this represents a missed opportunity. Investigating the connections between deep tech innovations (including startup creation and growth) and SDGs should also include mapping emerging clusters in the ASEAN+3 region detailing how deep technologies are used to advance all 17 SDGs. A portal with relevant use cases could be developed under ACCSME to facilitate sharing good practices as well as cutting-edge SDG-related startup business models that are emerging in various deep tech application areas.

[181] Promoting deep tech startups is a long-term strategy and, thus, requires substantial resources. Such a national strategy should focus on prioritized industries where the nation has the most comparative advantages. In light of this, the ASEAN member states may want to create a deep tech hub network with vertical focuses based on national competitiveness.

[182] Regarding this tour, national agencies (who are in charge of deep tech startup development), or ideally the national deep tech hubs, should be the national hosts. When it comes to the US and Europe, ASEAN+3 launchpads, such as K-startup Centers, should be leveraged. Diaspora deep tech talents should be also invited to join the tour.

[183] See Figure 1.2 in Chapter 1 of this report.

[184] Examples of areas of focus could include: healthtech (as a way to bring health innovations to wider segments of the population), fintech (as a way to promote financial inclusion and accompany individuals from informality into the formal economy), agritech (as a way to enhance food security and accelerate the green transition and bring innovations to rural areas), women and girls in tech and innovation (to promote more women-led deep tech startups and grow ASEAN+3 economies), etc.

10. Monitor the indicators for the entrepreneurial ecosystem of deep tech startups to facilitate evidence-based policy planning and implementation.

Monitoring indicators reflecting on the entrepreneurial ecosystem (EE) for deep tech startups is the baseline for policy design, implementation, and assessment.[185] The indicator measurement and data collected should be based on the harmonized definition and periodically monitored to facilitate collaboration among the APT countries. Collecting up-to-date and reliable data for the EE indicators in and across the APT countries is challenging in practice. Some indicators are unavailable or outdated in certain countries, while others are difficult to compare across countries. It will be necessary for data collection to harness partnerships with a range of public and private entities, such as national statistical agencies, public research institutes, industry/startup associations, and private investors. The ACCSME at the ASEAN+3 level has the opportunity to take the lead and embark on a data collection exercise that can explore and examine the latest trends and developments in the APT region, with a particular focus on the SDGs.

[185] The EE indicators should be developed to ensure that they are related to the factors influencing the ecosystem's stakeholders and components as well as deep tech startups. The indicators of EE for deep tech startups need to cover the startup and innovation ecosystems. They also need to be designed given the feasibility of applying the concepts of deep tech startups and EE to policy practice. Refer to Chapter 2 of this report.

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Appendix

Appendix A. Additional information on the policies for deep tech startups or tech startups in the APT countries

China Ministry of Industry and Information Technology (MIIT) (2024)'s six future industries[186]

- Future Manufacturing: Develop smart manufacturing, biomanufacturing, nanofabrication, laser manufacturing, and circular manufacturing, make breakthroughs in key and core technologies such as intelligent control, intelligent sensing, and simulation and emulation, promote flexible manufacturing and shared manufacturing models, and drive the development of the industrial internet and industrial metaverse.
- Future Information: Promote the industrial application of technologies such as next-generation mobile communications, satellite internet, and quantum information, accelerate innovation breakthroughs in quantum and photonic computing technologies, accelerate deep empowerment, with brain-inspired intelligence, swarm intelligence, and large models, and foster intelligent industries.
- Future Materials: Promote the upgrading of advanced basic materials such as non-ferrous metals, chemicals, and inorganic non-metals, develop key strategic materials such as high-performance carbon fibre and advanced semiconductors, and accelerate innovation and application of cutting-edge new materials such as superconducting materials.
- Future Energy: Focus on key areas such as nuclear energy, nuclear fusion, hydrogen energy, and biomass energy, and build a "collection-storage-transportation-application" complete chain of future energy equipment systems. Develop new types of crystalline silicon photovoltaic cells, thin-film solar cells, and related electronics equipment, accelerate the development of new types of energy storage, and promote the integration and upgrading of the energy electronics industry.
- Future Space: Focus on the aerospace, deep-sea, and deep-earth fields, develop manned spaceflight, lunar and Martian exploration, satellite navigation, near-space unmanned systems, advanced and efficient aircraft, and other high-end equipment. Accelerate the development and innovative application of deep-sea submersibles, deep-sea operations equipment, deep-sea search and rescue and detection equipment, and deep-sea intelligent unmanned platforms, and promote equipment development in deep-earth resource exploration, urban underground space development and utilization, and polar exploration and operations.
- Future Health: Accelerate the industrialization of cutting-edge technologies such as cell and gene technology, synthetic biology, and bioengineered breeding, promote new medical services empowered by technologies such as 5G/6G, the metaverse, and AI, and

[186] Source: https://cset.georgetown.edu/wp-content/uploads/t0582_future_industries_EN.pdf

develop high-end medical equipment and health products integrating digital twins, brain-computer interaction, and other advanced technologies.

China's deductions on R&D expenses to promote technology innovation[187]

- For technology SMEs (TSMEs): As of January 1, 2022, if the R&D expenses of TSMEs do not form intangible assets and are included in the current profits and losses, on the basis of actual deduction, an additional 100 % of such R&D expenses could be deducted from the taxable income amount; if the R&D expenses have formed intangible assets, they can be amortized before CIT at 200 % of the actual cost of intangible assets.
- For manufacturing enterprises (except tobacco manufacturing): starting from January 1, 2021, if the R&D expenses do not form intangible assets and are included in the current profits and losses, on the basis of actual deduction, an additional 100 % of such R&D expenses could be deducted from the taxable income amount; if the R&D expenses have formed intangible assets, they can be amortized before CIT at 200 % of the actual cost of intangible assets.
- For other enterprises (except tobacco manufacturing, lodging and catering, wholesale and retail, real estate, leasing and commercial services, and entertainment): starting from January 1, 2023, if the R&D expenses do not form intangible assets and are included in the current profits and losses, on the basis of actual deduction, an additional 100 % of such R&D expenses could be deducted from the taxable income amount; if the R&D expenses have formed intangible assets, they can be amortized before CIT at 200 % of the actual cost of intangible assets.

China's tax policies for venture capitals (VCs) and angel investors investing in tech startups (from January 2018 to December 2023)[188]

- VC companies that have directly invested in technology-based startups or seed-stage companies through equity investment for two years can deduct 70 % of the investment amount from its taxable income in the year when the equity has been held for two years; if the amount is not enough for the deduction in the current year, it can be carried forward and deducted in the following tax year.
- For limited partnership VC enterprises that have directly invested in technology-based startups or seed-stage companies in the form of equity investment for two years, the partners are eligible for the following deductions: (a) a legal entity partner can deduct 70 % of the investment amount from the share of income received from the partnership; and (b) individual partners can deduct 70 % of the investment amount from the operating income that individual partners receive from the partnership.
- Angel investors who have directly invested in technology-based startups or seed-stage

[187] Source: https://www.china-briefing.com/news/china-startup-landscape-industries-investment-and-incentive-policies/?form=MG0AV3

[188] Source: https://www.china-briefing.com/news/china-startup-landscape-industries-investment-and-incentive-policies/?form=MG0AV3

companies through equity investment for a period of two years may deduct 70 % of the investment amount from the taxable income obtained from the transfer of equity. Furthermore, if an individual angel investor has invested in multiple technology startups, and one of them is liquidated, then the taxable income obtained by the investor from the transfer of equity to other startup technology companies can be deducted within 36 months from the date of liquidation. This is provided the angel investor has not already deducted 70 % of the investment amount from the taxable income (of the startup being liquidated).

Review of 'The Indonesian Ministry of Cooperatives and SMEs' Startups Capacity Enhancement Program'

- Policy brief and/or major goal: The Indonesian Ministry of Cooperatives and SMEs' Startups Capacity Enhancement Program is an initiative which aims to support early-stage startups to increase their competitiveness and sustain growth, enabling them to reach the global market such as Japan, South Korea, and the Netherlands.[189] Since its launch in 2021, the program also aims to leverage the country's educated human resources to drive economic growth through science and technology. The program was held in collaboration with incubation institutions from universities and local governments, as well as external partners such as financial institutions, venture capitals, state-owned enterprises, and non-governmental institutions. Specifically, there are three phases for the incubation program: (i) pre-incubation, encompassing participant selection and contract signing; (ii) incubation, providing mentorship, consultations, and business-matching to transform ideas into viable ventures; and (iii) post-incubation, offering networking support, evaluations, and improved access to financing.[190] More details and provisions on the program are regulated by Government Regulation (GR) No. 7/2021 on the Ease, Protection, and Empowerment of Cooperatives and SMEs ("GR No. 7/2021") and the Minister of Cooperatives and SMEs Regulation No. 14/2023 on the Norms, Standards, Procedures, and Criteria for Conducting Incubation Development.
- Policy targets or scope: The program aims to foster startups with potential high economic value, especially those which leverage technological innovation for their business model or product, helping to solve relevant economic, environmental, and social issues. Hence, one of the prioritized criteria for the selection is the startups' role in green transition or green business. As for the scope, provincial-level local governments are required to facilitate at least 50 startups or participants annually, while municipal-level governments must support a minimum of 20 startups[191]—though it is unclear if participant nominations may overlap at these levels.

[189] IPB News. "LKST Collaborates with Ministry of Cooperatives and SMEs to Select 20 Tenants for Startup Capacity Enhancement Program." https://www.ipb.ac.id/news/index/2024/05/lkst-collaborates-with-ministry-of-cooperatives-and-smes-to-select-20-tenants-for-startup-capacity-enhancement-program/

[190] GR No. 7/2021. https://www.fao.org/faolex/results/details/en/c/LEX-FAOC222252/#:~:text=Indonesia-,Government%20Regulation%20no.,b%20of%20the%20Law%20no.

[191] *Ibid.*

- Period of the policy support: While there is no specific duration for the program, it is stipulated that the incubation period must be no shorter than three (3) years, including at least two (2) years of monitoring and evaluation of participants' business development.[192]
- Organizations and financial budgets/investments for the policy design and implementation: The Ministry of Cooperatives and SMEs of the Republic of Indonesia is the main focal point of the program, spearheading the establishment of a nation-wide network and partnerships with business incubators from universities and local governments. It also provides funding to support the incubation processes and programs. Meanwhile, a budget of almost 11 billion Indonesian Rupiahs (IDR) (equivalent to USD 701.8 thousand) has been allocated in 2024 for this program. The total amount of budget spent between 2021-2024 alone is more than IDR 30.4 billion rupiahs (USD 1.9 million).[193]
- Criteria to select policy targets: The program focuses on targeting technology-based startups which leverage technological innovation, with the 2024 round specifically prioritizing startups in sectors such as aquaculture, agriculture, green business, and ICT. Nevertheless, the program is open to non-digital startups as long as they have an export orientation or are based in the creative industry. Startups must also already be legally operational, generating revenue or actively developing, and aged a maximum of 3 years. Additionally, proficiency in English is required for startups who wish to participate as the program aims to help access international markets.[194]
- Means for support: As a business incubation program, the policy is designed to provide startups with training, mentorship, consultations, business-matching, and network opportunities to support growth and expansion. These services are specifically focused on product design, manufacturing, marketing, human resource development and management, financing, and the use of technology.[195] The program also provides funding for business incubator institutions throughout the country, helping to promote human resource development and improve the overall startup ecosystem.
- Policy performance: Since its launch in 2021, a total of 4926 participants[196] and 557 business incubators have joined the program.[197] However, more comprehensive data or reports on the performance of the program have yet to be made publicly available. According to information that the authors obtained during conversation with officials from the Ministry of Cooperatives and SMEs, most startups experience business growth after incubation and promotion, though overall it remains modest. This is partly due to the short incubation period, which is based on activity stages rather than outcomes.

[192] *Ibid.*

[193] Indonesian policy review submission by the Indonesian SC: Indonesian Ministry of Cooperatives and SMEs. "Startup Capacity Building Program 2024." https://dikst.ub.ac.id/program-peningkatan-kapasitas-startup-kemenkop-ukm-tahun-2024/

[194] https://dikst.ub.ac.id/program-peningkatan-kapasitas-startup-kemenkop-ukm-tahun-2024/ (in Indonesian)

[195] GR No. 7/2021 https://www.fao.org/faolex/results/details/en/c/LEX-FAOC222252/#:~ =Indonesia-,Government%20Regulation%20no.,b%20of%20the%20Law%20no.

[196] There is no further information on the type of these enterprises, specifically whether they are startups or general SMEs, and in which sectors they operate (technology, green business, or creative industries).

[197] Ministry of Cooperatives and SMEs. "Startup and SME Incubators." https://sipensi.kemenkopukm.go.id/

Additionally,

- post-incubation business acceleration mechanisms are not fully optimized. Monitoring and evaluation results show that, after the program—especially in the second and third years—some startups do not continue their businesses, as they struggle to grow, shift careers, or change their business focus[198]. Challenges also include selecting quality business incubators which can provide better opportunities for startups to grow. Out of the 557 incubators listed in the program, only 15 have been accredited, while the rest are either not yet accredited or have applied for accreditation.[199]
- Other considerations: It is noteworthy that the policy recognizes the importance of developing a robust national startup ecosystem through a comprehensive approach, targeting not only startups but also business incubators through the funding mechanism. Upon reviewing the listed incubators, it is evident that most of them come from educational institutions and/or universities. This is an important step to strengthen university-industry linkages, which are crucial for supporting the national innovation ecosystem. However, it is unfortunate that Indonesia's GERD is still among the lowest in the ASEAN+3 countries (refer to Section 2.2. in Chapter 2). The low level of government's commitment eventually reduces the potential to transform this connection into a significant boost for deep tech innovation.

  Moreover, concerns regarding the absence of proper and legal definitions for startups in Indonesia remain, as it raised questions regarding the policy's target and expected outcomes. While the legal basis for the program, particularly GR No. 7/2021, provides only general provisions governing 'Cooperatives and SMEs' without specific mention of startups, ministry documents were circulated for publicly listed startups as targeted participants. This lack of legal clarity ultimately correlates with the absence of specific Acts and/or policies that regulate startups, as startups in Indonesia are most commonly categorized only as either legal entities without legal entity status[200] or, at best, as SMEs. Furthermore, with the absence of a legal definition for "deep tech", the technologies mentioned in the policy remain vague, with references made only to digital technology or ICT, suggesting that the program is not specifically aimed at developing deep tech startups. In addition, there were only limited efforts by the government to make data on this program more accessible to the general public, both in terms of availability and language, as the main webpage for the program only provides limited information in Indonesian.

Review of additional information on Thailand's policies for digital deep tech startups

- Policy overview: the Digital Economy Promotion Agency (DEPA) illustrates the mechanisms and strategies for promoting digital industry and innovation. It highlights

[198] Per conversation between authors and officials from the Ministry of Cooperatives and SMEs

[199] Ministry of Cooperatives and SMEs. "Startup Incubators Overview." https://sipensi.kemenkopukm.go.id/inkubators

[200] Indonesia Business Post. "Understanding Startup Regulations in Indonesia." https://indonesiabusinesspost.com/regulatory/how-to/how-to-understand-startup-regulations-in-indonesia/

three main areas: Reinforcement, Transformation, and Ecosystem. The policy emphasizes the importance of digital startups in various sectors such as Healthtech, Govtech, Agritech, Edtech, Fintech, and Traveltech. It also focuses on transforming businesses and creating new growth engines in agriculture, SMEs, industry, and community. Additionally, it outlines the importance of enabling a digital ecosystem and improving manpower skills from literacy to advanced expertise. The mechanisms listed include improving employment rate, purchasing power, quality of life, community, civil society, and sustainable economic growth.

- Policy goal: The policy aims to develop a strong, resilient, and dynamic digital economy and society based on advanced human capital, technology, and innovation.
- Key pillars of the policy: (i) Automation: Integrated system, Simulation, Robotics, Robotic Process Automation; (ii) Data: Big Data and Analytics, AI, Blockchain, High-Performance Computing; (iii) Connectivity: IoT, Next Gen Network, Digital Twin, Web 3.0; (iv) Access: Cloud and Edge, X-Reality, Additive, NANO-CHIPS, Cyber Security, PDPA.
- Policy target and implementation mechanisms: (a) transform human capital for the digital economy and society (build new skills for new generations, upskill and reskill existing workforce, and fill up a digital talent pool); (b) transform traditional Economy into high-value digital economy (accelerate digital startups to reach global markets, accelerate value creation by digital industry, accelerate the digitalization of Indigenous sectors, and accelerate the digitalization of the local economy); (c) build new opportunities and inclusive economic development (build liveable smart cities, build inclusive new opportunities, and build a quality digital society); (d) optimize the use of digital infrastructure (optimize digital infrastructure for all, and enhance the competitiveness of the Thai digital ecosystem)
- Other considerations: This policy framework aims to create a conducive ecosystem for deep tech startups, addressing their unique challenges and fostering innovation across various sectors. By leveraging advanced technology and innovation, Thailand strives to build a sustainable and competitive digital economy.

Review of additional information on Viet Nam's policies for deep tech startups

In Viet Nam, policies promoting deep tech startups can be found in various policies and programs at both national and municipal levels. In addition to the central government's 844 Program implemented by the Ministry of Science and Technology, the following programs are reviewed: 1665 Program by the Ministry of Training and Education; Decree 80, Decree 39, and Decree 38 on supporting startups and innovative SMEs; special mechanisms to support startups by the local government of Ha Noi (4889 Program), Da Nang, and Ho Chi Minh.

'Central Government's 1665 Program (National Program on Supporting Pupil and Student Entrepreneurship)'

- Policy goal and/or major goal: On October 30th, 2017, the Prime Minister of Viet Nam signed Decision No. 1665 approving the National Program on Supporting Pupil and

Student Entrepreneurship to 2025; in short, the 1665 Program. The 1665 Program aims to promote entrepreneurship in pupils and students by (a) offering entrepreneurship education and training, (b) enabling favourable environments to develop ideas into startup projects and companies. Specific goals of the Program are as follows: by 2020 (i) 100% of universities, academies, colleges, and vocational schools have developed plans for promoting entrepreneurship in pupils and students; (ii) At least 90% of high school pupils and students have access to entrepreneurship training and education; (iii) 100% of universities, academies and 70% of colleges, and vocational schools have at least 2 startup projects/companies receiving funding or investment; by 2025 (i) 100% of universities, academies and 70% of colleges, and vocational schools have at least 5 startup projects/companies receiving funding or investment.

- Policy targets or scope: All high school pupils and students in universities, academies, colleges, and vocational schools, as well as the teachers and staff members, are eligible to receive support from the 1665 Program.
- Period for the policy support: 2017-2025
- Organizations and financial budgets for the policy design and implementation: The Department of Student Affairs (Ministry of Education and Training) is the implementation agency of the 1665 Program. There is no dedicated financial budget for the 1665 Program. The implementation agency has to collaborate with other ecosystem players including government agencies, universities and schools, municipal governments, and corporations to finance activities and events.
- Criteria to select policy targets: N.A.
- Means for support: In addition to collaborating with other ecosystem players, the MOET has introduced performance indicators to measure if universities or schools have been moving toward the Program's goals. The indicators include "if a plan for promoting entrepreneurship is available," "if the university allocates a budget for entrepreneurship training and events," "number of student startup teams," and so on. The flagship of the 1665 Program is the annual SV-Startup Competition.[201] The Competition has two rounds. The first is at schools, universities, and colleges to select winners to compete in the national/final round.
- Policy performance: By the end of 2023, the 1665 Program has almost reached its goals. (a) 100% of universities, academies, colleges, and vocational schools have developed plans for promoting entrepreneurship in pupils and students; (b) 90% of high school pupils and students have access to entrepreneurship training and education; and, (c) 8% of students become founders in 5 years after graduation.
- Other considerations: Although universities are great sources of innovation and deep technology, innovation, especially the commercialization of research results and technologies, is not among the top agendas of most universities.

[201] SV means student.

Appendix B. Additional cases on deep tech startups in the APT countries

Review of deep tech startup cases in Indonesia

[C] 'Jala' case (https://jala.tech**)**

- Basic profile: Jala was Founded in Yogyakarta, Indonesia, in 2018. Jala has been a pioneer in sustainable shrimp farming since its inception in late 2016. Under the leadership of Co-Founder and CEO Liris Maduningtyas, Jala is dedicated to enhancing productivity and efficiency in shrimp farms, ultimately promoting sustainability in the aquaculture industry, both in Indonesia and globally. By actively engaging in the aquaculture process and supply chain, Jala empowers farmers to make informed decisions and reduce uncertainty in production outcomes. Additionally, Jala won 2nd place in the 2023 UMKM Digital Heroes, held by the Ministry of Cooperatives and SMEs (KemenKopUKM).
- Products and Services: Jala offers three main products designed to support shrimp farmers: (1) Digital Technology (Jala App & Jala Baruno): These tools provide real-time data recording and monitoring features, delivering comprehensive analyses of cultivation productivity. (2) Farm Management (Jala Smartfarm): This service includes joint operations with shrimp farms, providing partnership and assistance while integrating Jala's technology and expertise. (3) Harvest and Market Access (Jala Harvest): This offering enables direct harvesting at the farm with fair pricing, a broad network, and quick, secure transactions.
- Performance: Jala has established a significant presence in the shrimp industry, earning the trust of over 20,000 users. The Jala App has monitored shrimp across more than 35,300 ponds, leading to the successful harvest of over 9,900 tons of shrimp. Notably, Jala has partnered with Conservation International to create the first Climate Smart Shrimp initiative, combining traditional shrimp farming practices with mangrove restoration efforts. In addition to harvest access services that help farmers market their products effectively, Jala provides farm assistance, offering direct guidance to tackle daily challenges.
- Recent Investment (Fundraising): Jala has recently completed a Series A funding round, securing $13.1 million. This investment will allow Jala to further strengthen the shrimp cultivation industry in Indonesia and expand its operations into regions such as Sumatra, Sulawesi, and Nusa Tenggara, each with unique potential for shrimp farming growth. The funding round was led by Intudo Ventures, the only venture capital firm focused exclusively on Indonesia, with participation from SMDV, a VC firm specializing in technology companies. Existing investors, including Mirova, which emphasizes sustainable investments, and Meloy Fund, which focuses on fisheries and seafood, also contributed.
- Impact and Sustainability: Jala addresses critical issues in sustainable shrimp farming, a vital industry in Indonesia. By enhancing water quality management, Jala mitigates environmental degradation from poor aquaculture practices, aligning with Sustainable Development Goals (SDG) 14 (Life Below Water) and SDG 12 (Responsible Consumption and Production). By helping small-scale farmers boost productivity, Jala contributes to

SDG 8 (Decent Work and Economic Growth) by increasing employment opportunities within the aquaculture sector.

- Innovative Approach: Jala stands out for its innovative integration of IoT and AI technologies in shrimp farming. Its real-time monitoring systems and predictive analytics for disease prevention and water quality management represent a disruptive advancement in the sector. Furthermore, Jala's business model combines hardware sales with recurring SaaS-based subscriptions for data analytics, fostering long-term customer engagement.

[D] 'Nusantics' case (https://nusantics.com**)**

- Basic profile: This company was founded in 2020 by Revata Utama. Nusantics has been at the forefront in handling various health challenges such as launching the COVID-19 RT-PCR Test Kit, Variant Detection Kit, Biome Scan – Skin microbiome profile analysis, AirScan, PUMU PCR Child-friendly mouthwash, RT-PCR Test Kit for detecting Foot and Mouth Disease (FMD) in livestock, and early detection services for shrimp diseases.
- Underlying technologies and business model: Nusantics is a molecular diagnostic company in Indonesia that focuses on PCR and Next Generation Sequencing-based solutions to improve the quality of health in humans and animals.
- The company's ultimate goals and impacts: The company aims to develop precision medicine based on genomics and microbiomes. Its mission is to eliminate diagnostic gaps, thereby improving healthcare outcomes in humans and animals.
- Recent performance: The company's technology was used in more than 8 million tests during the COVID-19 pandemic. Nusantics won the award at G20 Digital Innovation Network (DIN) 2022 in Bali for the healthcare category and the award for best startup from the Ministry of Health Republic of Indonesia in 2023. Nusantics also received investment from east ventures and world-renowned genomics company Illumina.

Review of deep tech startup cases in Thailand

[B] 'GENSURV Robotics' case (https://gensurv.com/en/home/)

- Basic profile: (a) establishment year: 2012; (b) founder: Ms. Wareemon Puraphati (CEO and founder); (c) size (sales) of USD 1.37 million; employs a team of experts in marine and land robotics engineering; (d) current stage: expansion or scale-up; (e) major customers and business segments: internal logistics, warehouse 4.0, agriculture, security, and surveys of hazardous areas, such as mining sites. This company has carved a niche for itself as a pioneer in developing cutting-edge automated solutions tailored to meet the diverse needs of industries ranging from internal logistics to hazardous area surveys. This company specializes in researching, designing, and developing intelligent and flexible automated systems designed to enhance productivity while being environmentally friendly.
- Underlying technologies and business model: GENSURV Robotics specializes in advanced

robotics for industrial automation and surveillance. Their business model focuses on: (a) novelty: developing autonomous systems such as forklifts, pallet stackers, large survey boats, and shuttle systems; (b) investment and market/technology tests: significant investment in R&D to innovate and stay ahead in the market. The company's solutions undergo rigorous testing to ensure reliability and efficiency.

- The company's ultimate goals and impacts: (a) market aspects: enhance operational efficiency and productivity in various sectors; (b) social aspects: create new job opportunities, drive economic growth, and promote sustainability through environmentally friendly practices.
- Starting points: (a) pain points: Addressing the need for efficient and reliable automation in industrial processes; (b) key value proposition: Providing intelligent, flexible, and reliable robotic solutions; (c) background organizations: The company has received support from various Thai government agencies, including the Thailand Research Fund, DEPA, and the National Innovation Agency.
- Growth path: Since its establishment in 2012, GENSURV Robotics has grown significantly as follows: (1) 2012-2016: Developed autonomous boats and underwater robots; (2) 2017-2018: Introduced autonomous forklifts and pallet stackers; (3) 2019-2020: Launched DD Navigation and DD Fleet Management systems; (4) 2021-2022: Developed autonomous tow trucks and 5G-enabled mobile robots for agriculture; (5) 2023-2024: Working on autonomous buses.
- Recent performance for fast-growth or scale-up: (a) 75% for the last three years (sales of $1,367 K in 2022 and $551K in 2020) (b) employment growth: employs a team of experts in robotics engineering; (c) evidence of scale-up: (c) expansion into various sectors (e.g., agriculture; security and hazardous area; healthcare and hospitals) and continuous development of new autonomous systems for diverse fields (e.g., autonomous electric bus; electric tow trucks, autonomous technology software) (d) increase of funding amount or market valuation: received grants from the Thailand Research Fund, DEPA, and the National Innovation Agency;
- Embeddedness in the ecosystem for deep tech startups: (a) collaboration and alliances: collaborates with the Center of Robotics Excellence and the Thai German Institute; (b) benefits from the ecosystem: access to funding, research facilities, and a network of industry experts.
- Support from government policies or public programs: (a) government policies: supported by Thailand's policies for deep tech startups, including financial and infrastructural support; (b) public programs: benefited from programs like the Digital Transformation Fund and the National Innovation Agency's initiatives; (c) national infrastructure: utilizes national research facilities and innovation centers.
- Internationalization: collaboration with international partners for R&D.
- Information sources: Department of Business Development, National Innovation Agency and News articles

Review of deep tech startup cases in Viet Nam

[C] 'Genetica' Case (https://genetica.asia/en**)**

- Basic profile: This company provides DNA-based genetic testing and analysis platform for medicine and personalized preventative healthcare. It was established in 2018 by Dr. Cao Anh Tuan and Dr. Bui Thanh Duyen to bring the most advanced genetic testing and decoding technology to Asia, and is one of the top gene decoding platforms in the region.
- Underlying technologies and business model: The two core technologies that set Genetica apart from other gene decoding services on the market are the integration of proprietary AI (Artificial Intelligence) technology to accurately and effectively process petabytes of genetic data, and blockchain technology which guarantees the security and ownership of users' private data. The technology is designed specifically to analyse Asian human genomes, addressing the genetic variations unique to the region. For the business model, the company provides personal gene decoding services: Genetic analysis for personalized health, nutrition, and lifestyle recommendations (e.g., planning for child upbringing and education; personalizing physical training and nutrition regimes; assessing the risk of hereditary diseases (stroke, diabetes, allergies, virus risk); screening for 20 common hereditary cancers among Asians).
- The company's ultimate goals impact: It aims to become the leader in gene analysis across Asia, driven by a commitment to expanding healthcare solutions which cater to the demand for tailored medical services. By leveraging advanced technologies in genomics, it aspires to empower individuals and communities with accessible and secure genetic insights, ultimately improving health outcomes through enhanced, data-driven healthcare decision-making. It offers a holistic approach to improving well-being at a regional and global scale.
- Starting points: After many years working in the U.S., the founder (Dr. Tuấn Cao) and his colleagues recognized a significant gap in genetic data regarding Asians in general and Viet Namese people in particular. The consequence of this gap is that the latest medical research and breakthroughs have primarily focused on Western populations. Even research on drugs and vaccines for Asians during complex phases such as global pandemics faced many challenges due to the lack of sufficient genetic data. After careful analysis, the founders recognized the potential risks of mismanaged genetic data in the U.S. and the West in general. Thus, Genetica aims to focus on Viet Namese and Asian genes in the global genetic map, and to redesign its genetic analysis and data security model using new technologies like blockchain and AI.
- Growth path: Its growth is marked by strategic expansion, technological innovation, and impactful collaborations. (i) 2018-2019: founded in Viet Nam and partnered with leading research institutes to establish a strong foundation in biotechnology; (ii) 2019-2022: expanded operations into Southeast Asia, choosing Viet Nam as its development hub, and launched personalized gene decoding services, forged partnerships with healthcare and insurance companies, and began building its reputation as a reliable provider of precision healthcare solutions; (iii) 2022-2023: established the largest gene decoding center in

Southeast Asia and expanded its genetic database, focusing on the unique genetic traits of Asian populations, thus providing more accurate and relevant genetic insights; (iv) 2023-present: continued to expand regionally, integrating genetic services into healthcare ecosystems across different markets, providing personalized healthcare to a larger audience through partnerships and collaborations.

- Recent market performance for fast-growth or scale-up: (i) sales growth – a rapid increase in sales for the last three years due to the growing interest in personalized health solutions, expansion into Southeast Asia and strategic collaborations with key partners; (ii) market expansion: from Viet Nam to Singapore, Thailand, and other Southeast Asian countries, establishing itself as a leader in gene decoding for the Asian population; (iii) employment growth - in response to increased demand, a growth of workforce with a focus on expanding its R&D and customer support teams to meet market needs; (iv) funding and valuation - completed 3 rounds of funding, raised $11.9M to fuel its growth
- Embeddedness in the ecosystem for deep tech startups: Genetica's deep integration into the ecosystem of healthcare, biotechnology, and tech-driven solutions has significantly contributed to its rapid growth and success. Key collaborations and alliances include:
- healthcare institutions (partnerships with over 30 hospitals); government and public sector (e.g. with strong support from the Viet Namese government, including endorsement from the National Innovation Center), academic and research alliances (collaborations with research institutes and universities; blockchain and data security partners (e.g. Avalanche Ecosystems), corporate collaborations (e.g. insurance companies like AIA and Prudential), etc.
- Support from government policies, public programs or national infrastructure: benefited from (i) startup policy support for training and networking; (ii) Ministry of Planning and Investment that provided support through various initiatives and programs to encourage innovation, including facilitating connections with global investors and healthcare-focused partners; (iv) National Innovation Center (NIC) for facilities and international partnerships; (v) tax Incentives for high-tech enterprises.
- Other considerations: Genetica faces several challenges as a deep tech startup, including high costs, market education barriers, data privacy concerns, the complexity of obtaining regulatory approvals, the need for specialized talent, and competition from larger international players. Genetica is actively working to overcome these barriers through partnerships, technological advancements, and government support.[202]
- Information sources: information provided by the founder-CEO; information from

[202] The challenges are as follows: (i) investment cost - high initial costs for gene decoding technology and infrastructure; (ii) market awareness - limited consumer knowledge about genetic services, especially in emerging markets; (iii) building trust - concerns about data privacy and the sensitivity of genetic information are major challenges, (iv) affordability - often expensive services, making less accessible to the broader population in developing markets; (v) regulatory challenges - complex regulatory requirements in different countries, leading to time-consuming and costly and hindering market expansion; (vi) access to specialized talent – recruiting and retaining specialized talent in genetics, AI, and data science is challenging due to high competition in the industry; (vii) competition from established players - competing with larger international companies with more resources and brand recognition is a significant barrier to growth.

company website (https://genetica.asia/en); news articles; [203] other sources (https://pitchbook.com/profiles/company/462689-20#overview)

[D] 'Viet Nam Food Joint Stock Company (VNF)' case (https://www.vnfoods.vn/**)**

- Basic profile: VNF, established in 2013, develops agricultural by-product processing and makes a range of products such as agricultural inputs (bio-solutions), pet food and pet care, human food & human care, supplements, and industrial.
- Underlying technologies and business model: Regarding the business model (BM), VNF is a pioneer in upcycling shrimp by-products into value-added applications for various industries. VNF employs biotechnology with a zero-waste production mindset to maximize nutrient extraction while minimizing resource use and reducing environmental impact. For this BM, VNF has developed and maintained key technologies for inputs and outputs. The input technologies apply biotechnology to extract the bioactive ingredients in shrimp by-products (i.e. Peptides, Chitosan, Astaxanthin, etc.) and advanced physical techniques to increase values (i.e. Filtration, Concentration, Spray-drying, Cold grinding, etc.). The goal of the company is to develop new bio-solutions derived from above-mentioned ingredients to be reapplied into various industries, and to focus on the reduction or replacement of imported and chemical-based agricultural materials, which currently make up over 80% of the sector's inputs, and thus foster a more circular, self-sufficient, and sustainable economy
- The company's ultimate goals and impacts: This company aims to recover valuable nutrients from Agricultural by-products to meet global demand for nutrition and sustainable development.
- Starting points: Each year, Viet Nam's agricultural sector discarded more than 160 million tons of by-products without proper treatment, leading to significant environmental pollution. In contrast, countries like the United States, Iceland, and Norway have managed to transform these by-products into valuable industries. At the same time, Viet Nam's agricultural sector struggles with a shortage of raw materials, leading to reliance on imports for up to 80% of its inputs. Most of these materials are chemically based, resulting in a decline in farming yields, environmental degradation, and negative impacts on public health. Therefore, the company aims to upcycle these discarded natural resources into agricultural inputs, and address two critical objectives at once. To tackle this issue, Mr. Loc Phan (MBA, Harvard Business School, USA) co-founded VNF. He possesses over 30 years of experience from various management & consultant positions across differing industries and countries. In 2007, Mr. Loc moved back to his home country and established VI Group (a private equity firm that focuses on high growth businesses in Viet Nam), with more than US$ 600 million under management. In 2013,

[203] https://vir.com.vn/genetica-brings-southeast-asias-largest-gene-sequencing-centre-to-vietnams-nic-88296.html
https://www.dealstreetasia.com/stories/genetica-funding-mobile-money-231175
https://technode.global/2024/10/02/discover-vietnam-tech-how-vietnam-can-lead-in-tech-genetica-and-life-ais-dr-tuan-cao-on-ai-talent-and-global-competitiveness/

the founder (Mr. Loc) discovered the untapped yet underexploited potential of Viet Nam's shrimp co-products. This urged him to divert focus to forming VNF.

- Growth path: Over the past decade, VNF has developed a diverse and multi-functional portfolio of over 80 products used in Animal farming, Crop production, Pet Care, Food, Supplements, and various other industries. These products are not only widely available in Viet Nam but also in more than 15 other countries.
- Recent performance for fast-growth or scale-up: The company has expanded its business operations and R&D based on one headquarter, an R&D centre, and two factories. Approximately 250 staff are employed, and total annual sales are $ 10 to 12 million.
- Embeddedness in the ecosystem for deep tech startups: The company draws on both in-house R&D and open innovation approaches to develop new technologies in the ecosystem. It has a strong in-house R&D team. It also collaborates with local and international research institutes and industry experts for lab scale and pilot scale production, and with large corporates (industry leaders) and experts for on-field experiments and mass commercialization. As a result, VNF's groundbreaking solutions have received high recognition for their innovation, such as the Future of Nutrition (FI Paris 2019), the Innovation Award (Global Shrimp Summit 2023), the Top 23 Viet Nam Pioneering Enterprises (USAID IPSC 2023). Additionally, VNF has been acknowledged for its inclusive and sustainable approach, being honoured with the ASEAN Inclusive Business 2023 (United Nations ESCAP) award, and recognized as one of the Top 3 Viet Nam ESG Initiatives (USAID IPSC 2023). The company also receives strong support from USAID IPSC Viet Nam (2023–2025), Climate Finance Accelerator (CFA) 2023, and Viet Nam Climate Innovation Center (VCIC) (2019 & 2022).
- Information sources: information provided by the SC; Company website in English (https://www.vnfoods.vn/)

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