TECH FOR GOOD INSTITUTE

Full Report

Advancing Digital Sustainability in Southeast Asia

August 2025

Research Partner

Centre for Impact Investing and Practices

Data Partner

IPOS INTERNATIONAL

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About This Study

Supported by the Infocomm Media Development Authority (IMDA) for the ATxSummit 2025, this study aligns with ATx's vision of "Redefining Tech for a Better Future."

This study examines how Southeast Asia (SEA) can leverage its digital momentum to become a **living lab** and a **global hub** for investment, collaboration and policy leadership for digital sustainability.

Digital sustainability refers to the strategic use of digital technologies to address pressing societal and environmental challenges such as poverty, inequality and climate vulnerability while enabling inclusive growth and resilience. With the right enabling policies, business models and financing strategies, digital innovation can serve as a force multiplier for achieving **Sustainable Development Goals (SDGs)** across the region.

Our analysis draws on:

- Comprehensive literature reviews covering regional policy frameworks, infrastructure readiness and innovation ecosystems;
- Patent analytics to assess SEA's positioning in technologies such as AI, IoT and data systems;
- A regional survey of 72 capital providers, spanning impact investors, family offices, philanthropic funders and mission-aligned enterprises;
- In-depth interviews with 28 capital and solution providers working across financial inclusion, agriculture, healthcare and climate-tech domains, and;
- Case studies of successful digital sustainability models from across SEA.

This study uniquely includes perspectives from impact-oriented capital provider and non-traditional funders-groups often underrepresented in digital innovation analyses.

Our sectoral deep dives focus on **financial inclusion, food and agriculture** and **healthcare.** These sectors were selected based on:

- The scale and urgency of sustainability gaps;
- Relevance to investors and funders seeking measurable impact, and;
- Current momentum in digital innovation.

Digital climate tech solutions is featured as a **cross-cutting enabler**, amplifying outcomes across all three sectors.

This study was conducted in collaboration with the Centre for Impact Investing and Practices (CIIP), our research partner who co-led the survey and interviews with capital and solution providers from their network and contributed valuable insights on financing innovation and impact capital, along with IPOS International, who provided specialised patent analytics and data insights.

Insights from the survey and interviews are integrated throughout the report to illustrate stakeholder perspectives and contextualise innovation and investment trends across sectors.

Note: A detailed explanation of our research methodology is provided in **Appendix A**.

Acknowledgements

We appreciate the contributions of **84 capital providers, companies, intermediaries, and philanthropic and nonprofit organisations** that participated in our survey and interviews, providing valuable insights into the role of digital innovation in advancing the Sustainable Development Goals (SDGs) in Southeast Asia (SEA).* We also acknowledge additional contributions from organisations who shared case study inputs, which further enriched the findings and practical illustrations featured in this report. Their inputs have been instrumental in shaping this report, including actionable recommendations for policymakers, funders, and innovators across the region.

Funders and Capital Providers		Philanthropic and Nonprofit Organisations	Companies and Intermediaries
• 500 Global • ABC Impact • ADB Ventures • ADM Capital • AC Ventures • Antares Ventures • B Current Impact Investment • British International Investment (BII) • Bintang Capital Partners • Circle Capital • Circulate Capital • Do Ventures • Daya Selaras Group • Earth Venture Capital • Elevar Equity • Envisioning Partners • Eurazeo • Fuping Social Venture • Garden Impact Fund VCC • GenZero • Golden Gate Ventures • Happiness Capital • Helicap • Incofin Investment Management • Insitor Partners • Integra Partners • Invesco Limited • LeapFrog Investments • JG Digital Equity Ventures	• Lendable • MYSC • Mirova • Mistletoe • NH Absolute Return Partners • NIO Capital • Openspace • Proparco • Quantedge Advancement Initiative Ltd • Quona Capital • Save the Children Global Ventures • SIIF Impact Capital, Inc. • SOSV • Sweef Capital • The Rise Funds, TPG • Temasek • Toll Group • Touchstone Partners • Tsao Family Office • Unreasonable Group • UntroD Capital Asia Pte Ltd • UOB Venture Management • Wavemaker Impact • Vertex Ventures SEA & India	• Artificial Intelligence Institute for Progress • Cartier Women's Initiative • Ishk Tolaram Foundation • Mastercard Center for Inclusive Growth • Quantedge Foundation • Temasek Foundation • The Rockefeller Foundation • Hyundai Motor Chung Mong-Koo Foundation	• BillEase • d.camp • Dashlabs.ai • Doctor Anywhere • EPIC World Private Limited • Grab • HELIX • MiyaHealth • Rize • RSPO • Singtel

*Some organisations have requested to remain anonymous.

Furthermore, we would like to acknowledge the United Nations Development Programme (UNDP), particularly the Private Finance for the SDGs team, for their analysis of the digital potential of SDG Investor Maps in SEA. We also extend our gratitude to the UNDP local country offices for their valuable insights into the philanthropy and impact of the regulatory landscape in SEA markets. Our appreciation also goes to the Global Centre for Technology, Innovation and Sustainable Development, UNDP for sharing their work on the Universal Trusted Credentials (UTC) initiative, which has significantly enriched our understanding of digital inclusion and financial access in the region.

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We are also grateful to Grab, TFGI's founding donor, for supporting TFGI's mission of leveraging the promise of technology and the digital economy for inclusive, equitable and sustainable growth in SEA.

Funders do not determine research findings nor the insights and recommendations of research.

ATXSUMMIT

This is a Special Report produced by the Infocomm Media Development Authority of Singapore for ATxSummit, a part of ATxSG.

About the Tech for Good Institute

The Tech for Good Institute is a non-profit organisation working to advance the promise of technology and the digital economy for inclusive, equitable and sustainable growth in Southeast Asia (SEA). With a population twice the size of the US and having strong demographics, SEA's digital economy is evolving rapidly. At the same time, the region's trajectory is unique, shaped by its diverse cultural, social, political and economic contexts. The Tech for Good Institute serves as a platform for research, conversations and collaborations focused on SEA, while staying connected to the rest of the world. Our work is centred on issues at the intersection of technology, society and the economy, and is intrinsically linked to the region's development. We seek to understand and inform policy with rigour, balance and perspective by using research, effective outreach and evidence-based recommendations.

The Institute was founded by Grab, to advance the vision of a thriving and innovative SEA for all. We welcome opportunities for partnership and support, financial or in-kind, from organisations and individuals committed to fostering responsible innovation and digital progress for sustainable growth in the region.

More information about the Institute can be accessed at www.techforgoodinstitute.org

About the Centre for Impact Investing and Practices

The Centre for Impact Investing and Practices (CIIP) was established in 2022 as a non-profit entity by Temasek Trust to foster impact investing and practices in Asia and beyond by building and sharing knowledge, bringing together stakeholders in the community, and bringing about positive action that accelerates the adoption of impact investing principles and practices. CIIP is the anchor partner for UNDP's Private Finance for the SDGs, providing investors and businesses in Asia with clarity, insights and tools that support their contributions towards achieving SDGs. Temasek and ABC Impact are CIIP's strategic partners.

For more information, please visit www.ciip.com.sg

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Special Thanks

Infocomm Media Development Authority (IMDA)

The Infocomm Media Development Authority (IMDA) leads Singapore's digital transformation by developing a vibrant digital economy and an inclusive digital society. As Architects of Singapore's Digital Future, they foster growth in Infocomm Technology and Media sectors in concert with progressive regulations, harnessing frontier technologies, and developing local talent and digital infrastructure ecosystems to establish Singapore as a digital metropolis.

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Asia Tech x Singapore (ATxSG)

ATxSG 2023 is Asia's leading technology event jointly organised by Infocomm Media Development Authority (IMDA) and Informa Tech - supported by the Singapore Tourism Board (STB). The event consists of two main segments, ATxSummit and ATxEnterprise.

ATxSummit comprises the invitation-only Plenary covering themes like generative AI, web 3.0 and trust, "soonicorns" and sustainability across four key pillars: Tech x Trust, Tech x Good, Tech x Builders and Tech x Creative. ATxSummit also features the ATxAI and SG Women in Tech conferences, alongside G2G and G2B closed-door roundtables to facilitate a closer partnership between the public sector and digital industry.

ATxEnterprise organised by Informa Tech and held at Singapore Expo, will host conferences as well as exhibition marketplaces comprising B2B enterprises across Technology, Media, Infocomm, Satellite industries and start-ups. ATxEnterprise consists of BroadcastAsia, CommunicAsia, SatelliteAsia, TechXLR8 and InnovFest x Elevating Founders.

For more information, please visit asiatechxsg.com.

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Executive Summary

Southeast Asia (SEA) has the potential to become a living lab and global hub for digital sustainability-where digital innovation can accelerate solutions to the region's most pressing societal and environmental challenges, **advancing Sustainable Development Goals (SDGs) while unlocking significant market potential.**

Development gaps as catalysts for innovation

The region's unmet needs are not just barriers—they are opportunities for innovation to deliver impact. Meeting the region's sustainability targets requires massive financing—US$1.5 trillion annually across Asia-Pacific and US$210 billion annually in SEA for climate-resilient infrastructure alone. This report focuses on three priority sectors: financial inclusion, food and agriculture, and healthcare, selected through a structured analysis based on development needs, digital innovation potential and investment relevance (methodology detailed in **Appendix A**).

- **Financial inclusion:** Over 225 million adults remain outside the formal financial systems and more than 350 million lack access to credit. Yet, the region's fintech sector has attracted over US$20 billion in funding since 2015—most of it into early-stage startups—highlighting strong investor interest in bridging access gaps.
- **Food and agriculture:** Around 100 million smallholder farmers need greater financial, business, and other form of support and empowerment. With food insecurity rising, the sustainable agriculture market is projected to reach US$22 billion by 2028. Digital solutions that boost productivity, reduce emission and improve market access are urgently needed.
- **Healthcare:** Healthcare access remains critically constrained, with physician-to-population ratios in Indonesia, The Philippines, Thailand and Vietnam ranging from 0.7 to 0.9 per 1,000, far below the global average of 1.7. At the same time, regional healthcare demand is rising. Spending on health across the region grew 42% to US$156.3 billion between 2016 and 2021. The digital health industry is projected to expand by 8.6% annually through 2028. Innovations in telemedicine, Artificial Intelligence (AI)-assisted diagnostics and mobile health are addressing access issues and chronic disease burdens.

Digital leapfrogs for impact in SEA

The United Nations estimates that **digital technologies could accelerate progress on over 70% of SDG targets, offering scalable, cost-effective solutions to complex global challenges.**

SEA's digital momentum, fueled by high smartphone penetration, a digitally-engaged population, strong demographics and policy innovations like regulatory sandboxes, has created conditions for the region to leapfrog traditional development barriers. Technologies such as AI, Internet of Things (IoT), cloud computing and data analytics enable **affordability and accessibility, trust and transparency, real-time insights and analytics, and mass customisation**, increasing both the effectiveness and inclusivity of solutions.

Digital sustainability, however, is not achieved through technology alone but through the integration of **technology, business, policy** and **financing** innovations. While 94% of capital providers that were surveyed allocate part of their portfolio toward impact and 92% allocate specifically toward digital sustainability solutions, SEA attracts only 3% of global impact investing
assets, despite rising investor interest. This gap between need, opportunity and capital deployment highlights the urgency for targeted interventions. Notably, 40% cite unclear return on investment and 39% cite regulatory uncertainty as major barriers to scaling investments.

A call to collective action

To fully realise SEA's digital sustainability potential, coordinated collaboration across governments, capital providers, solution developers and ecosystem enablers is needed, particularly in the following areas:

1. **Strengthening digital foundations**
   Close foundational gaps by expanding last-mile connectivity through public-private-philanthropic (4P) investment models to ensure affordability and to build inclusive Digital Public Infrastructure (DPI). This includes interoperable ID systems, payment platforms and data exchanges that enable equitable access, trust and participation.

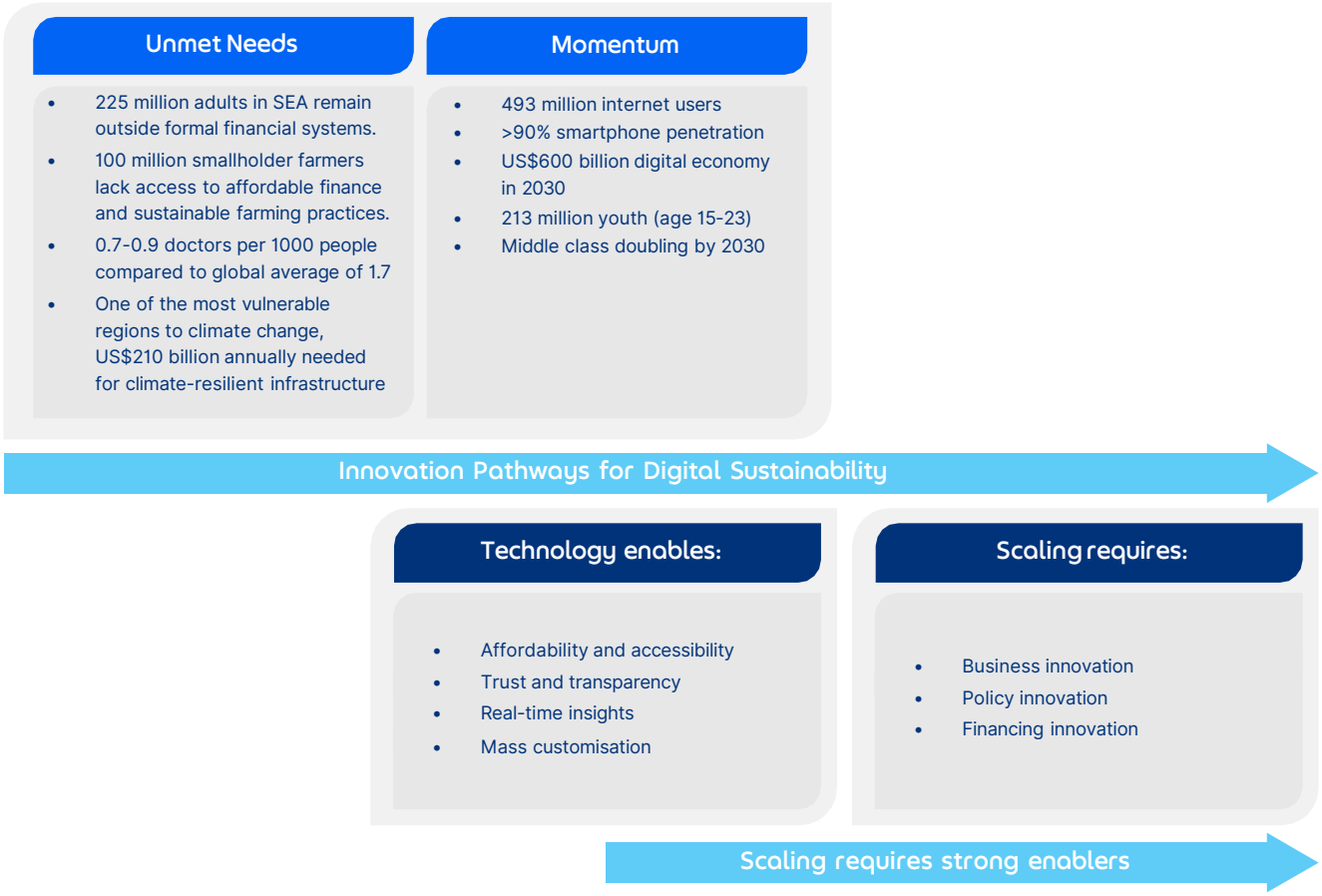
2. **Enabling future readiness**
   Invest in workforce capabilities that blend digital and sustainability skills. Strengthen governance so that policymakers can align innovation with national development goals.

3. **Encouraging fit-for-purpose solutions**
   Localise technology and business models to cultural, linguistic and regulatory contexts. Co-design with communities, support hybrid online-offline delivery models and scale innovations through multidisciplinary collaborations that centre contextual relevance.

4. **Evolving and aligning policy frameworks**
   Promote policy coherence through risk-based governance, regional harmonisation and integration of digital transformation with national sustainability roadmaps. Pilot regional sandbox corridors and prioritise outcome-driven regulations to foster responsible experimentation and investment certainty.

5. **Integrating multiple types of innovation**
   Combine technology, business, policy, and finance innovation to bridge the gap from pilot to scale. Mobilise blended capital to support underfunded sectors, balancing risk and impact.

6. **Establishing integrated regional approaches**
   Move beyond national-level strategies by fostering regional and multilateral initiatives to harmonise regulatory environments, enable data interoperability and align digital sustainability priorities. Advance shared digital and sustainability frameworks, co-developed platforms and standards to enable cross-border experimentation and collaboration to reduce duplication and enhance regional resilience.



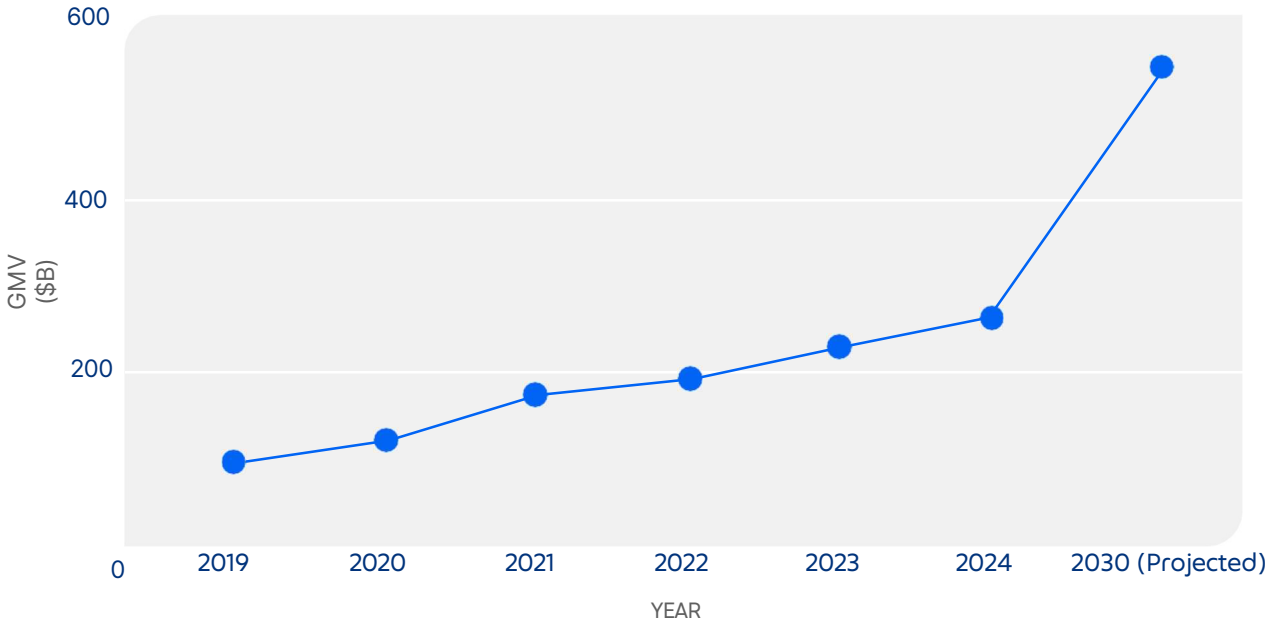
Source: Tech for Good Institute analysis for this report, 2025

1. Southeast Asia: Momentum for Digital Sustainability

1.1 SEA's Digital Momentum

Southeast Asia (SEA) is undergoing a rapid digital transformation. Between 2019 and 2022, nearly 100 million new internet users came online, bringing the total to over 493 million.[1] The region's digital economy is projected to reach US$600 billion by 2030, powered by e-commerce, digital financial services, transport, travel and online media (**Figure 1**).[2]

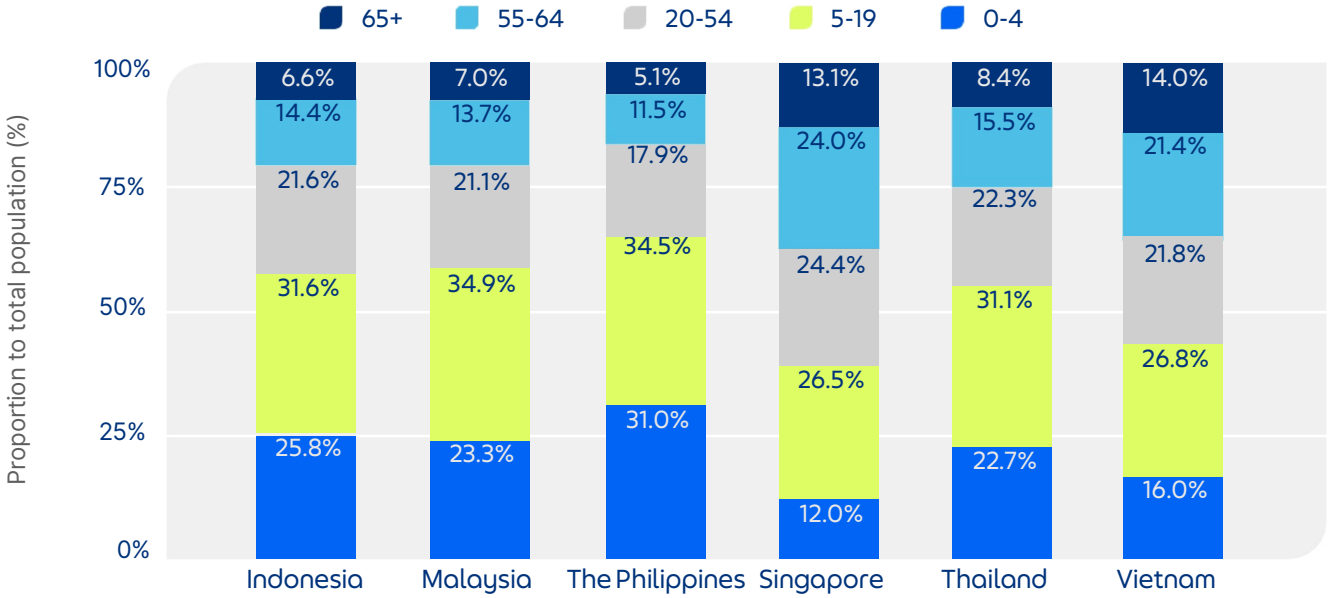
Figure 1: SEA Digital Economy Growth



Source: e-Conomy SEA 2019[3], 2023[4], 2024[5] Reports by Google, Temasek, Bain and Company. Consolidated by the Tech for Good Institute, 2025

A young, tech-optimistic population underpins this growth. SEA is home to 213 million youth aged 15-35 (**Figure 2**) and its middle class is expected to more than double, from 200 million in 2020 to 472 million by 2030.[6] Smartphone penetration is projected to reach over 90% by 2026,[7] surpassing rates in many developed markets.

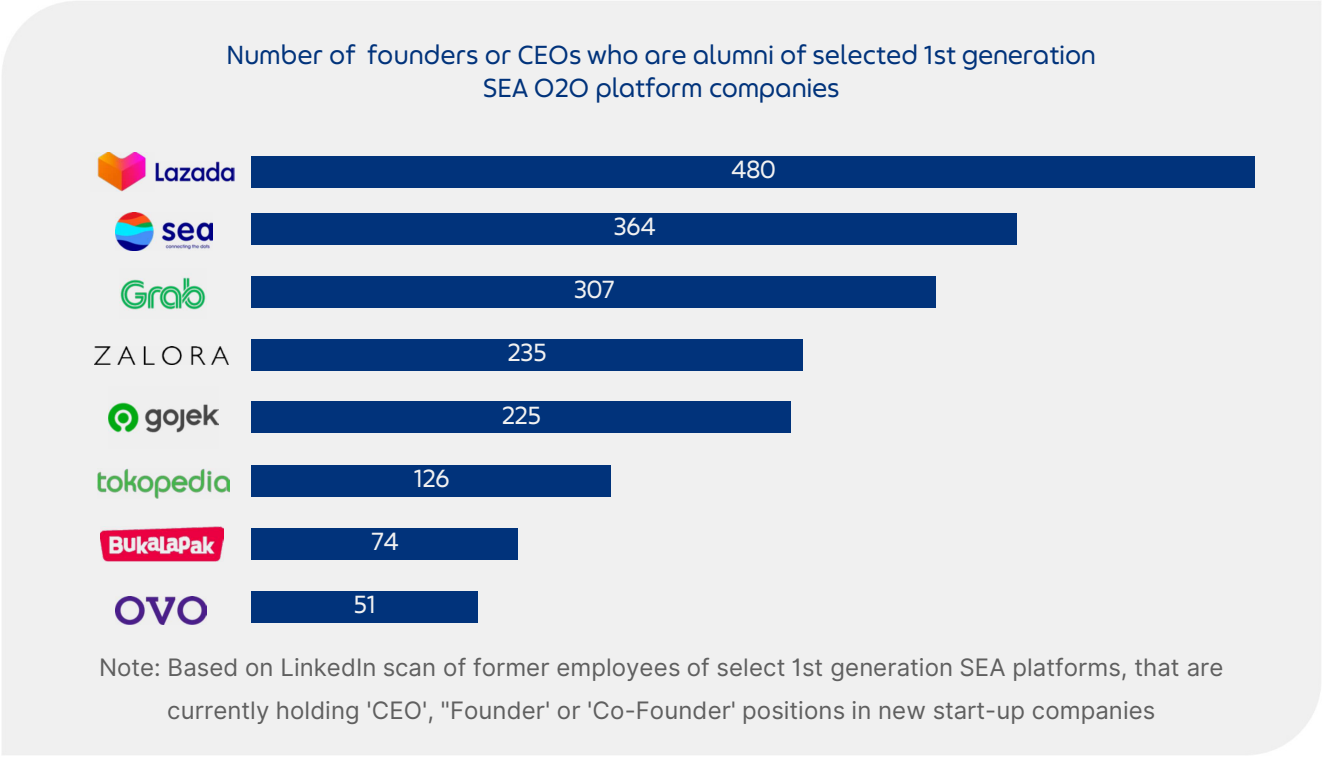
Figure 2: SEA's Population by Age Group



Source: United Nations Economic and Social Commission for Asia and the Pacific, 2022[8]

SEA's innovation ecosystem is maturing, with tech hubs in Ho Chi Minh City, Jakarta and Singapore attracting investment and nurturing a new wave of startups. Early unicorns like Grab and SEA Group have laid the groundwork for scalable digital innovations (**Figure 3**).

Figure 3: SEA's Early Unicorns have Nurtured the Next Wave of Startups



Note: Based on LinkedIn scan of former employees of select 1st generation SEA platforms, that are currently holding 'CEO', "Founder' or 'Co-Founder' positions in new start-up companies

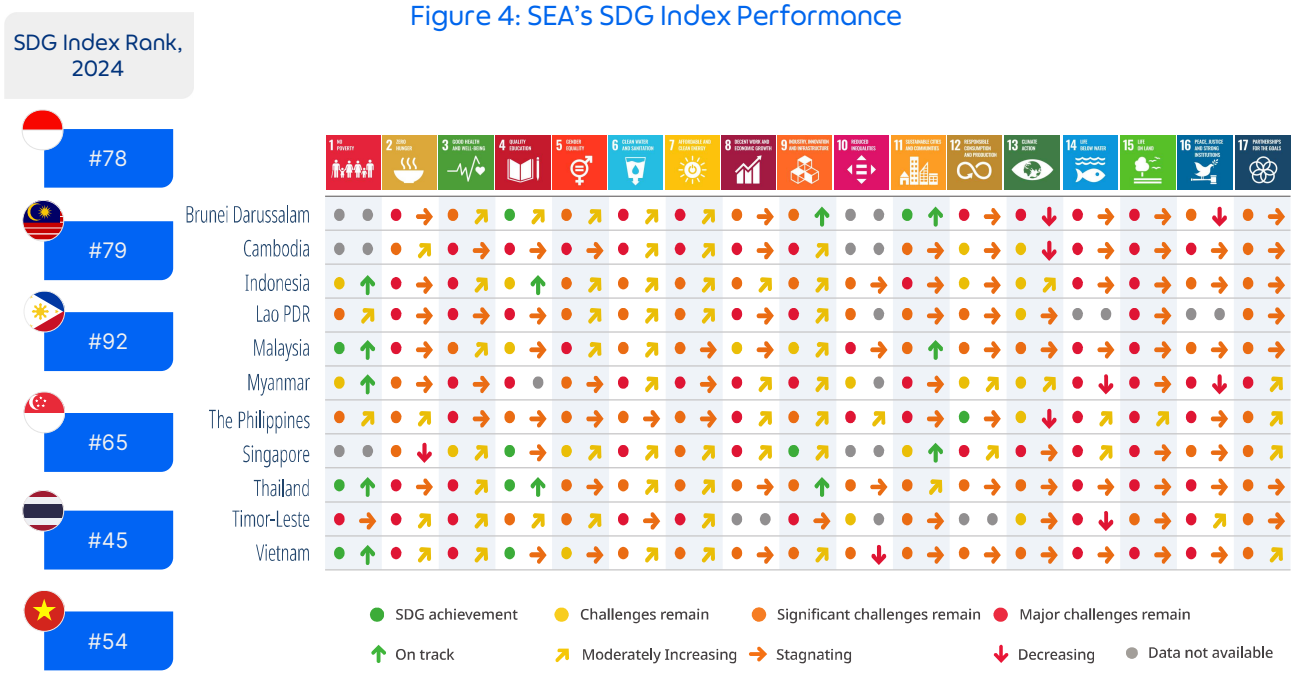
Source: Tech for Good Institute, 2023[9]

1.2. Gaps in Sustainable Development in SEA

As SEA's digital economy continues to expand, **how can SEA's digital momentum be leveraged to advance the region's sustainable development?**

Despite strong digital momentum, progress toward Sustainable Development Goals (SDGs) remains uneven across SEA. According to the 2024 SDG Index, Thailand ranks highest in the region at 45th globally, while other countries continue to struggle with deep-rooted challenges such as poverty, inequality and infrastructure deficits (see **Figure 4**).

Figure 4: SEA's SDG Index Performance



Source: SSDG Index Score Dashboard and Sustainable Development Report (**Figure 2.8**) on 2024 SDG Dashboard by Region and Income Group (Levels and Trends). Analysis on SEA conducted by this study's research team.[10]

"To truly accelerate Southeast Asia's transition towards a sustainable future, the strategic adoption and innovative application of digital tools are indispensable. These technologies offer unprecedented opportunities for enhanced monitoring, data-driven decision-making and the fostering of collaborative solutions across the region."

- Prof. Lawrence Loh, Centre for Governance and Sustainability, National University of Singapore

1.2.1. Illustrative sectors for digital sustainability

This study examines three sectors for potential growth areas for digital sustainability in SEA. **Financial inclusion, food and agriculture**, and **healthcare** were selected through a structured analysis using three criteria:

1. the gap to sustainable and inclusive development,
2. the attractiveness for impact capital and funding,
3. the digital innovation potential.

This methodology is detailed in **Appendix A.**

Persistent financial exclusion amid digital finance growth

Digital platforms and mobile-first models have transformed SEA's financial landscape. The average digital spending per consumer across Indonesia, Malaysia, The Philippines, Singapore, Thailand, and Vietnam (SEA-6) markets jumped by 60% between 2020 and 2021, while online retail penetration nearly doubled, from 5% to 9%.[11] E-wallets have emerged as the preferred payment method, chosen by 37% of consumers compared to the 28% who favor cash.[12]

However, this momentum masks deep financial exclusion. Over 225 million adults remain excluded from formal financial systems and more than 350 million lack access to credit, underscoring the potential for digital financial inclusion.[13] Affordability remains a critical barrier- many financial services are still priced out of reach for low-income users, and transaction or account maintenance fees can deter usage. Digital and financial literacy are major barriers: the former is the strongest predictor of Digital Financial Services (DFS) use across the region, while financial literacy also correlates with trust, especially in non-e-wallet services. Gender disparities are notable, with significant literacy gaps between men and women in most SEA-6 countries. Moreover, trust remains uneven. Banks are still seen as slightly more trustworthy than digital finance providers, while confidence in digital services varies widely, particularly among first-time users and low-income populations, limiting broader adoption.[14]

Meanwhile, the digital finance sector itself is booming. Fintech funding across the Association of Southeast Asian Nations (ASEAN) grew more than tenfold between 2015 and 2024, reaching US$20 billion in total.[15] In 2021, funding peaked at US$6.4 billion. In 2024, ASEAN saw only a 1% year-on-year decline, compared to a 28% global drop. Notably, over 60% of regional funding went to early-stage startups, with average deal sizes rising to US$14.2 million.[16] Singapore and Thailand lead as sources of funding, accounting for 75% of total investment altogether, while payments and blockchain remain the top funded sub-sectors.[17]

This combination of persistent access gaps and investor interest presents an opportunity to develop digital financial systems that serve the underserved. With high smartphone penetration and growing consumer familiarity, the region has the tools to shift from growth-driven digitalisation to inclusion-led innovation if stakeholders prioritise trust, literacy and affordability.

Structural barriers in food and agricultural systems

SEA's 100 million smallholder farmers are vital to the region's food security and economic base, producing global commodities like palm oil, cocoa and rice.[18] Agriculture remains constrained by low productivity, poor access to inputs and information, and fragmented value chains that result in limited yields per hectare, reduced efficiency and earnings. These constraints are compounded by financial exclusion and environmental degradation, locking many farmers out of more resilient and profitable agricultural models.

Access to finance is a persistent barrier. Smallholders require US$100 billion annually, but less than one-third of that demand is met.[19] Just 10% of rural adults have formal savings and many rely on informal lenders who charge over 10% interest per month.[20] Most smallholders live on under US$2 a day. Additionally, an ageing farming population further limits sectoral renewal.[21]

At the same time, input intensity and land conversion have surged. Agrochemical use is up 67% and over 50% of farmers report pesticide poisoning annually.[22] The food and land use sectors contribute over one-third of regional emissions, yet climate solutions remain underfunded. Practices like "Alternate Wetting and Drying" for rice production, for example, have enabled methane reductions of up to 70%.[23] With food insecurity tripling since the pandemic and the sustainable agriculture market projected to hit US$22 billion by 2028, scaling innovation in this sector is both urgent and viable.[24]

Widening healthcare gaps and rising demand

SEA's healthcare systems face mounting pressure from demographic shifts, rising wealth and chronic disease burdens. The region's population is ageing rapidly. By 2050, 22.2% will be over 60, double the share in 2020.[25] Meanwhile, the old-age support ratio is expected to fall from 9.5 working-age individuals (aged 15-64) per elderly person (aged 65 and above) to just 3.9, intensifying demand for long-term care.[26] Chronic diseases are compounding the system strain. In Indonesia, for example, diabetes cases tripled over two decades to 19.5 million and are projected to grow another 47% by 2045.[27]

Access remains uneven. Physician density is just 0.7 to 0.9 per 1,000 people in major markets like Indonesia, The Philippines, Thailand and Vietnam, well below the global average of 1.7.[28] Rural populations are especially underserved and health systems struggle to meet basic care.

Yet, healthcare demand is rising. GDP per capita in SEA grew by a third since 2019, driving higher health spending across the region.[29] Between 2016 and 2021, ASEAN's total health expenditure rose by 42% to US$156.3 billion.[30] Governments are responding. Malaysia's 2024 health budget rose by 13.5% and Singapore's 4.6%, where health now exceeds education in social spending.[31]

Technology helps to extend the reach of healthcare services. Digital health in ASEAN is forecast to grow 8.6% annually through 2028, led by telemedicine, AI-assisted diagnostics and precision medicine.[32] However, innovation alone cannot close access gaps. Greater capital flows, workforce expansion and systemic investment are equally critical.

With low public health spending and high out-of-pocket costs, the region is attracting venture capital, insurance innovation and medical tourism, and is projected to exceed US$100 billion by 2035.[33] The convergence of rising demand, digital momentum and investment appetite presents an opportunity to develop more inclusive healthcare systems.

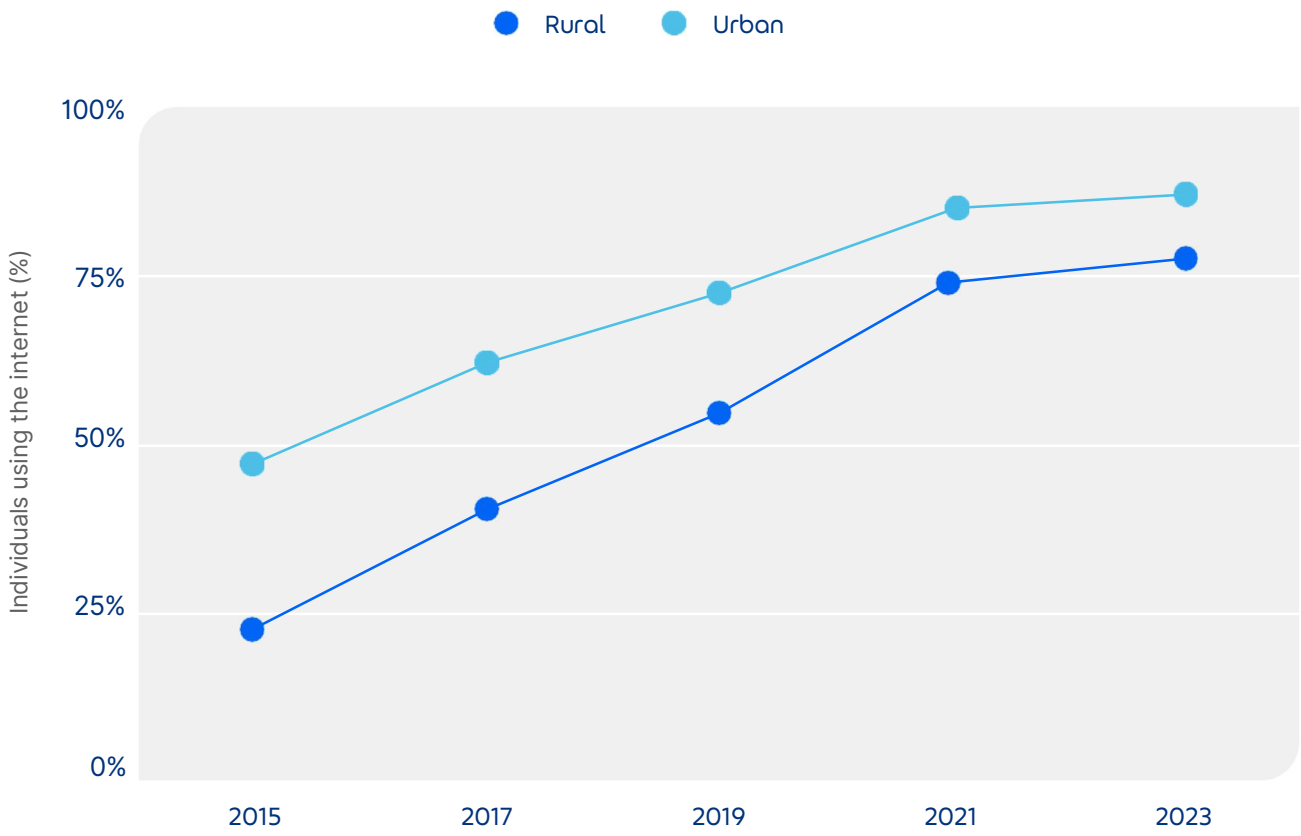
1.2.2. Digital infrastructure and inclusion gaps

While the challenges in financial services, food and agriculture, and healthcare are often treated in isolation, they are compounded, and in some cases, driven, by deeper systemic gaps. For SEA to evolve from a consumer-driven digital market into a sustainable digital ecosystem, the development, deployment, disposal and governance of digital technologies need to evolve.[34]

Inequitable access

Basic connectivity has improved significantly across SEA over the past decade. Mobile broadband now reaches over 96% of the population and internet use has increased across urban and rural areas alike. However, the digital divide is not disappearing, but evolving. Data compiled for **Figure 5** show that meaningful disparities persist: 87% of urban residents use the internet compared to 78% in rural areas, up from just 23% in 2015.

Figure 5: Urban-Rural Gap in Average Internet Usage (%)



Source: Data was calculated by Tech for Good Institute from the average % of individuals using the internet by urban and rural areas in Cambodia, Indonesia, Malaysia, Singapore, Thailand and Vietnam. Individuals using the internet is defined by the proportion of individuals who used the internet from any location in the last three months. Access can be via a fixed or mobile network.[35]

Beyond physical coverage, affordability represents a critical dimension of meaningful access. Thailand's "Net Pracharat" initiative demonstrates effective policy intervention by mandating that telecom providers support the national broadband network with specific requirements for service quality and affordability in rural regions.

The digital divide is no longer simply about **who is online**, but **who can benefit** from internet access. Low-income households, women and rural users face barriers like affordability, digital literacy and device quality, limiting their ability to use digital tools to improve livelihoods, access public services or build resilience. Individuals with tertiary education are five times more likely to be online than those with only primary education, and gender gaps in digital access persist in some SEA markets like Indonesia.[36]

Geographic fragmentation further complicates access. In archipelagic countries like Indonesia (consisting of 17,000+ islands) and The Philippines (consisting of 7,000+ islands), the cost of last-mile connectivity remains prohibitively high, deterring private sector investment in infrastructure. Innovation in last-mile connectivity such as satellite and edge computing facilities are expanding to support applications requiring low latency and high availability.

Without targeted policy and financial interventions, this evolving digital divide risks entrenching existing inequalities, even as headline connectivity statistics improve.

Environmental impact of digital infrastructure

Digital growth has environmental consequences. The Information and Communication Technology (ICT) sector now accounts for 3-4% of global Greenhouse Gas (GHG) emissions,[37] and Artificial Intelligence (AI) workloads are doubling every 100 days.[38] Generating a single AI image can consume as much energy as charging a smartphone.[39] Data centres contribute nearly half of the ICT footprint and most Digital Economy Companies (DECs) in SEA prioritise cybersecurity and compliance over sustainability.[40]

Governments and the private sector are responding. Thailand's Digital Economy Promotion Agency has partnered with telecommunications providers to deploy edge computing nodes in secondary cities, supporting smart city applications while reducing data transmission costs and energy consumption.[41] These efforts reflect a broader regional shift towards sustainable digital infrastructure. Governments and industry leaders across SEA are increasingly recognising the need to balance growth with environmental sustainability, particularly in energy- and resource-intensive sectors such as data centres. Singapore, a regional data centre hub and compact city-state, launched its Green Data Centre Roadmap to overcome its constraints through sustainable growth (see **Case Study 1**). Likewise, Thailand's resource management policies to manage water and electricity consumption of data centres seeks to ensure equitable resource distribution among all sectors, while sustainable energy policies can mandate or incentivise the use of renewable energy sources for data centres to reduce reliance on fossil fuels and minimise environmental impact. National or international Green Data Centre certifications can also encourage industry-wide adoption of sustainable standards. Singapore's data centre expansion strategy, for example, includes plans for electricity and water efficiency.[42,43]

Case Study 1

Singapore's Green Data Centre Roadmap: An example of sustainable digitalisation[44]

Singapore's Green Data Centre Roadmap supports the nation-state's aims to add at least 300 megawatts of capacity through green energy deployments.

The roadmap accelerates facility-level energy efficiency enhancements such as implementing advanced thermal management systems and intelligent energy optimisation algorithms, complemented by the use and operation of energy-efficient computer/IT equipment. It also prioritises the development and use of low-carbon energy solutions.

The roadmap outlines the government's role in advancing these priorities, including standards and certifications such as the refreshed Green Mark for Data Centres, as well as supporting research and development, and anchoring best-in-class data centres.

Finally, the roadmap outlines ways to enhance water usage effectiveness, such as optimising cooling towers' water consumption. Through this framework, Singapore aims for its data centres to achieve Power Usage Effectiveness (PUE) of ≤1.3 and Water Usage Effectiveness (WUE) of 2.0 m3/MWh or lower for all data centres within the next decade.

1.3. Beyond Sustainable Digitalisation

1.3.1. The case for digital sustainability

While much more needs to be done to internalise and mitigate environmental and social costs into digital investment and deployment decisions, technology can also be a transformative tool and force multiplier to achieve sustainable development for the region.[45] The UN Digital Compact, for example, not only promotes shared principles for responsible digital development but also urges the application of digital innovations to advance SDGs.[46]

Digital sustainability goes beyond making digital systems more environmentally-friendly and efficient.[47] Digital sustainability technologies have demonstrated the ability to create value in the following ways:[48]

1. **Supportive:** Digital technologies optimise existing systems, such as real-time poverty tracking or impact measurement frameworks that enable faster and more effective interventions.
2. **Facilitative:** Innovations such as telemedicine, online education and fintech expand its access to essential services, disrupting outdated models and improving affordability for underserved populations.
3. **Transformative:** Emerging technologies drive entirely new opportunities, from carbon markets to sustainable supply chains to foster transparency and sustainable economic growth.

Governments, non-profit organisations and companies are using supportive, facilitative and transformative approaches to sustainability. For example, Internet of Things (IoT) and sensor networks are increasingly deployed for environmental monitoring and resource management in these countries:

- Indonesia's "Tsunami Early Warning System" integrates IoT sensors with data analytics to provide critical advance warning for coastal communities.[49]
- Thailand's "Chiang Mai Blue Sky" project has deployed air quality sensors, providing real-time data that informs public health measures during pollution events.[50]
- Singapore's Public Utilities Board (PUB) has implemented a comprehensive sensor network monitoring water quality, consumption patterns and infrastructure status, reducing water losses and improving management of this critical resource.[51]

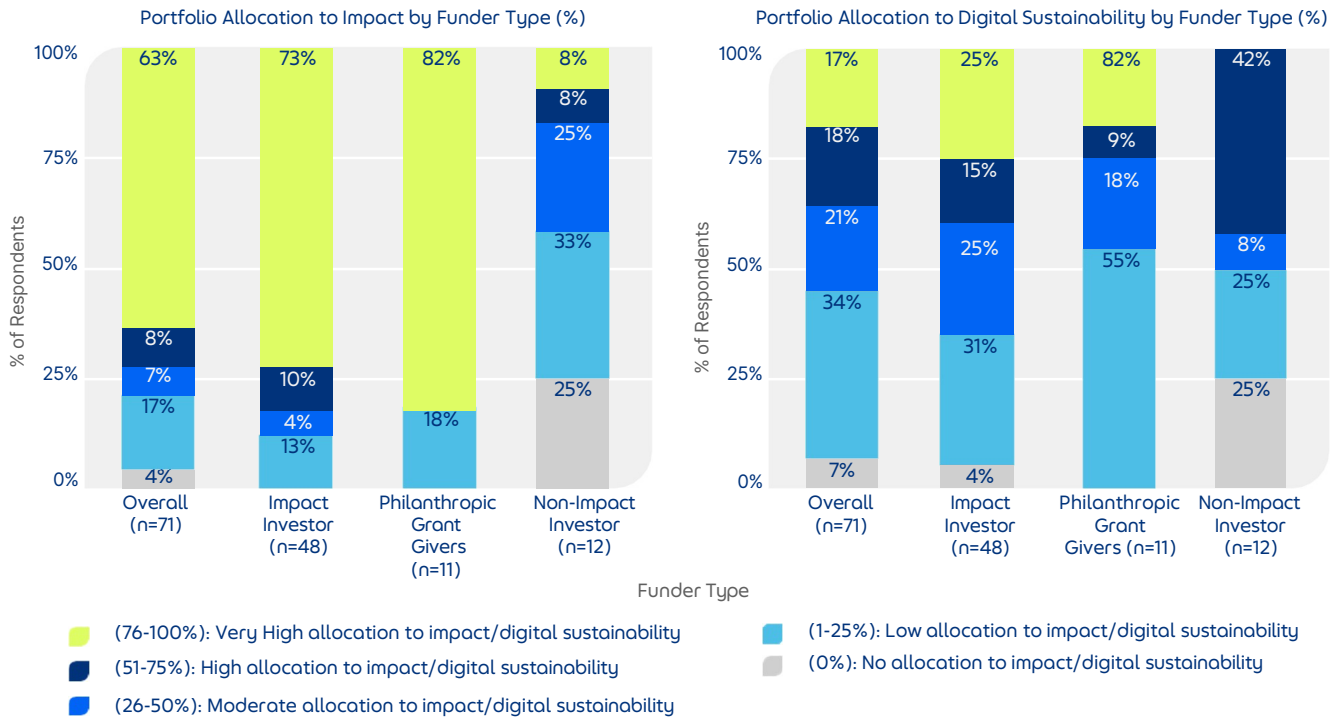
These integrated infrastructure systems enable a more responsive and efficient resource management while generating data that supports evidence-based policymaking for sustainability challenges. **The United Nations estimates that digital technologies could accelerate progress on over 70% of SDGs, offering cost-effective and scalable solutions to complex global challenges.[52]**

Despite concerns over energy use, technologies such as AI have immense potential to advance sustainable development. Research indicates that AI-based technologies can contribute to 93% of environmental targets, 63% of economic targets and 79% of social targets when deployed strategically.[53] AI-enabled technologies such as sensors, data analytics and automation can enhance visibility, transparency and responsiveness in supply chains and critical infrastructure, allowing stakeholders to better anticipate and respond to potential disruptions.

Analysis by the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) estimates that achieving these SDGs by 2030 requires an annual additional investment of US$1.5 trillion for developing countries in the Asia-Pacific region.[54] According to the Asian Development Bank (ADB), SEA will require US$210 billion annually until 2030, or US$1.2 trillion altogether, to invest in climate-resilient infrastructure alone.[55]

Meanwhile, the Global Impact Investing Network (GIIN) estimates that the size of the global impact investing market in 2024 was US$1.57 trillion, representing a 21% compound annual growth of the total impact investing market since 2019.[56] As part of this study, we conducted a regional survey of 72 capital providers-including impact investors, philanthropic funders and mission-aligned enterprises-to understand perspectives on digital sustainability, investment trends and innovation readiness across SEA (See **Appendix A** for full methodology). In this study, 94% and 92% of capital providers surveyed allocate some portion of their portfolio to impact and to digital sustainability, respectively, even those who do not identify as impact investors. 71% of capital providers in our sample allocate more than half of their portfolio towards impact (Figure 6). This suggests that beyond merely integrating Environmental, Social, and Governance (ESG) principles, a significant share of investors is making impact a core part of their financial strategy-not just a niche or secondary priority.

Figure 6: Allocation to Impact and Digital Sustainability by Funder type (N=71)



Source: Survey conducted by TFGI and CIIP, 2025 with one respondent choosing to exclude the question

However, only 3% of global impact investing assets under management, or an estimated US$47 billion, is currently allocated to SEA. 33% of capital providers surveyed by GIIN have allocated capital to the region.[57] Despite the region's small share of the global impact investing market, interest in the region is growing. 49% of investors surveyed by the GIIN indicate that they expect their proportion of capital allocated to SEA to increase in the next 5 years.[58] With its digital momentum and urgent sustainability challenges, SEA has the opportunity to serve as a living lab, innovation platform and global hub for digital sustainability.

1.3.2. Opportunity for digital sustainability

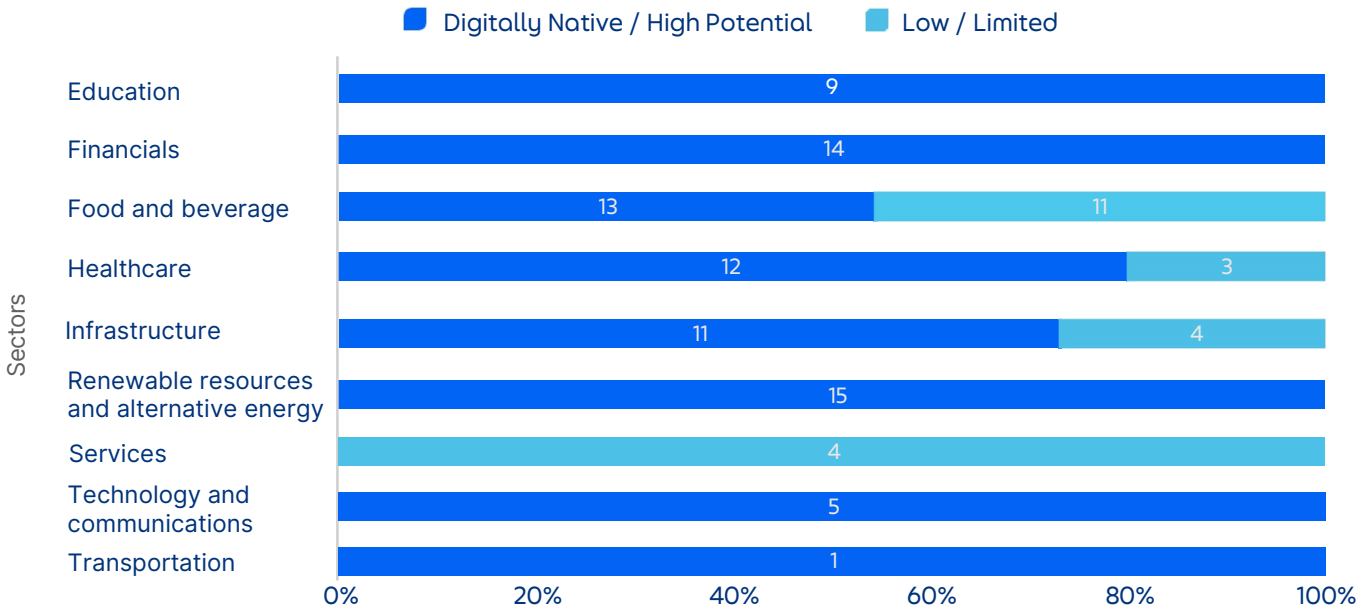
SDG Investor Maps, developed by United Nations Development Programme (UNDP), identify Investment Opportunity Areas (IOAs) based on development needs, local government priorities and business model viability.[59] Alignment of these three factors suggest where private capital is more likely to generate a return with tangible social or environmental impact (see **Table 1**).

Table 1: SEA's IOAs by Sector and Country

Sectors	Cambodia	Indonesia	Lao PDR	Malaysia	The Philippines	Thailand	Vietnam	Total
Education	1	4	1		1	1	1	9
Financials	3	4	2	2	1	2		14
Food and beverage	4	4	3	3	1	4	5	24
Healthcare	1	3	2	3	3	1	2	15
Infrastructure	3	2		2	3	2	3	15
Renewable resources and alternative energy	3	1	1	3	2	2	3	15
Services			2			2		4
Technology and communications				2	1			3
Transportation						1		1
Total	15	18	11	15	12	15	14	100

Of these 100 IOAs, 78 have high potential for digital solutions to improve access, availability and adoption of critical products and services. For example, all IOAs in the financial services sector, from payments to credit to insurance, rely on digitally-enabled business models. Similarly, 12 out of 15 healthcare opportunities and 13 out of 24 agriculture and food opportunities show strong digital potential, confirming these sectors' readiness for digital sustainability investments (see **Figure 7**).

Figure 7: Digital Potential of UNDP SEA SDG Investor Map IOAs by Sector



Source: Analysis conducted by the UNDP Private Finance for the SDGs team with data from the UNDP SEA SDG Investor Maps.

1.3.3 Digital sustainability readiness in SEA

How can SEA countries create an enabling environment for digital sustainability innovation? Similar to the baseline conditions for sustainable digital economy growth, readiness for digital sustainability includes strong foundations (i.e. internet accessibility, digital literacy, financial technology adoption) and future preparedness (i.e. AI adoption, data governance, cybersecurity resilience).[60] Policy clarity, innovation-friendly environments and regional coordination, including ASEAN's efforts to align infrastructure, cybersecurity and data flow policies, are key enablers of digital innovation.[61]

In addition, digital public infrastructure, policy momentum and openness to partnerships can support investment and innovation in digital sustainability.

Digital Public Infrastructure

Digital Public Infrastructure (DPI) are foundational systems that work together to create a secure and inclusive digital ecosystem. They include digital identity systems, payment infrastructure and data exchange platforms. SEA countries are at varying stages of DPI maturity:

- **Digital identity systems:** Digital identity establishes the foundation for trusted service delivery across multiple sectors, yet nearly a billion people worldwide lack official proof of identity, and legal and verifiable identity documents.[62] In government services, digital identity platforms streamline access to social protections and entitlements, directly addressing one of the most persistent barriers to serve vulnerable and undocumented populations. Moreover, beyond government services, digital identity systems facilitate inclusion into a broader range of digital services. In **financial services**, for example, it enables remote onboarding and Know Your Customer (KYC) compliance, significantly reducing transaction costs and facilitating broader financial inclusion. In **healthcare**, digital identities enable the creation of portable health records that support continuity of care, particularly valuable in fragmented or multi-provider environments. Malaysia's MyKad represents one of the region's earliest integrated identity systems, combining authentication with multiple service applications for users and businesses alike.[63] Singapore's Singpass, Thailand's National Digital ID, and Vietnam's VNeID serve as models for how digital identity systems can underpin a secure and scalable service delivery.[64] Indonesia's single identity number system is expanding its digital applications.[65] As of 5 February 2025, over 92 million Filipinos have successfully registered to the National ID system, though implementation has faced challenges.[66]

- **Digital payment infrastructure:** The region has seen rapid growth in digital payment systems, with Singapore's PayNow, Thailand's PromptPay and Malaysia's DuitNow enabling real-time interoperable payments. The Philippines' InstaPay system processed over 45 million transactions monthly by late 2024,[67] while Indonesia's Quick Response Code Indonesia Standard (QRIS) has unified previously fragmented QR code payment systems.[68]

Data exchange frameworks and Open Government Data (OGD) initiatives: The government collects, generates and processes huge amounts of data that can inform digital sustainability efforts. Malaysia has implemented a three-pronged strategy focusing on developing frameworks, identifying and publishing datasets, and coordinating open data portals to enhance public access to government information.[69] In Singapore, the data.gov.sg portal, part of the Open Government Products initiative, provides secure access to datasets across multiple public agencies, enabling businesses, researchers and citizens to develop data-driven solutions.[70] Vietnam's National Data Exchange Platform connects 22 ministries and 63 provinces,[71] while Thailand's Government Data Exchange platform enables secure data sharing between government agencies, reducing redundant data collection and improving service delivery.[72] Furthermore, access to environmental data can drive climate action and green technology. OGD policies and platforms can foster openness and collaboration in data sharing and governance through cybersecurity, data protection and digital inclusion. For example, Singapore's Trusted Research and Real World Data Utilisation (TRUST) platform enables secure health data exchange between the public and private sectors.[73] By using the Five Safes framework (safe purpose, people, settings, data and output), the platform protects sensitive information like genetic and biometric data. This ensures security while driving innovation in precision medicine.

Case Study 2

Gates Foundation: A framework for inclusive digital public infrastructure[74]

The Gates Foundation has positioned itself as a prominent proponent of Digital Public Infrastructure (DPI), conceptualising it as a fundamental enabler of sustainable development outcomes. The Foundation characterises DPI as "a digital network that enables countries to safely and efficiently deliver economic opportunities and social services to all residents."

Within the SEA context, the Foundation has operationalised support for DPI initiatives through a tripartite approach, encompassing technical advisory services, strategic funding allocations and knowledge transfer mechanisms. Their strategy is predicated on three core principles:

- **Openness:** The Foundation advocates for open technical standards and system interoperability, strategically designed to mitigate vendor dependency risks and create low-barrier entry points for innovation across the ecosystem.
- **Inclusion:** Their architectural requirements mandate universal accessibility by design, with particular emphasis on accommodating marginalised demographic segments that face structural barriers to technology adoption.
- **Governance:** The Foundation prioritises institutional frameworks characterised by accountability mechanisms, operational transparency and comprehensive user rights protections throughout the data lifecycle.

The Foundation's "Digital Public Goods Alliance" has conferred recognition on several SEA DPI implementations, including Vietnam's biometrically-enhanced electronic identification system and Singapore's blockchain-enabled digital trade documentation platform, as examples of sustainable digital infrastructure development. These implementations provide empirical evidence of how methodically architected DPI can function as a force multiplier, simultaneously accelerating progress across multiple SDG indicators through a single integrated intervention.

Policy alignment for sustainability and digital innovation

Across the region, governments are increasingly embedding sustainability and digital transformation into national strategies. As shown in **Table 2**, Indonesia, Thailand and Vietnam have explicit SDG roadmaps or action plans, while Malaysia, The Philippines and Singapore have national development plans that align with SDG goals. These frameworks are complemented by specific environmental strategies that address key sustainability challenges in each country.

Table 2: An Overview of Sustainability Policy Frameworks Across SEA-6

Country	Overall National Sustainability or SDG Roadmap	Environmental Strategy or Roadmap
Indonesia	• National Action Plan (RAN) for Sustainable Development Goals (2018) • Sub-national Action Plan for SDGs (RADs) (2018) • Roadmap of SDGs Indonesia (2019)	• Circular Economy Roadmap and National Action Plan Indonesia for 2025-2045 (2024)
Malaysia	• National SDG Roadmap • Shared Prosperity Vision 2030 (SPV 2030) (2019)	• Malaysia's Roadmap Towards Zero Single-Use Plastics 2018-2030 (2018)
The Philippines	• Ambisyon Natin 2040 (2016) • 10-Point Socio-economic Agenda (2016)	• Philippines' National Climate Change Action Plan (2011-2028) (2011)
Singapore	• Sustainable Singapore Blueprint (2015)	• Singapore Green Plan 2030 (2024)
Thailand	• 20 Year National Strategy Framework (2017-2036) (2016) • Thailand's SDGs Roadmap	• Thailand's Climate Change Master Plan (2015-2050) (2015)
Vietnam	• National Action Plan for the Implementation of the 2030 Agenda (2017) • Socio-economic development plan for 2021-2025 (2021)	• National Action Plan on Green Growth for 2021-2030 (2021)

Source: Compiled by Tech for Good Institute, 2025[75]

These policy frameworks vary in their explicit integration of digital technologies for sustainability outcomes. Singapore's Green Plan 2030 includes specific provisions for green data centres and digital solutions for environmental monitoring.[76] The Malaysian Digital Economy Blueprint recently incorporated sustainability goals by setting targets for green technology adoption and digital solutions that reduce environmental impact.[77] Similarly, Vietnam's National Action Plan on Green Growth incorporates elements of digital transformation to achieve resource efficiency.[78]

Not all sustainability strategies are linked with broader digital transformation strategies. For instance, Thailand's 20-Year National Strategy Framework includes a specific digital transformation component that connects to sustainability objectives, while Malaysia's Shared Prosperity Vision 2030 incorporates digital inclusion as a mechanism for achieving more equitable and sustainable growth.[79,80] The policy momentum for sustainability across SEA can spur innovation and investment by creating a conducive environment for research, development and deployment of digital sustainability solutions.

Clearer linkages between digital transformation, digital economy growth and transitions for sustainability are needed to encourage innovation and investment in the development and deployment of digital sustainability solutions.

Openness to Public-Private-Philanthropic Partnerships

Multi-stakeholder approaches, such as the Public-Private-Philanthropic Partnership (4P) model, can support digital sustainability by pooling expertise and resources, de-risking early innovation, enabling effective scale and ensuring inclusion.

- **Public sector (government):** Provides enabling policies, digital infrastructure and open data platforms;
- **Private sector (businesses and commercial funders):** Drives innovation through the development, deployment and financing of scalable solutions. This includes technology providers, venture capital, private equity and other commercial investors, and;
- **Philanthropic sector (funders):** Offers patient and risk-tolerant capital, supports capacity building and funds market validation.

The 4P approach brings together the complementary strengths of each sector to:

1. Addressing market failures in areas where purely commercial solutions might not reach underserved communities;
2. Providing technical expertise alongside funding to build local capacity;
3. Ensuring solutions are contextually appropriate through community engagement, and;
4. Creating pathways to scale through policy alignment and private sector participation.

While not always formally named in the 4P model, **community actors**-including civil society organisations and local leaders-play a cross-cutting role in ensuring contextual relevance, building trust and enabling an effective last-mile delivery.

This 4P approach has proven to be effective in advancing digital sustainability for sectors requiring significant behaviour changes or addressing complex market failures. Integrating these different stakeholders creates a more robust ecosystem for digital sustainability initiatives, with each sector bringing complementary strengths to overcome barriers to adoption and scale.

Readiness for such partnerships varies across the region, with more advanced ecosystems in Malaysia and Singapore, where formal structures for public-private collaboration are well-established. Other countries are developing their capabilities for multi-stakeholder coordination, recognising that the complex challenges of digital sustainability require collaboration across sectors.

Case Study 3

Universal Trusted Credentials: Public–private–philanthropic partnership for MSME financial inclusion[81]

The Universal Trusted Credentials (UTC) initiative, led by UNDP, exemplifies effective Public-Private-Philanthropy Partnership in the Financial Inclusion sector. This programme helps Micro, Small and Medium-sized Enterprises (MSMEs) gain better access to financial services by creating a system of verified and trusted data about businesses, which financial institutions can use to more accurately assess creditworthiness.

The framework includes verified data points such as business registration numbers, tax IDs, and utility bills, integrated through blockchain technology. By demonstrating their financial literacy and ESG credentials, MSMEs can improve their chances of obtaining loans and other financial services. The initiative is being piloted in Cambodia, Ghana, Rwanda and Indonesia, with ongoing discussions with ministries and other stakeholders.

The UTC initiative demonstrates the power of 4P models through:

1. **Public Sector Involvement:** Government entities like the National Bank of Cambodia and the Ministry of Economy and Finance provide regulatory support and endorsement.
2. **Private Sector Participation:** Financial institutions, FinTech companies, and credit bureaus engage in consultations and pilot designs, contributing financial and technological expertise.
3. **Philanthropic Support:** The DFINITY Foundation, a Switzerland-based not-for-profit organisation, serves as the technology partner to prototype the data platform.
4. **Collaborative Approach:** The initiative has engaged more than 20 market stakeholders in Cambodia alone, creating a multi-stakeholder environment for solving financial inclusion challenges.

Additionally, UNDP partners with financial literacy providers to leverage their digital and financial literacy courses for MSMEs. Upon completion, MSMEs receive a credential signifying their financial literacy graduation, which can be integrated into the UTC framework. This provides an additional trusted data point that enhances their profiles when seeking financial services, illustrating how collaboration can address both technological and educational barriers to financial inclusion.

"The UTC initiative is a transformative solution for bridging the global MSME financing gap. By leveraging cutting-edge technology and a multi-stakeholder approach, the UTC initiative empowers MSMEs to grow their businesses, embrace sustainability and access new financial opportunities. At the same time, it enables financial institutions to reach underserved clients, fostering a more inclusive and sustainable economy. This aligns with UNDP's commitment to supporting MSMEs worldwide through digitalisation, financing access and sustainability integration, while recognising the transformative potential of automated, data-driven digital solutions in scaling impact."

- Joe Hooper, Director, UNDP Global Centre Singapore

2. Enabling Innovation for Digital Sustainability in SEA

Investors surveyed highlighted four common ways in which digital technologies have enabled innovation and growth, which are highly applicable to realising digital sustainability:

- **Affordability and accessibility:** Mobile-first and low-cost platforms can deliver essential services more efficiently;
- **Trust and transparency:** Adoption, particularly by new users, requires digital systems that are secure, accountable and trusted;
- **Real-time insights:** Data and connected systems can provide timely, actionable insights, for example, in climate-smart farming or patient monitoring; and
- **Mass customisation:** Data analytic and AI can tailor solutions to adapt to diverse local needs and user preferences.

While these outcomes are often enabled by digital technologies, they cannot be achieved through technology alone. This transformative power depends on inclusive business models, supportive policies and fit-for-purpose financing. These enabling conditions are essential for digital innovations to move from prototypes to real-world solutions that reach the region's most underserved communities. This chapter proposes how reinforcing innovation may unlock digital sustainability at scale across SEA.

- **Technology innovation:** New or improved inventions, processes or products.
- **Business innovation:** New or improved business structures, revenue streams or customer engagement strategies to create, deliver and capture value. Business innovation is thus vital for driving technology adoption.
- **Policy innovation:** Effective governance, standards and incentives are key to an inclusive digital transformation, but the fast-evolving nature of technology and business innovation challenges traditional regulatory practices. In response, governments are using a range of policy tools to promote innovation while protecting public interest.

Digital sustainability growth can also benefit from a fourth type of innovation:

- **Financing innovation:** Strategic capital deployment that engages new capital providers, uses flexible instruments like blended finance and opens pathways for returns through tools like impact and biodiversity credits. 80% of capital providers surveyed by this study are actively or intending to participate in blended finance mechanisms.

An example of how these multiple innovations reinforce one another for systemic change is in the mobile payments revolution, summarised in **Box 1**. The technology-business-finance-policy nexus creates a mutually reinforcing innovation ecosystem, resulting in dramatically expanded financial access and inclusion across SEA. The shift to digital payments also created a digital infrastructure upon which additional services, from credit and insurance to investment and savings, have been built.

BOX 1
Multiple innovations accelerating mobile wallets and account-based payments in SEA

In 2020, up to three-quarters of consumer payments in the region's six biggest economies-Indonesia, Malaysia, The Philippines, Singapore, Thailand and Vietnam-were still transacting in cash.[82] Credit card penetration was highly variable, from 85% in Singapore, 30% in Thailand, 11% in Vietnam to 6% in Indonesia.[83] By 2023, digital payments made up more than 50% of the region's transactions.[84] This shift has been driven by investments in foundational digital readiness, such as mobile access and digital IDs, as well as innovations in technology, business models, financing and policy.

Technology Innovations

- Mobile technology
- Cloud computing for scalable and cost-efficient platforms.
- QR codes are used for account management, payments and robust security protocols.
- Near Field Communication (NFC) enables contactless payments.
- Magnetic Secure Transmission (MST) adapts card-based terminals for mobile payments.
- Application Programming Interfaces (APIs) facilitate integration between digital wallets, merchants and banking systems.

Business Innovations

- Non-bank digital financial services providers of Digital wallets, e.g., ShopeePay, GCash, OVO GrabPay.
- Buy Now, Pay Later (BNPL) provides flexible payment options beyond cards.
- Peer-to-peer (P2P) lending enhances financial inclusion without traditional banking systems.
- Alternative credit scoring through non-financial data points enables access to credit for underbanked populations.

Policy Innovations

- Regulatory sandboxes allow fintech companies to test mobile payment solutions safely.
- Self-regulatory organisations foster industry-led best practices to scale mobile payment systems.

Financing Innovations

- Catalytic capital supports fintech startups.
- Blended finance helps build financial service ecosystems.

2.1. Technology Innovation

> "Science is what we need to help us deal with complex problems like climate change, but digitalisation is critical to create direct value to customers and expand impact across Emerging Asia."
>
> **- Tien Nguyen, Founding Partner, Earth Venture Capital**

The appetite for digital solutions in SEA is strong. In this study, **92% of capital providers surveyed agreed that digital technology has the potential to accelerate sustainability outcomes across the region.** Defined using the International Patent Classification (IPC) codes, three dominant technology domains have underpinned SEA's digital momentum:[85]

- **Computer Technology:** Encompasses inventions related to computing hardware and software, including processors, memory architecture, input/output arrangements, data processing methods and computer systems, focusing on how information is processed, stored and represented within standalone or networked computing systems.
- **Telecommunication:** Covers technologies for the transmission of signals over distance for communication purposes using electrical, optical or electromagnetic means, including circuit switching, telephone systems and infrastructure for managing call routing and signal modulation, with a focus on general network architecture and traditional communication systems.
- **Digital Communication:** Refers specifically to inventions related to the digital transmission of data over wired or wireless media, including techniques for error correction, signal encoding, packet switching and protocols used in data networks, distinct from Telecommunications by emphasizing the handling and integrity of data in digital format across network layers.

These digital technologies have enabled the common value pathways consistently highlighted by investors surveyed for this study:

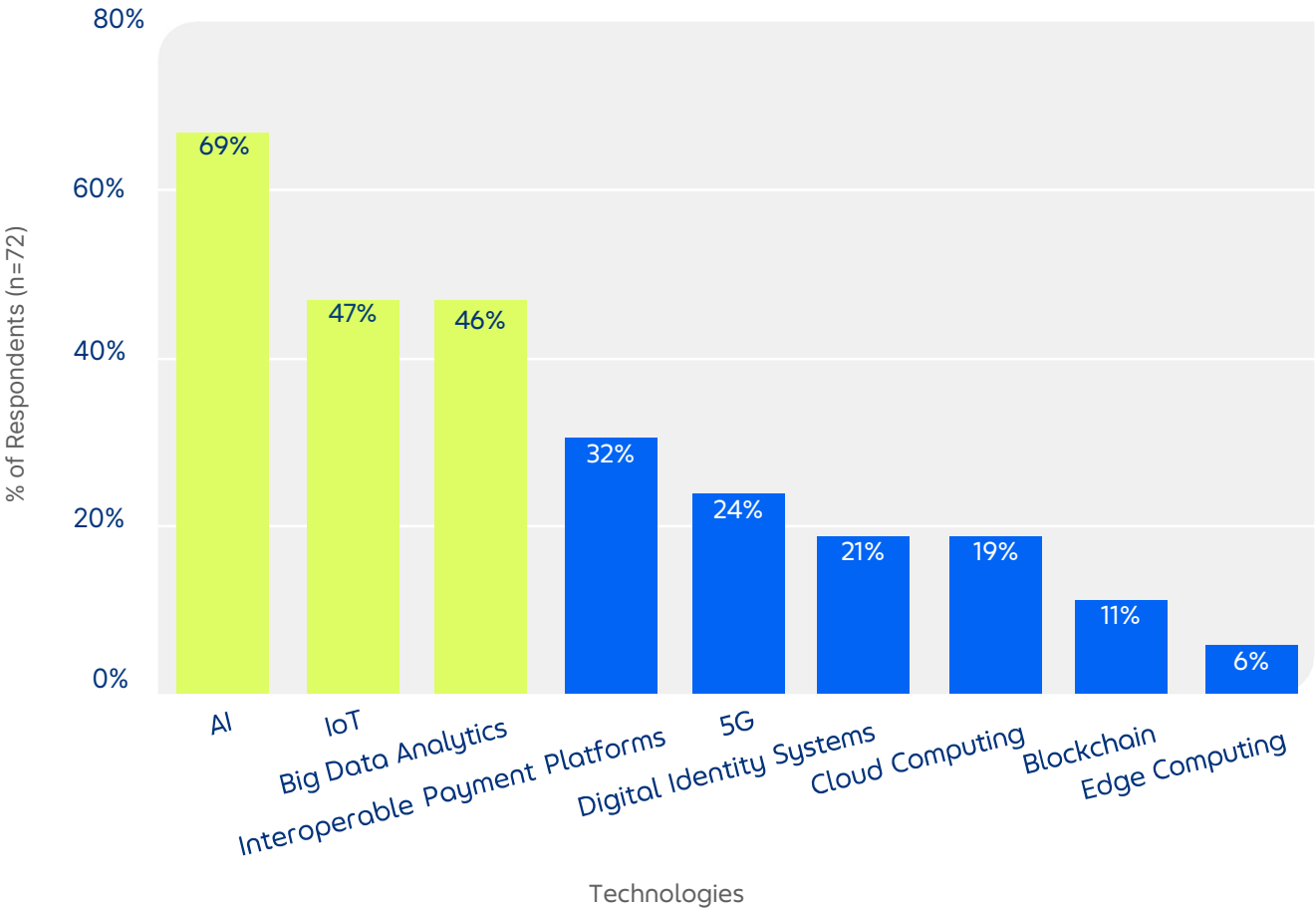
- **Affordability and Accessibility:** Digital technologies fundamentally restructure cost models for service delivery by removing costly intermediaries from value chains and eliminating physical infrastructure requirements for end-users to reduce barriers to essential services. For instance, mobile banking and digital wallets have dramatically reduced the cost of delivering financial services by reducing minimum transaction sizes, eliminating branch requirements and offering simplified user experiences. Telemedicine platforms such as Doctor Anywhere and Halodoc have restructured healthcare delivery, enabling consultations at lower cost than traditional visits while extending reach to underserved areas. In Indonesia, Halodoc, backed by regional investors including UOB Venture Management, has connected over 20,000 doctors with millions of patients in remote areas, providing consultations at a lower cost than traditional care while maintaining quality standards.[86]

- **Trust and Transparency:** Implementing immutable record systems enhances security and reliability in sensitive transactions. Blockchain technologies, in particular, have strengthened transaction security and enabled novel approaches to microfinance that were previously impractical due to trust deficits and high verification costs.
- **Real-time Insights:** Data and connected systems support the transition from retrospective to real-time data analysis, allowing data-driven decision-making for more efficient, timely and actionable insights. This shift is evident in many domains, from agriculture, where predictive agronomy and climate analytics now optimise farming decisions, to patient monitoring in healthcare and in supply chains, where blockchain ensures unprecedented levels of traceability.
- **Mass Customisation:** Perhaps most significantly, these technologies enable the tailoring of services to individual needs at scale-a capability previously impossible without prohibitive cost structures. Mass customisation through digital technologies have been employed to achieve the seemingly contradictory goals of scale and personalisation, creating solutions appropriate for SEA's heterogeneous markets. For example, companies in SEA like Advance Intelligence Group and DANA provide AI-driven financial products tailored to individual customer needs and risk profiles, expanding credit access while managing default risks. In healthcare, customised treatment and drug plans are yielding measurable improvements in patient outcomes, while education platforms such as Solve Education!'s, edbot.ai and Ruangguru deliver AI-powered personalised learning experiences based on student progress, learning style and specific knowledge gaps, making quality education accessible to lower-income students.[87]

> "Technology is playing a transformative role in expanding access to insurance for low- and middle-income consumers. Companies like bolttech and PasarPolis are not only reducing operational costs through automation but also using AI to better predict and manage risk. This allows them to price policies more accurately, making insurance more affordable and driving both scale and social impact."
>
> **- Fernanda Lima, Partner, LeapFrog Investments**

Looking ahead, capital providers surveyed highlighted AI, IoT and big data analytics as most instrumental in enabling digital sustainability (**Figure 8**):

Figure 8: Capital Providers' Perspectives on Technologies with the Highest Digital Sustainability Potential



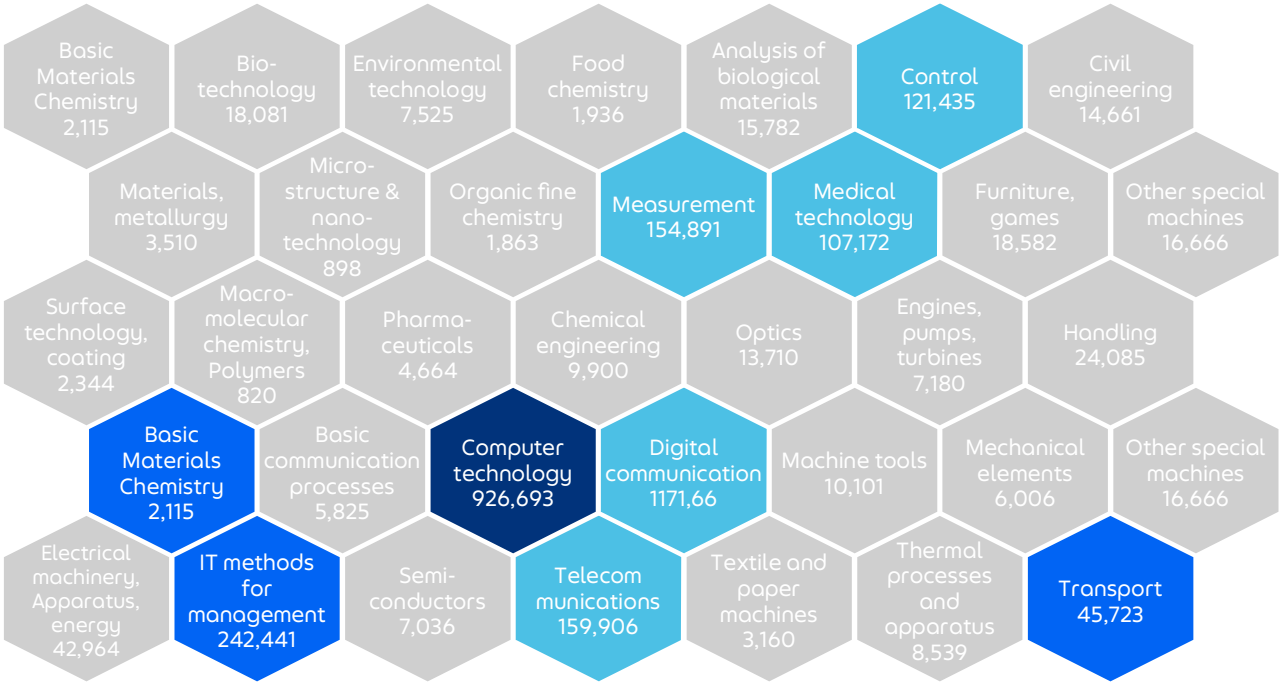
Source: Enabling technologies with greatest potential to accelerate sustainability, according to survey respondents (N=72). Survey respondents were asked to select the top three enabling technologies with greatest potential. Survey conducted by TFGI and CIIP, 2025.

As a general enabling technology, AI was selected by 69% of respondents. In particular, its abilities to support mass customisation and trust-building systems through advanced decision models and risk profiling were highlighted by capital providers as promising. IoT (47%) was seen as critical for expanding real-time insights, particularly in agriculture, energy and logistics. Big Data Analytics (46%) enables more responsive and precise interventions-especially in financial inclusion, food and agriculture and healthcare sectors. These technologies do not operate in isolation; together, they form the digital backbone for delivering real-time, data-driven and personalised solutions.

2.1.1. Artificial intelligence and data analytics

Rather than representing a single technology, AI encompasses a diverse ecosystem of technologies, tools and techniques that are increasingly integrated across digital applications. This integration enhances automation, enables real-time data processing and transforms decision-making across industries. AI's general enabling capabilities are evident from patent data, with AI innovation in all tech domains. Thus, the cross-sector applicability of AI technologies means that its impact on digital sustainability will be both broad and deep, potentially transforming even traditionally low-tech sectors (Figure 9).

Figure 9: Patent Activity of AI Across Technology Domains Between 2015-2024



Source: Patent data was retrieved from the Questel FAMPAT database and analysed by IPOS International for this project. **The colour intensity reflects the level of innovation activity within each technology domain.** The number in each domain represents total inventions published from 2015 to 2024. The technology domains are defined based on the World Intellectual Property Organization's (WIPO) IPC-Technology Concordance.[88]

AI applications hold much potential for digital sustainability across many fields, such as:

- **Machine learning for resource optimisation:** Algorithmic approaches to reducing waste in agriculture, energy and manufacturing.
- **Natural Language Processing (NLP) for inclusive services:** By breaking language barriers in education, healthcare and financial services, these technologies address accessibility challenges in linguistically-diverse regions.
- **Computer vision for environmental monitoring:** Automated tracking of deforestation, pollution and climate impacts creates unprecedented capabilities for environmental protection and climate action.

2.1.2. Internet of Things (IoT) and Big Data Analytics

IoT technologies were identified by 47% of capital providers surveyed for this report as potentially transformative for digital sustainability, especially in traditionally resource-intensive sectors. The combination of IoT sensors, cloud computing, big data analytics and machine learning can translate information into actionable insights that support sustainable decision-making by individuals, businesses and communities. This supports adaptive services across multiple sustainability dimensions including:

- **Smart Agriculture:** Quantitative assessment of precision farming systems demonstrates multiple efficiency gains: water usage reduction by up to 20%, fertiliser application reduction by 7% and yield improvements by 4%.[89] These figures represent significant resource efficiency improvements in a sector that traditionally struggles with sustainability metrics. Companies mentioned in our interviews like Cropin (expanding across SEA) provide farmers with customised recommendations based on real-time soil, weather and crop data, and optimise resource use while increasing yields and resilience.

- **Healthcare Monitoring:** Remote patient monitoring systems generate dual benefits of expanded healthcare access while simultaneously reducing delivery costs, a combination that addresses both social and economic dimensions of sustainability.

- **Predictive Healthcare:** AI-powered predictive analytics enables earlier interventions and personalised treatment plans for chronic diseases and mental health conditions, which are particularly valuable in underserved areas with limited specialist access.

- **Energy Management:** Smart grids and building management systems optimise energy usage by enabling dynamic response to demand fluctuations, addressing a critical environmental sustainability challenge.

Integrating IoT with cloud computing and edge analytics is particularly noteworthy, as it creates a technological synergy especially suited for resource-constrained environments. This integration enables sophisticated data collection and analysis in areas with limited connectivity, a crucial capability for extending digital sustainability benefits to underserved regions.

2.1.3. Other foundational and complementary technologies

Beyond the top-ranked enabling technologies such as AI, IoT and Big Data Analytics, capital providers also identified a suite of foundational and complementary technologies that are essential to unlocking digital sustainability in SEA. These include 5G connectivity, cloud computing, blockchain, edge computing, interoperable payment platforms and digital identity systems. These technologies underpin infrastructure required to scale and can integrate digital solutions across diverse systems and populations, playing a particularly important role in enabling affordability, trust and accessibility, especially in underserved and fragmented contexts.

- **5G connectivity:** 5G networks improve speed, reduce latency and enable high-density connections-factors that are essential for delivering **real-time insights** and enabling **mass customisation**. The rollout of 5G in SEA is particularly relevant to use cases requiring low-latency feedback loops, such as remote diagnostics, mobility platforms and smart energy systems.

- **Cloud computing:** Cloud infrastructures support **affordability** and **scalability** by offering cost-effective and flexible data storage and processing. Cloud infrastructures enable rapid deployment of services across large and distributed populations, while supporting the data processing needs of AI and analytics-driven solutions.

- **Edge computing:** By processing data closer to its source, edge computing reduces dependence on high-bandwidth central networks. This enables **real-time insights** and localised decision-making in connectivity-constrained areas, such as rural farms or remote health clinics, where data latency and network reliability are limiting factors.

- **Interoperable payment platforms:** These platforms reduce friction in digital transactions, enhancing the **affordability** and **accessibility** of financial services. It supports financial inclusion and reduces onboarding by enabling seamless payments across providers and borders.

In markets where institutional trust may be limited, technology that enhances trust and transparency can create significant value. Examples of technology-enabled transparency include:

- **Supply chain verification:** Organisations like Fairfood (operating across SEA) use blockchain technology to provide traceability in agricultural supply chains, enabling smallholder farmers to showcase sustainable practices and access premium markets.[90]

- **Verified credentials:** Platforms in SEA such as Accredify enable secure and verifiable digital credentials for education and employment, reducing fraud while improving mobility and opportunity.[91]

- **Transparent lending:** Digital lending platforms in SEA like Funding Societies provide transparent terms and algorithmically-assessed credit for MSMEs traditionally excluded from formal finance.[92]

2.2. Business Innovation

> "If technology solutions are implemented, they need to be right-sized and right-priced."
>
> **- Wingee Sin, Global Programme Director, Cartier Women's Initiative**

While technology innovation has significant potential for digital sustainability within SEA, business innovation is essential for developing and deploying products and services that meet the needs of underserved populations.

2.2.1. Market knowledge for solution development and deployment

Sustainable innovation starts with identifying the right problems to solve, then fostering adoption through context-appropriate business models. Innovators embedded within local markets are uniquely positioned to execute this critical function-identifying needs, developing context-sensitive products and ensuring adoption through appropriate business models.[93]

Our interviews with solution providers consistently revealed that business innovation plays a critical role in overcoming on-the-ground challenges that inhibit technology adoption and impact delivery. New products, modes of service delivery or new pricing models help make technology accessible to low-resource and underserved populations. Digital solutions that have gained traction in SEA are not necessarily the most advanced, but rather those that are most effectively adapted to local contexts. Factors such as infrastructure limitations, diverse use capabilities and cultural contexts, can be regarded as design parameters, rather than constraints:

1. **Infrastructure limitations** create non-ideal conditions, such as intermittent internet connectivity, power outages and basic device incompatibilities. Resilient solutions in low-resource settings include offline-first design, local agents or decentralised service hubs to maintain continuity.

2. **Diverse user capabilities, access and confidence** form persistent barriers to uptake. Varying levels of digital literacy and a lack of access to affordable devices and data are further compounded by language diversity, and generational and gender-based access gaps. Their market knowledge is particularly valuable given SEA's extraordinary diversity: 655 million people comprising over 100 ethnic groups who speak more than 1,000 languages and dialects, with economic fragmentation across at least 71 million Micro, Small and Medium-sized Enterprises (MSMEs).[94,95] This heterogeneity demands business models that can adapt to vastly different contexts while maintaining economic viability.

3. **Cultural preferences and trust norms** significantly shape adoption patterns. In many contexts, interpersonal trust remains more influential than institutional trust. Local communication styles, community validation and face-to-face engagement, such as through agent networks or local champions, build trust and drive adoption.

Table 3: Examples of how business innovations overcome implementation and adoption challenges

Design Parameters for Business Innovation	Accessibility and Affordability	Trust and Transparency	Real-time Insights	Mass Customisation
Infrastructure limitations	Tiered service levels that function at different bandwidth capacities	Community connectivity hubs in underserved areas	Edge computing solutions that reduces data transmission needs	Low-power infrastructure with renewable energy sources
User capabilities and the digital divide	Offline-first applications with asynchronous syncing	Promoting Interoperability in ESG reporting	Automated processes reducing skill requirements	Peer learning networks and digital ambassadors
Cultural preferences and trust norms	Products designed with local cultural contexts in mind	Local/indigenous knowledge integrated into sustainable solutions	IoT and remote sensing in agriculture tailored to local knowledge	Features celebrating cultural identity and values

As with technology, business, product and service innovations do not exist in silo, but holistically reinforce one another. For example, online-offline solutions, tiered service models and trust-building mechanisms have demonstrated, and will likely continue, to be particularly effective in SEA:

1. **Online-offline solutions:** Combining digital tools with in-person engagement is often needed to reach underserved markets beyond urban centers, and is especially critical to build trust and drive inclusive adoption. For example, fintech companies like GCash, OVO and MoMo serve previously unbanked populations through agent networks to build confidence and trust. Interview insights from this study highlight that digital technologies are most effective when complemented with traditional and physical methods. In soil carbon measurement, for instance, satellite technology can continuously track changes, but a physical "true-up" sample is still essential during carbon credit issuance to validate digital data.

2. **Tiered service models:** Tiered service models address various affordability levels and digital capabilities, with basic services for users with feature phones, intermittent connectivity and minimal digital literacy, standard services for smartphone users with moderate connectivity and digital skills, and premium services with advanced functionality for digitally-proficient users with reliable connectivity. In this way, companies can broaden their market reach, ensuring that each customer segment receives a level of service that aligns with their needs and capabilities, while designing for user satisfaction.

3. **Trust-building mechanisms** can demystify digital services and create progressive engagement strategies to foster consumer confidence. The former uses clear communication processes, such as through real-time mapping, pricing and data usage, while the latter begins with small, low-risk interactions before requiring more significant commitments.

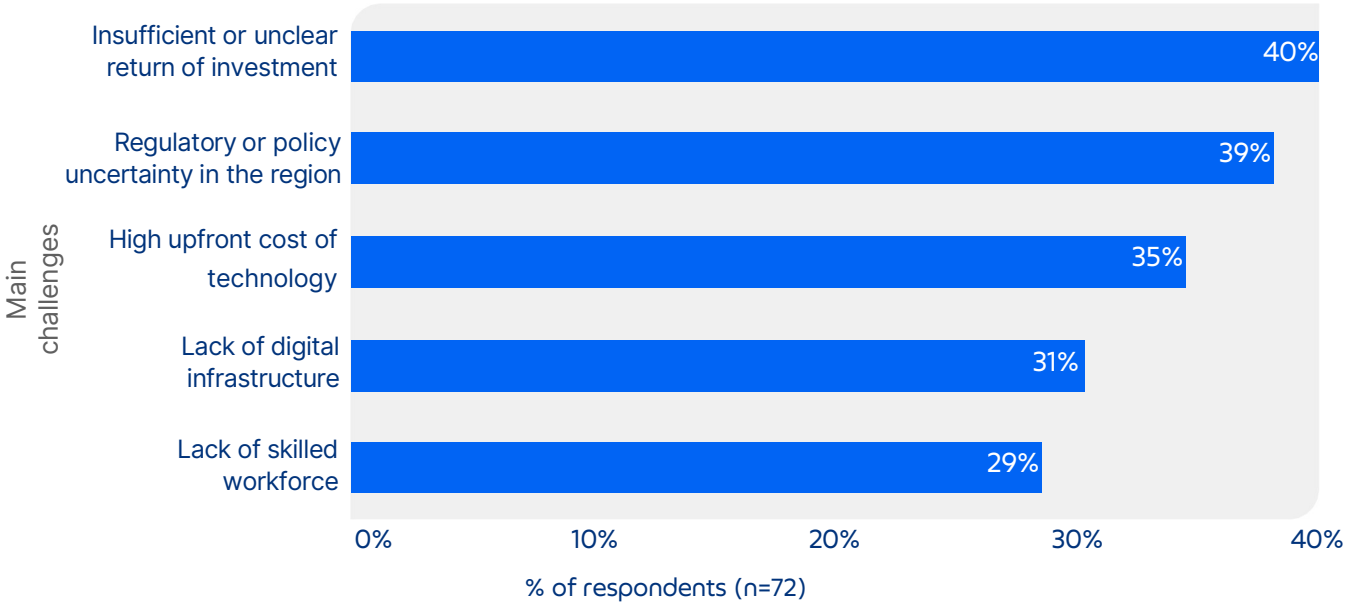
SEA's population diversity demands continued experimentation with new customer journeys, service models and other business interventions to deliver impact.

2.3 Policy Innovation

> "Government support can play a vital role in ecosystem development, particularly by fostering an investment-friendly environment and facilitating collaboration among key stakeholders."
>
> **- Pang (Thitirat) Sittakaradej, from ADB Ventures**

39% of capital providers who participated in this study cited regulatory uncertainty as a significant barrier to investing in digital sustainability, only second after uncertain return on investment (**Figure 10**).

Figure 10: Challenges in Investing in Digital Sustainability Identified by Survey Respondents (N=72)



Source: Survey respondents were asked to select their top two challenges.
Survey conducted by TFGI and CIIP, 2025

Policy alignment can provide a pathway to clarity while leaving the room for innovation and learning. This involves complementing traditional policymaking with a range of policy levers, such as adopting principles-based regulatory approaches, fostering multi-stakeholder collaboration and regional policy alignment. Policy innovation can also improve learning for all stakeholders. Pilots or regulatory sandboxes, for example, test innovations in a controlled and time-bound manner while enabling data collection for evidence-based decision-making.

2.3.1. Principles before prescriptive regulations

Principles-based approaches can guide rapid technology and business innovation, while leaving space for the market to develop and deploy products and services. In the case of AI, for instance, many countries across the region are developing guiding frameworks that reflect a spectrum of governance strategies—from principles-based to more directive regulatory approaches.

Indonesia has taken a regulatory approach, issuing ministerial regulations that mandate the ethical and accountable use of AI. In contrast, The Philippines has adopted a National AI Strategy Roadmap 2.0 which outlines strategic priorities around AI talent, ethics, innovation and research. While not binding regulations, they reflect strong strategic intent. Malaysia has also published its National AI Roadmap and has developed ethical AI guidelines under the Ministry of Science, Technology, and Innovation.

Thailand, similarly, is pursuing a roadmap approach with an emphasis on ecosystem development, capacity building, and sectoral integration, though binding regulations have not yet been introduced. Meanwhile, Vietnam has issued a national strategy on AI through 2030, focusing on investment, capacity building, and international cooperation. Singapore, has also a roadmap and maintains one of the most mature governance ecosystems through sectoral toolkits and its Model AI Governance Framework, widely seen as a reference in the region. These varying approaches reflect a broader trend: while SEA countries share common priorities in AI governance, they diverge in approach.[96]

In addition to soft-law mechanisms like guidelines and frameworks, SEA countries are using regulatory sandboxes to test emerging technology and technology-enabled business models in a controlled and time-bound manner before full market deployment (**Table 5**).

Table 5: Key Sandbox Developments in SEA-6, 2024

Country	Sandbox development
Indonesia	Updated framework for the Financial Sector Technology Innovation sandbox under OJK Regulation No. 3 of 2024, superseding the 2018 regulation
Malaysia	Released policy document on Financial Technology Regulatory Sandbox Framework, which supersedes the 2015 regulation
The Philippines	Established Strategic Sandboxes for the financial sector through a memorandum circular
Singapore	Expanded the Privacy Enhancing Tech (PET) Sandbox to cover innovations supported by generative AI
Thailand	Established the Digital Assets Regulatory Sandbox under the Securities and Exchange Commission (SEC) and updated the framework for testing Fintech Innovations under the Bank of Thailand
Vietnam	Updated the draft law on Fintech Regulatory Sandbox under the State Bank of Vietnam

Source: Tech for Good Institute analysis on the Evolution of Tech Governance in SEA-6, 2025[97]

These sandboxes serve multiple purposes in the regulatory ecosystem:

- **Real-world testing:** Allowing innovative solutions to be tested with actual users under controlled conditions;
- **Regulatory learning:** Enabling regulators to develop expertise in emerging technologies;
- **Research-industry collaboration:** Facilitating partnerships between research institutions and industry experts;[98]
- **Evidence-based policymaking:** Generating empirical data to inform future regulatory frameworks, and;
- **De-risking innovation:** Creating safe spaces for experimentation that might otherwise be deterred by regulatory uncertainty.

The sandbox approach is an example of a shift toward more adaptive, responsive governance models better suited to the pace of technological change. While the fintech sector has benefited from this form of policy innovation for almost a decade, there are currently 39 active sandboxes in the region across various verticals: fintech, healthcare, transportation, drones, agriculture, energy, environment, built environment and education.[99,100]

2.3.2. Multi-stakeholder governance and implementation

In addition to government, other stakeholders can play a role in innovation governance. Co-regulation, for example, may involve industry formulating a code of practice in consultation with the government, with code breaches usually enforceable by industry or professional organisations rather than the government directly. Examples of these approaches include:

- **Digital industry forums:** Industry-led self-regulatory bodies that develop standards and best practices, such as in the fintech sector;
- **Public-private digital governance committees:** Co-regulatory approaches where government and industry jointly develop governance frameworks, such as AFTECH (*Asosiasi Fintech Indonesia*), and;
- **Civic-tech partnerships:** Collaborative initiatives that engage civil society in designing and monitoring digital governance, such as AI Verify.

These multi-stakeholder approaches may be preferable in highly technical or rapidly evolving sectors to allow:

- **Adaptation speed:** Ability to respond more quickly to technological changes;
- **Technical expertise:** Access to industry and academic knowledge;
- **Implementation effectiveness:** Greater buy-in from regulated entities, and;

2.3.3. Cooperation on common priorities

While countries across SEA may share common policy priorities, they diverge in structure and approach given the diversity of development, legal traditions and national priorities (**Table 6**).[101] As with AI governance (**Table 4**), each SEA country is working to provide regulatory clarity around cybersecurity, data protection, consumer protection and online safety in their own way.

Table 6. Regulatory frameworks of Shared Priorities across SEA-6

Country	Common Tech Governance Areas of Interest in SEA in 2024	
	Cybersecurity and Data Protection	User Protection and Safety
Indonesia	Updates to the Electronic Information and Transaction (EIT) Law Personal Data Protection (PDP) Law National Cyber and Crypto Agency (BSSN) Regulations	Draft Amendments to the Consumer Protection Law (under review) OJK Regulation No. 3 of 2024 (Financial Sector Technology Innovations)
Malaysia	Cybersecurity Act of 2024 Amendments to the Online Safety Act Personal Data Protection Act (PDPA) Amendments 2024	Online Safety Act Amendment to the Communications and Multimedia Act (CMA)
The Philippines	National Cybersecurity Plan 2025-2028	Implementing Rules and Regulations of the Internet Transactions Act Anti-Financial Scamming Act (AFASA)
Singapore	Cybersecurity (Amendment) Bill No. 15/2024 Personal Data Protection Act (PDPA) Advisory Guidelines	Shared Responsibility Framework for Digital Transactions
Thailand	Cloud Security Standard 2024	Digital Platform Services (DPS) Law Guidelines for Managing Advertisements on Digital Platform Services Cybercrime Case Division
Vietnam	National Data Strategy to 2030 Decision No. 1437/QD-TTg: Promulgating the National Action Plan on development of digital economy in the 2024-2025 period	National Data Strategy to 2030 (Decision No. 142/QD-TTg: Approving the National Data Strategy by 2030

Source: Tech for Good Institute analysis on the Evolution of Tech Governance in SEA-6, 2025[102]

Despite different national approaches, regional efforts to further interoperability can advance digital sustainability. The ASEAN Digital Integration Framework, for example, supports cross-border digital infrastructure development. The ten ASEAN member states are negotiating the ASEAN Digital Economy Framework Agreement (DEFA) to establish shared principles on data governance, digital trade and cross-border services.[103] Regional policy alignment is vital for regional scaling, particularly for sectors like health, agriculture and financial services that rely on cross-border data flows.

ASEAN has facilitated cooperation on present challenges and emerging topics. Cybersecurity response coordination is an example of the former, while the ASEAN Guides on AI Governance and Ethics and Generative AI the latter.[104] Looking ahead, cross-border policy learning and sandbox corridors enable governments to observe and adapt their own digital governance approaches to innovation.

2025 will likely see updates from key ASEAN cooperation plans, including the ASEAN Economic Community Blueprint and the ASEAN Vision and Strategic Plan of Action for Food, Agriculture and Forestry.[105,106] Continued cooperation and regulatory alignment across countries will be a key factor in advancing technologically-enabled digital sustainability solutions to the region's social, economic and environmental challenges.

2.4. Financing Innovation

> "What's most crucial is driving innovation in finance. In Southeast Asia, there's tremendous potential to de-risk investments that are often seen as high-risk. Tools like blended finance, project financing, and carbon credits can play a pivotal role in lowering barriers and unlocking greater private capital participation."
>
> **- Tan Jun Da, Vice President at GenZero**

In addition to technology, business model and policy innovations, financing innovation is needed to drive digital sustainability in SEA. Over the last decade, the region's digital economy focused on rapid scaling and market capture, and has been nearing profitability.[107] Meanwhile, strategic initiatives like regulatory reforms and cross-border collaboration are enabling successful investment exits and strengthening long-term market confidence.

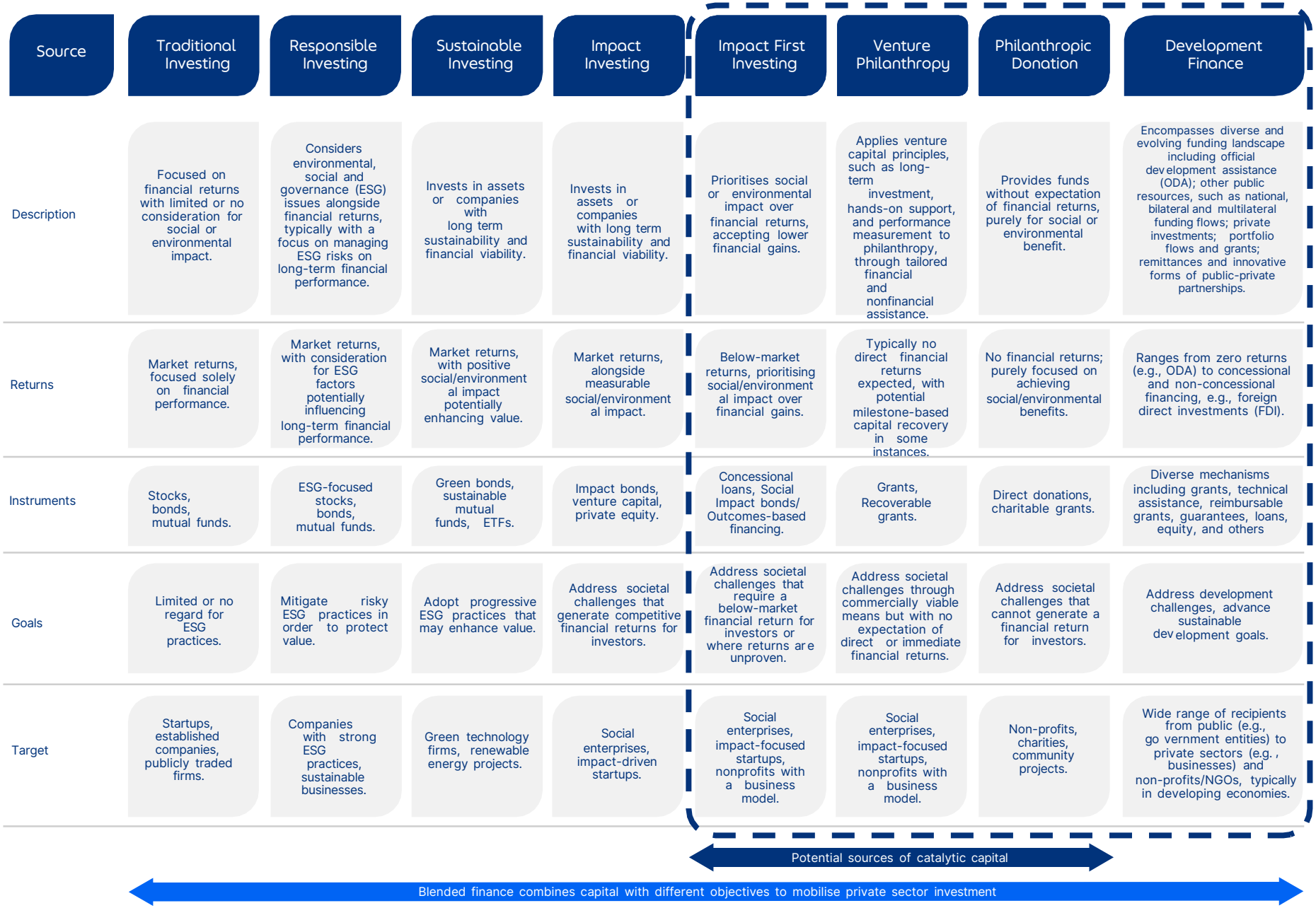
However, uncertainty over Return on Investment (ROI) for digital sustainability remains the top concern for investors (**Figure 10**). Current market expectations are often misaligned with the broader social and environmental value of digital sustainability initiatives. Benefits like reduced emissions, improved health outcomes, public goods and financial inclusion are frequently undervalued or overlooked. Further, time horizons for financial return are typically longer than conventional investment cycles. Traditional digital economy capital sources, therefore, may not suit early-stage or mission-driven business models, such as circular and regenerative enterprise models or those serving bottom-of-the-pyramid customers.

Financing innovation involves three key aspects:

- **Engaging** new sources of capital, such as impact investments and philanthropy;
- **Creating** innovative instruments for capital deployment, such as recoverable grants and blended finance, and;
- **Developing** new pathways for financial returns and exits to improve liquidity, including activities like trading impact or biodiversity credits.

Crucially, different sources of capital, instruments, and exit pathways are needed at different stages of a technology or company's maturity.

Figure 11: Spectrum of Capital



Source: Analysis by Tech for Good Institute, based on the Spectrum of Capital found in "Scaling Impact in Asia: Achieving Purpose and Profit, by CIIP, Accenture and SMU" and the Organisation for Economic Co-operation and Development (OECD)'s definition of development finance. The examples provided in the table are non-exhaustive and intended for illustrative purposes only. [108]

2.4.1. A spectrum of capital for digital sustainability

Structuring and delivering funding and capital for digital sustainability can take many forms- from **traditional investments** seeking financial returns, to **philanthropic donations** with no return expectations, to **development funding** that spans a wide spectrum, including no-return grants and concessional capital with modest returns. **Impact capital** (**Figure 11**), which draws from sources across the spectrum of capital, can **help bridge the early-stage funding gap**, where pure philanthropic capital is not sufficient, and where commercial investors perceive the risks as too high.[109] By offering flexible return expectations, impact capital enables the development and scaling of technologies that might otherwise struggle to attract funding—while ensuring that long-term social and environmental benefits remain central to their success metrics.

1. Impact investing

> "For me, there's no difference between innovation and impact because all innovation makes an impact – I believe it should be good for humans and for society. That is why we do not segregate impact and innovation for our investment thesis."
>
> **- Atsushi Taira, Managing Director, Mistletoe**

Commercial (market-rate) impact investments seek the simultaneous pursuit of profit and social and/or environmental good. Their defining feature is an articulated motive and intent to generate positive social and/or environmental impact alongside a targeted market-competitive financial return, without one foregoing the other as both are of equal importance. Impact-focused venture capital and private equity firms deploy commercial impact investments such as digital sustainability solutions. For example, **500 Global**, a Silicon Valley-based VC firm with a strong presence in SEA, invests from **pre-seed to pre-IPO**, focusing on AI, healthcare, sustainable cities and fintech among others to drive long-term value. **Mistletoe**, a Singapore-based seed-stage vehicle and angel investor, funds high-risk digital solutions, including drone logistics and AI-driven healthcare. **Antler**, an active **early-stage** investor founded in Singapore, has backed over 1,300 startups, with 40% classified as impact companies tackling sustainability challenges in sectors like carbon intelligence, water management and healthcare diagnostics.[110] Headquartered out of Singapore, **Wavemaker Impact ("WMi')** is Asia Pacific's leading climate-tech venture build fund. As the Impact Fund of Wavemaker Partners Group, WMi was launched with the goal of building a portfolio of companies that has the potential to reduce 10% of the global carbon budget by 2035. Global investment firm Invesco launched the **Climate Adaptation Action Fund**, investing in **public and private placement debt** in emerging markets to support **climate resilience** and digital infrastructure. **Bayshore Global**, another key player, focuses on **growth-stage** investments in technology-driven impact solutions. These firms illustrate that **impact-driven investments can be both scalable and profitable** across various funding stages and asset classes.

Concessionary and impact-first impact investments have similar commitments to create social or environmental impact, but neither regard financial returns as a secondary goal, nor will it extend capital beyond the usual return horizon (known as patient capital). Impact-first investors often target regions and sectors where traditional investors are less active but the potential for positive impact remains. Impact-first investors may accept below market rate returns or offer flexible/patient terms, while concessionary investors accept below-market returns more explicitly. For example, **SEA Clean Energy Facility (SEACEF)** pprovides early-stage development capital to renewable energy projects in Vietnam, Indonesia and the Philippines, steering these markets away from fossil fuels toward sustainable energy solutions.[111]

BOX 2
Characteristics of Impact Investing

According to the Global Impact Investing Network (GIIN), impact investments are made with the intention to generate positive, measurable social or environmental impact alongside a financial return.[112] Impact investments have four core characteristics:[113]

1. **Intentionality:** Impact investing is marked by an intentional desire to contribute to measurable social or environmental benefit. Impact investors aim to solve problems and address opportunities. This is at the heart of what differentiates impact investing from other investment approaches, which may incorporate impact considerations.

2. **Using evidence and impact data in investment design:** Investments cannot be designed on hunches. Specifically, impact investing must use evidence and data where available to drive intelligent investment design that will contribute to social and environmental benefits.

3. **Managing impact performance:** Impact investing comes with a specific intention and necessitates that investments be managed towards that intention. This includes establishing feedback loops and communicating performance information to support others in the investment chain to manage towards impact.

4. **Contributing to the growth of the industry:** Investors with credible impact investing practices use shared industry terms, conventions and indicators for articulating their impact strategies, goals and performance. They also share insights, where possible, to help others learn from their experience about what contributes to social and environmental benefit.

Impact investment is one source of impact financing. Other forms of impact capital include philanthropic capital as risk-tolerant catalytic funding and blended finance to de-risk and scale high-impact initiatives.

2. Philanthropic capital

Philanthropic capital is a financial resource dedicated to driving social and environmental change, prioritising impact over financial returns. It can be an outright gift with no return expectations or an asset with below-market returns. This capital typically funds non-profit organisations through donations or fuels commercially viable initiatives via venture philanthropy. Its risk-absorbing and patient nature makes it a powerful tool for catalysing early-stage innovations.

Compared to impact investments and other emerging innovative financing methods, philanthropic capital is more established and generally enjoys clearer regulatory frameworks in most SEA countries.[114] Incentives typically take the form of tax deductions, tax exemptions or direct government grants focused on supporting non-profit and local organisations.

Several initiatives in SEA exemplify this approach:

- **The SAFE STEPS D-Tech Awards,** created by the Prudence Foundation, the community investment arm of Prudential in Asia, recognise technologies for disaster-focused products or parts of the value chain that support disaster early warning systems, preparedness, prevention, mitigation, relief, response or recovery. Each winner receives US$15,000 to US$35,000 to support the development of their solutions.[115]
- **The Liveability Challenge,** presented by Temasek Foundation and organised by Eco-Business, is a global crowdsourcing call for viable, groundbreaking solutions that push the boundaries of innovation, offering up to S$2.4 million to fund solutions across two themes-Decarbonisation and Cool Earth-which tackle extreme heat-related weather conditions. In addition to catalytic support from Temasek Foundation, finalists have also received funding offers in investments and grants from strategic partners such as Enterprise Singapore, OCTAVE Well-Being Fund, TRIREC and Valuence Ventures.[116]
- **The Earthshot Prize,** supported by major philanthropists and backed by the UK's Prince William, awards £1 million across five sustainability categories.

3. Development finance

Beyond private and philanthropic sector funding, development finance plays a crucial role in promoting sustainable economic growth, job creation and supporting transitions in emerging economies. While the initial primary goal of development finance was to foster economic development, the motivations behind this type of financing have broadened significantly over time to explicitly include and prioritise sustainable development and facilitating transitions towards greener economies, such as climate finance for adaptation and mitigation initiatives.[117]

Multilateral Development Banks (MDBs) such as the World Bank, International Finance Corporation (IFC) and the Asian Development Bank (ADB) deploy pooled financial contributions from multiple countries and private sources. Such funding generally supports large-scale infrastructural projects to address global development challenges like poverty and climate change, to promote cross-border cooperation. **Bilateral development finance institutions** like the Japan International Cooperation Agency (JICA) and *Nederlandse Financierings-Maatschappij voor Ontwikkelingslanden N.V.* (FMO) are typically government-owned agencies of developed countries that provide financing to developing countries. While financial returns are not always expected, bilateral aid is underscored with intentions to improve relations between countries, promote stability and enhance the recipient country's ability to achieve long-term development objectives. **National development finance institutions**, such as The Philippines' National Development Company and Malaysia's Development Bank of Sarawak, aim to drive competitiveness and advance sustainable development at the national level.

These institutions employ various financial tools such as grants, technical assistance, loans, guarantees and equity participation to address market gaps and bridge the gap between public aid and private investment.[118] The *State of Blended Finance 2024: Climate Edition* report by Convergence[119] found that commercial financing from Development Finance Institutions (DFIs) and MDBs grew by 60% in 2023, to a six-year high.

The scale and focus of funding provided through development finance has historically meant that larger established companies tend to be selected as implementing partners. Recognising the need for innovation and new ideas, DFIs are now supporting early-stage companies and pilot initiatives. For example, the Creative Technology Solution (CTS) initiative by the Korea International Cooperation Agency (KOICA) and other DFIs are also participating in funds, such as the Omnivore Agritech and Climate Sustainability Fund-joined by the IFC, FMO, the German KfW and the Belgian Investment Company for Developing Countries and philanthropic backers like the Gates Foundation.[120,121]

Case Study 4

Mastercard Center for Inclusive Growth: Catalysing innovation in data and technology through philanthropy[122]

As Mastercard's social impact hub, the Mastercard Center for Inclusive Growth (the "Center") drives economic development by funding research and programmes that connect academia, government, business and social impact leaders. The Center is embedded into Mastercard's strategic imperatives, particularly around expanding financial and digital inclusion for all.

As of December 2023, Mastercard had supported 37 million women entrepreneurs and brought 870 million people into the digital economy. In November 2024, Mastercard enabled 50 million small businesses to grow digitally.

Catalytic philanthropy - Investing in scalable innovation

As a corporate philanthropist, the Center provides catalytic capital for early-stage, scalable initiatives, unlocking follow-on funding globally. One example is Data.org (co-founded by the Center and Rockefeller Foundation), a platform that builds and strengthens data fields for social impact. Its Inclusive Growth and Recovery Challenge, supported by the Center and the Rockefeller Foundation, funded nine data-driven initiatives across Australia, Denmark, India and Kenya, later attracting US$30.8 million in follow-on funding from USAID, Google.org and the Mastercard Foundation.[123]

Focus on SEA - Strengthening data capacity and innovation

In SEA, the Center is supporting two key initiatives in innovation:

- Asia Pacific Data Capacity Accelerator: The accelerator is a collaboration between data.org, the Association of Pacific Rim Universities (APRU) and the National University of Singapore (NUS). The accelerator trains students and professionals to use data science for social impact through training, case studies, real-world data sets and practical tests on how to distinguish and apply data in areas like health, climate and financial inclusion. Launched in Singapore, the APRU supports development of co-designed courses and materials across APRU's 61 member universities, including those in Indonesia, Malaysia, The Philippines, Thailand, as well as North America, Oceania and South America. This will be followed by the creation of open-source courses and resources. This is in line with data.org's goal to train one million data practitioners around the world by 2032.

- The Amplifier: The Center is an Impact Innovation Partner of the Amplifier, a programme by Philanthropy Asia Alliance (PAA) and CIIP supporting early-stage impact companies to scale across Asia through non-dilutive, catalytic capital, mentorship, advisory support and commercial opportunities. The inaugural 2024 cohort tackled Climate and Nature challenges, which included Filipino agritech startup Mayani that digitises food supply chains to improve farmer livelihoods and sustainability. In 2025, the Amplifier launched additional three tracks in employment, tourism, and textiles, with continued support from the Center as well as new funding partners Macquarie Group Foundation and SHEIN.[124]

Expected impact

By building capacity in data science, supporting innovation and scaling impact ventures, the Center strengthens SEA's ecosystem for inclusive growth. By supporting initiatives at an early stage, the Center paves the way for future funding from institutional capital providers to foster a more inclusive, sustainable and digitally empowered future.

"The Center has more than a decade of experience in catalysing capital to help unlock global funding opportunities for new ideas. We want to pilot and then transition new ventures and innovations to other private sector funders who can benefit from these solutions and maintain a clear understanding of how to use these tools responsibly, with a focus on protection, transparency and fairness. But, we cannot do this alone - thus we invite other organisations to join us in supporting and scaling innovations from around the world."

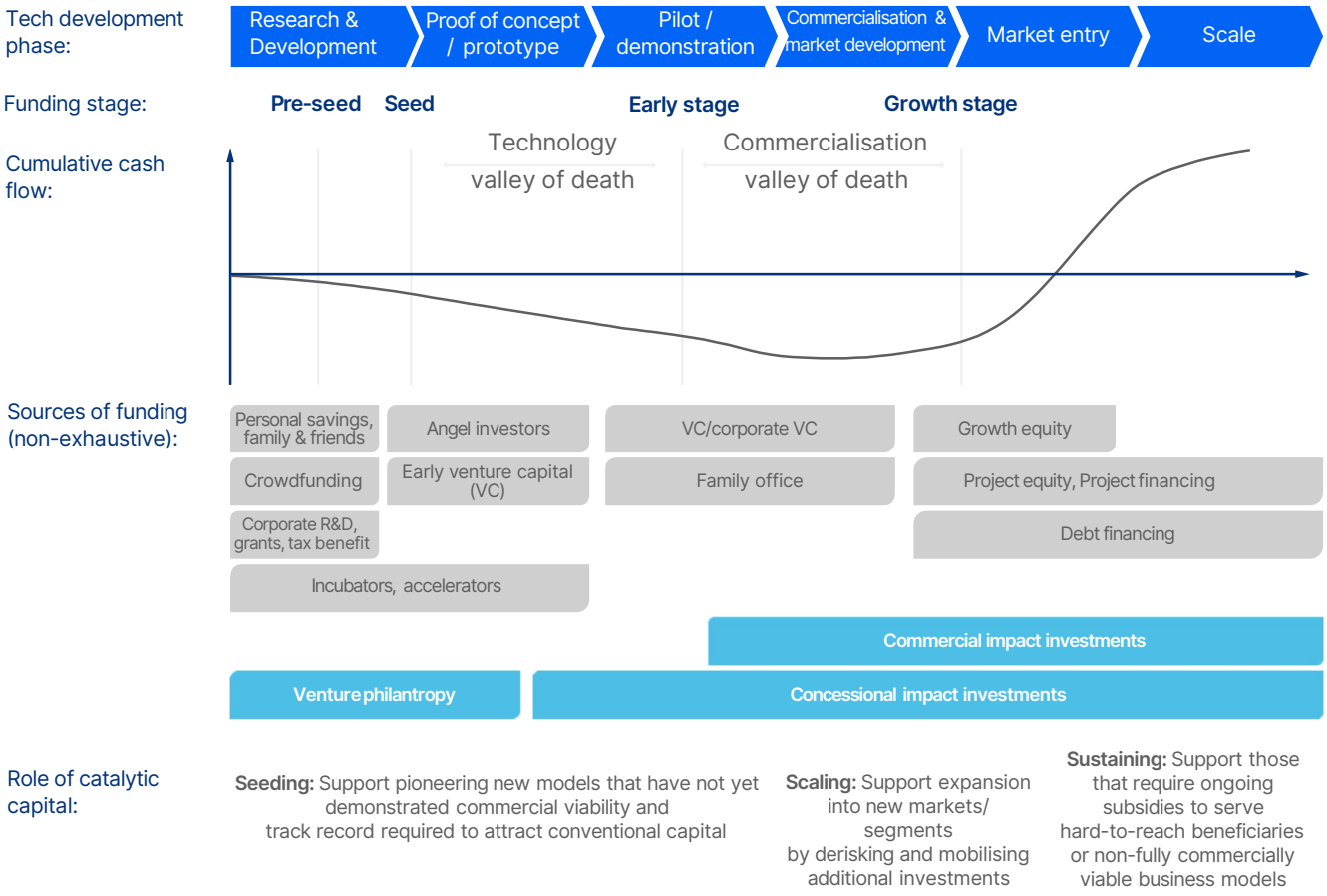
Subhashini Chandran, Senior Vice President of Social Impact for Asia Pacific, Europe, Middle East and Africa, Mastercard Center for Inclusive Growth

2.4.2 Innovative capital deployment

Innovations in financial product design, new return pathways and new exit pathways can expand access and improve liquidity in the impact financing market.

Blended finance strategically combines funding from governments, philanthropists and private-sector organisations.[125] Aligning capital with the right stage of a company or technology-and with funders' risk profiles-supports innovation (**Figure 12**). By pooling capital with different risk levels, blended finance also promotes cross-sector collaboration.

Figure 12: Capital Requirements across a Company's Lifecycle



Source: CIIP analysis adapted based on Kaylanpepin.com, BDC's ICE Venture fund, Catalytic Capital Consortium

For example, a blended finance vehicle can be established with three tranches of capital. The junior tranche carries the highest risk and is typically funded through catalytic capital (in the form of e.g., grants, unsecured debt) provided by impact organisations and philanthropic foundations. The mezzanine tranche is designed to be investible by MDB and DFI as previously mentioned, by high-yield investor in the form of bonds or loans, with commensurate return. The senior tranche, benefiting from asset diversification and 10-20% subordination, can achieve an investment-grade rating (e.g., BBB), making it attractive to a broad range of debt investors.[126]

Blended finance enables marginally unbankable opportunities-such as early-stage startups, large-scale infrastructure projects and others-to tap into larger and more diverse pools of capital, ultimately scaling social and environmental impact. Blended finance has been used in SEA and beyond to leverage public and private capital to address development challenges, particularly in sustainable infrastructure and trade finance. Blended finance and catalytic finance are still nascent, with few standalone national frameworks or taxonomies present globally. High-level principles on blended finance have been issued, such as the G20 Principles to Scale up Blended Finance in Developing Countries, agreed upon during the Indonesian G20 Presidency. The framework sets out voluntary principles that reflect the common strategic direction and aspiration for scaling up blended finance implementation in developing countries.

Case Study 5

Lendable: Harnessing innovation in finance, data and technology to drive financial inclusion[127]

Lendable is a leading debt finance provider to market leading companies across pre-frontier, frontier and emerging markets across Asia, Africa and Latin America. Lendable uses its proprietary technology, Maestro, to help investors understand risk and impact in the markets where it operates. By leveraging data science and innovative financing mechanisms, Lendable enhances financial inclusion by supporting fintech firms that offer MSME credit, asset finance, consumer lending, payments, remittances and embedded finance.

Challenge: bridging funding gaps

Traditional financial institutions often avoid lending to underbanked populations in emerging markets due to perceived risks and limited credit history, creating a funding gap that stifles economic growth and financial inclusion. Lendable tackles this challenge by establishing a blended finance vehicle that mobilises capital from diverse investors, including development finance institutions (DFIs), aid agencies and commercial investors. Central to this initiative is Lendable's proprietary technology, Maestro, which enables real-time monitoring and supports its blended finance setup by ensuring transparency, tracking impact metrics and streamlining due diligence, thereby facilitating the efficient scaling of socially and financially impactful investments.

Innovation in financing: Blended finance to unlock capital for inclusion

Launched in 2021, Lendable's MSME FinTech Credit Fund (LMFCF), employs a tiered capital structure to de-risk investments and attract private capital to balance risk and returns across various tranches. The fund was oversubscribed, surpassing its initial target of US$100M and closing at US$110M. The fund structure consists of:

- First-Loss Capital (~10%): Development finance institutions (DFIs) and aid agencies provided first-loss capital, absorbing initial losses to protect other investors.
- Subordinated Tranche (~25-35%): This tranche carries progressively higher risk and is filled by DFIs, family offices and impact-driven investors seeking higher returns while supporting financial inclusion.
- Senior Notes (~55-65%): Commercial investors contributed to this low-risk tranche, benefiting from the protection offered by the subordinated capital below them.

LMFCF achieved a 9:1 leverage ratio, with each dollar of catalytic capital mobilising an additional US$9 from commercial investors.

Key learnings from Lendable's blended finance experience include:

- Risk mitigation through layered capital and defined concentration limits
  - The tiered structure of LMFCF-where DFIs and aid agencies provide first-loss capital and mezzanine equity-has been crucial in attracting commercial investors who would otherwise perceive fintech investments in emerging markets as too risky.
  - To manage risk, the fund employs strict concentration limits on geographies and investment types to ensure diversification. This requires early coordination among capital providers to align on requirements while maintaining operational flexibility.

- Blended finance as a scalable model
  - The LMFCF model shows that structured finance solutions can help de-risk investments, making fintech firms in emerging markets more attractive to private capital. This approach is replicable across sectors requiring long-term capital but faces perceived high risk.

- Data and technology as a key enabler
  - Lendable's proprietary technology, Maestro, facilitates data-driven risk assessment by analysing borrower data from fintech borrowers, improving underwriting and risk management. Through API-based integration, fintech companies can seamlessly share with Maestro their disbursement, collection and delinquency data, enabling real-time monitoring of loan performance with Lendable, while maintaining data privacy through anonymisation. Maestro also tracks impact metrics, ensuring the fund meets catalytic capital providers' impact objectives, while offering commercial investors' confidence in the fund's accountability. By continuously assessing the performance of fintech companies, Maestro enables dynamic portfolio management, identifying early warning signs to protect returns. Additionally, it streamlines due diligence, reducing operational costs and allowing its fund to scale efficiently while preserving integrity.

Expected Impact: Expanding Access to Finance

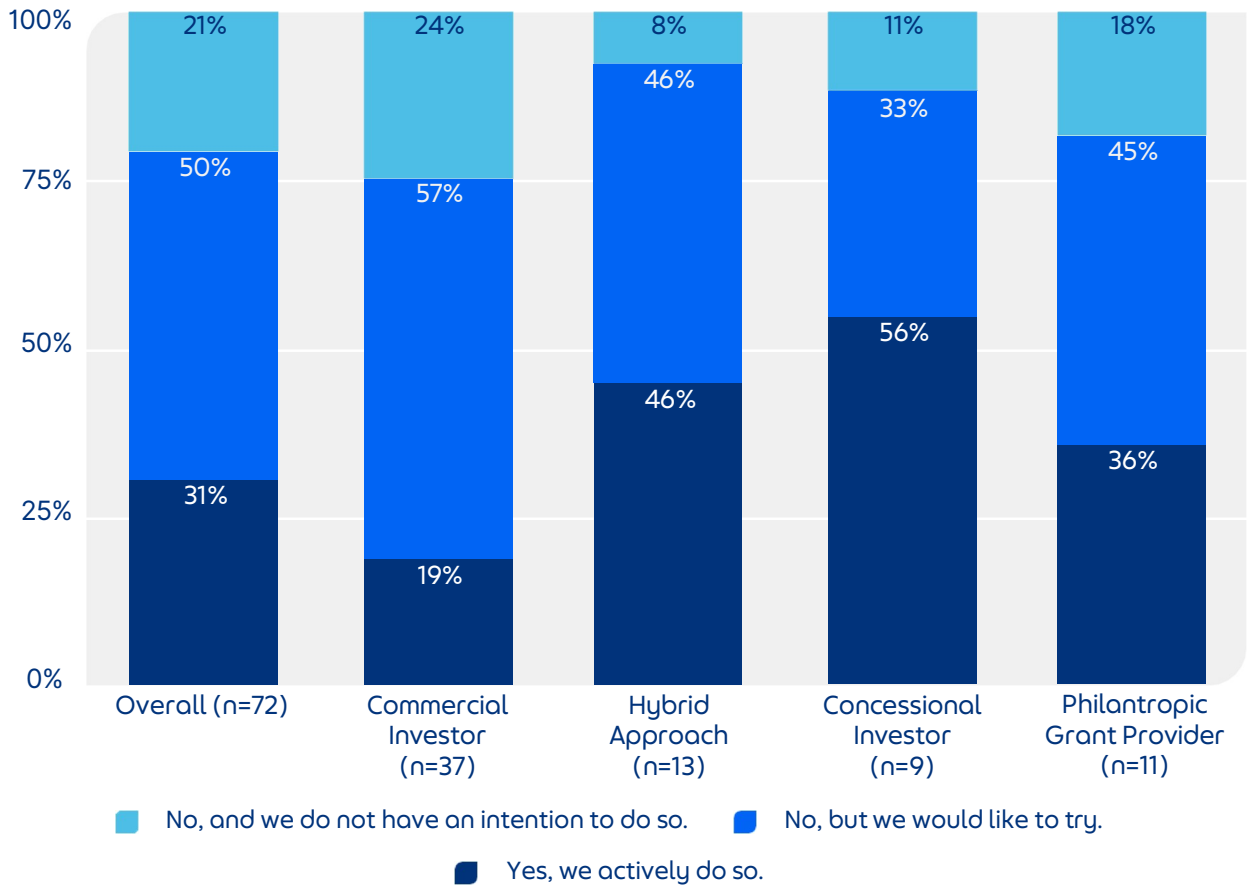
LMFCF has deployed capital across emerging markets, investing in fintech companies in countries such as Indonesia, the Philippines, Thailand and Vietnam. Some examples of Lendable's investments in SEA include investments in Amartha and Validus. Its goal is to foster financial inclusion by extending loans to over one million individuals and MSMEs, with a focus on reaching 300,000 female end borrowers. To do so, the fund seeks to support fintech innovation by financing companies that enhance MSME lending through alternative credit scoring, digitise supply chains and expand digital financial services to all.

Going Forward

Lendable's blended finance model demonstrates a scalable approach to mobilising private capital for fintech growth in emerging markets. Future efforts will focus on expanding investment in high-impact fintech innovations, enhancing technological integration for improved risk assessment and fostering strategic partnerships with DFI and private investors. As financial ecosystems continue to evolve, Lendable remains committed to driving financial inclusion by leveraging data-driven solutions and pioneering sustainable funding mechanisms for underserved communities.

Blended finance is attracting strong interest among capital providers. 31% actively participate in blended finance mechanisms, while 50% are interested to try (**Figure 13**). For those interested to try, a lack of know-how and access to viable opportunities may represent barriers. Among the groups, concessional funders lead in participation, followed by hybrid funders and then philanthropic grant providers. Notably, significant untapped interest exists among both commercial investors and philanthropic grant providers. The presence of over 2,000 family offices in Singapore alone offers a unique opportunity to tap such sources, as these entities often possess the flexibility, patience and resources to support innovative projects that drive meaningful social and environmental change.[128]

Figure 13: Blended Finance Interest by Survey Respondents with Different Funding Approaches (N=72).



Note: Investor category 'Others' (N=2) is not shown.
Source : Survey by TFGI and CIIP, 2025

Blended finance is just one example of financing innovation for digital sustainability. Another example is **green financing**, which refers to any structured financial activity created to ensure better environmental outcomes, including loans, debt mechanisms, green bonds, Shariah-compliant green sukuks[129] and investments. **Sustainability-linked bonds** are structurally linked to the issuer's climate achievement or broader sustainable development goals, while sustainability-linked **loans** are linked to predetermined sustainability performance targets on the borrower's end. For examples of green finance instruments, see **Appendix B**.

Capital flows can also be facilitated through co-investment platforms and marketplaces underpinned by strong impact management and measurement systems. These platforms can help open new pathways for returns and exits, and reduce barriers to fundraising. One such example is **Co-Axis**, a digital platform where global impact communities connect, collaborate and catalyse innovation for a sustainable world.[130] The platform serves as a matchmaker between funders and impactful early-stage initiatives raising catalytic capital funding. Co-Axis is part of the Temasek Trust ecosystem, availing access to a broader network of partners and entities such as the Philanthropy Asia Alliance and the Centre for Impact Investing and Practices. Another example is **AVPN's ImpactCollab**, an outcomes-based social investing system that leverages AVPN's impact data registry, called the Social Outcomes Platform, to adhere to impact data standards in evaluating social programmes. ImpactCollab was developed with the support of the Monetary Authority of Singapore (MAS) to facilitate philanthropic giving and impact investing, including cross-border capital deployment.[131]

Importantly, financial innovation must be underpinned by strong governance across all investment stages and continuous Impact Measurement and Management (IMM). This is critical to ensure desired impact outcomes are achieved and to avoid critical risks such as "impact-washing" or greenwashing.

Effective IMM depends on robust monitoring of outputs, outcomes and impact. Outputs-such as services delivered or individuals reached-provide immediate, actionable signals of progress. Outcomes reflect the longer-term changes experienced by stakeholders, while impact captures the measurable difference made. Together, they validate a theory of change[132] and help assess additionality-the unique value created by an investment.

Digital tools such as sensors and real-time data processing, as discussed in Chapter 2.1, enhance IMM by enabling more precise, continuous and tamper-proof tracking of results. For example, carbon markets rely on trusted and verifiable data. Light Detection and Ranging (LiDAR) sensors can monitor forests digitally for carbon stock monitoring, estimates on carbon yield and generation of carbon credits.

These technologies not only improve the quality of insights available to capital and solution providers, but also lower the cost of data collection and verification particularly in underserved contexts (see **Appendix C** for a case study on EPIC World, an example of how hyperlocal signals, AI and data science can help solution providers measure, adapt and maximise its impact). Ongoing tracking is essential for accountability and to refine strategies so that capital can drive meaningful change and manage potential harm as initiatives scale.

2.5. Integrated Innovation for Digital Sustainability

In summary, the interaction between innovations in technology, business, policy and financing shape the potential for digital technologies to contribute to sustainable development outcomes. Technology breakthroughs require business innovation to reach scale, appropriate financing to support growth and enabling policy frameworks to ensure responsible deployment. These dimensions do not operate in isolation. No single innovation type is sufficient in isolation; rather, they form an integrated ecosystem where advances in one area both enable and are enabled by developments in others.

SEA's diversity and rapid evolution demands continued experimentation that combines digital capabilities with contextual market, business and policy understanding-creating solutions that are not just technically sophisticated but genuinely adapted to local needs, constraints and opportunities.

Case Study 6

Grab: A platform marketplace to advance livelihoods across SEA[133]

Grab is a platform ecosystem in SEA with a mission to create economic empowerment opportunities for everyone. Evolving from a ride-hailing app to an everyday services platform, Grab operates across eight countries and in over 800 cities. In a region with 244 million informal workers[134] and 70 million Micro, Small and Medium-sized Enterprises (MSMEs),[135] Grab's suite of services spanning transport, food delivery, payments, financial services and insurance expands access to income opportunities and the digital economy for workers and MSMEs. Its **hyperlocal approach, user-focused innovation** and **participation in public-private partnerships** have enabled Grab's leadership and innovation in the digital transformation of the region.

A fit-for-purpose digital ecosystem that creates value for users across SEA

Many of its innovations are direct responses to the lack of fit-for-purpose solutions to local problems. Some innovations initially developed to serve adjacent needs have grown into full business verticals.

- ***Driving financial inclusion:*** While developing its transport and mobility business, Grab discovered that millions of Southeast Asians, including drivers and MSME owners, lacked access to basic financial services like banking. This led to its entry into financial services in 2017, with the aim of providing financial products that are simple, transparent and flexible. Embedded directly into the platform experience, and supported by alternative data and credit scoring, GrabFin provides users a single entry point to access payment, lending, and insurance services within the Grab app.[136] Its microfinance products include emergency cash loans, product-based financing, and microinsurance covering drivers and their families while merchant cash advances support small business operations. Grab's growth in financial services has expanded into fully licensed digital banks in Indonesia, Malaysia and Singapore.

User-centricity in Design

As a multi-sided marketplace, Grab integrates hyperlocalised services into a digital ecosystem that fits the unique needs of each market and each user.

- *For driver and delivery partners:* The platform promotes flexibility for partners, enabling them to work when they are able. Since demand for drivers and deliveries vary during the day, workers also have diversified earning opportunities,[137] from providing rides to delivering parcels to collecting mapping data for Grab's in-house mapping technology.[138] The proprietary mapping system,[139] together with AI-driven route optimisation[140] through real-time data, algorithms, batching and navigation, help drivers and delivery partners complete trips more efficiently.[141]

- *For merchants:* Businesses can grow and reach more customers not just through deliveries, but also with payments, marketing tools and financing support. Many merchants on Grab are food and mart-based small businesses. The GrabMerchant app's AI Merchant Assistant provides owners with round-the-clock operational support via the GrabMerchant app, assisting with menu updates, campaign creation, and access to financial tools.[142] To help owners optimise their marketing budgets, advertising on the Grab app is based on a "Cost-Per-Order" system, in which the merchants are charged only upon successful orders.[143]

- *For users:* Safety features such as recording feature AudioProtect[144] enhances passenger and driver safety. Additionally, the same technology that helps drivers locate jobs more quickly also reduces waiting time for users.

Collaboration for Scale and Inclusive Growth

Grab's open partnership philosophy has anchored the company's strategic partnerships with governments, regulators and other industry players. For example, the company has:

- Partnered with governments to extend national social protection schemes to gig workers in The Philippines, Indonesia, Malaysia.
- Participated in MAS' FinTech Regulatory Sandbox prior to GXS Bank's launch.
- Supported governments in identifying potholes and reducing traffic through its mapping and real-time data.[145]
- Contributed data on more than 800,000 kilometers of missing roads to OpenStreetMap, the open-source mapping platform[146]
- Provided data to other companies requiring accurate and up-to-date mapping, such as Bing, Amazon Location Services and Loqate.[147]

3. Three High Impact Sectors for Digital Sustainability in SEA

As SEA undergoes rapid digital transformation, the question is not **whether** to invest in the digital economy-but **where** digital investments might deliver the most impact. This chapter explores three high-opportunity sectors: **financial inclusion, food and agriculture** and **healthcare**, which advance multiple SDGs.[148] Financial inclusion expands access for underserved individuals and MSMEs to payments, credit and insurance, and strengthens financial health and resilience. Sustainable food and agriculture not only reduces hunger, but also improves nutrition, promotes health and wellbeing, reduces poverty, enables responsible consumption, protects ecosystems and supports climate resilience. Healthcare improves health and wellbeing, while reducing poverty and inequality (see **Figure 14**).

Figure 14: Primary SDG Impact by Each Priority Sector

Source: Analysis by TFGI and CIIP based on sector assessments and UNDP SDG Investor Maps

In terms of technology innovation, healthcare dominates in total patent activities (around 1.9 million patents), yet has the lowest digital technology penetration (19.8%). In contrast, financial services and food and agriculture show a greater proportion of digital technologies (**Table 7**).

Table 7: Total Invention and Digital Technology Inventions 2015-2024 By Focus Sector

Sectors	Total Inventions (2015-2024)	Digital Technology Inventions	% of Digital Technology
Financial	186,320	167,910	90.1%
Food and Agriculture	452,918	92,983	20.5%
Healthcare	1,865,228	368,910	19.8%

Source: % of digital technology is defined as the proportion of digital technology inventions out of total inventions. Patent data was retrieved from the Questel FAMPAT database and analysed by IPOS International for this study. Further detail on the patent analytics approach is available in **Appendix A**.

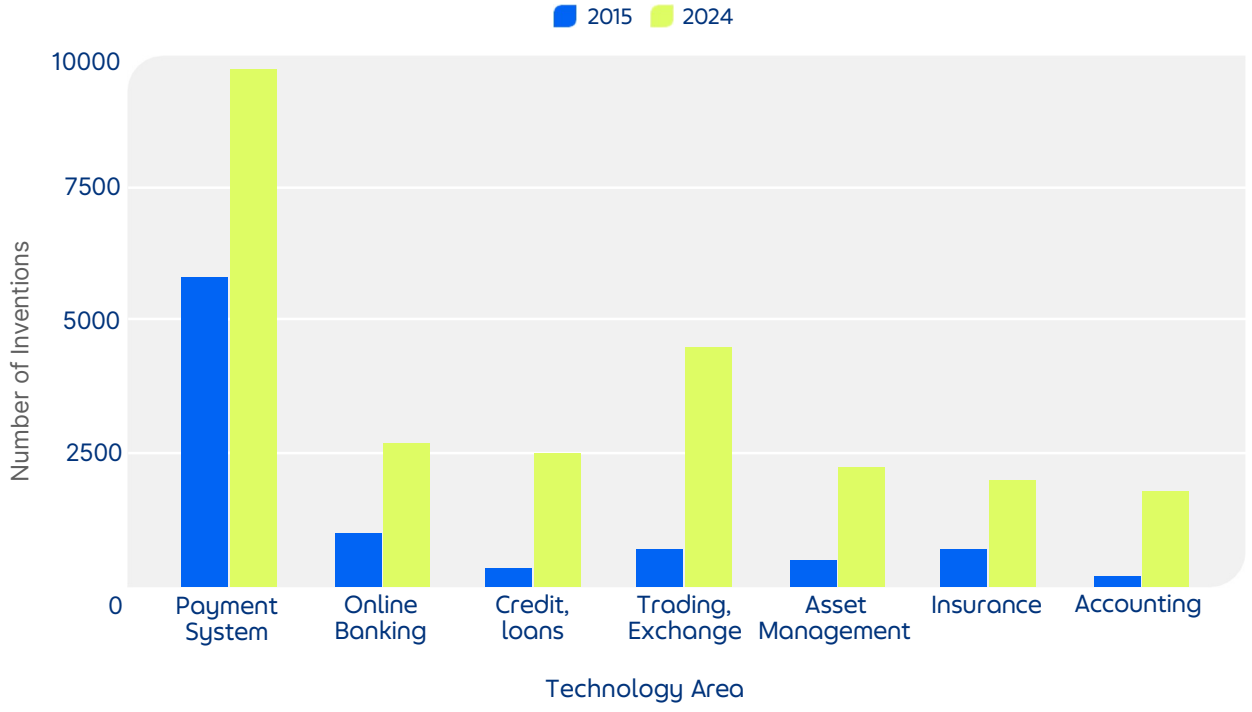
3.1. Innovation for Impact: Financial Inclusion

> "Financial inclusion remains a strategic priority for our fund in Southeast Asia. Digital financial services are demonstrating the ability to scale with strong fundamentals, but as the fintech sector matures, persistent gaps continue to present attractive opportunities for innovation, growth, and impact."
>
> **- Ming Xian Tan, Vice President, Investments, ABC Impact**

As discussed in Chapter 1, financial inclusion remains one of SEA's most persistent development challenges. In response, the industry has increasingly turned to digital innovation to improve service accessibility and foster financial inclusion.[149] Over the past decade, fintech has experienced significant growth (**Figure 15**), Technology areas such as credit loans, accounting and trading exchange have shown CAGRs of 28.5%, 27.6% and 25.9%, respectively.

Payment systems saw the most technological innovation over the past decade. Capital providers interviewed for this report viewed these technologies as transformative mechanisms, enabling individuals to access credit and transact more easily, while helping businesses expand reach and reduce cash-handling frictions. One investor noted its systemic impact in breaking down longstanding market barriers that have historically excluded underserved communities.

Figure 15: Financial Inventions by Technology Area, 2015 vs 2024



Source: Patent data was retrieved from the Questel FAMPAT database and analysed by IPOS International in this project. The scope of each technology area is defined in **Appendix A**. Some inventions may be included in multiple areas.

Alongside payment systems, online banking has overcome traditional banking infrastructure constraints, making it economically viable to serve unbanked populations through mobile channels. MSMEs, in particular, have benefited from this shift, using QR codes and mobile wallets to digitise their transactions and broaden customer reach. Building on these foundational innovations, the next wave of use cases will leverage advanced technologies, such as blockchain, AI and Decentralised Finance (DeFi), to address deeper structural barriers and further expand financial inclusion across SEA.

3.1.1. Use cases and innovation trends

Digital financial services across SEA are evolving from foundational access to sophisticated, inclusive systems that address longstanding structural barriers. The following use cases and innovation trends were highlighted by surveyed investors as particularly promising.

1. **Remittances**

   Related Challenge: Limited cross-border payment infrastructure.

   Cross-border inclusive payment systems are particularly significant in SEA, a region characterised by intra-regional migration and remittance flows. In 2023, SEA saw large remittance flows from both outside the region and between ASEAN countries. The Philippines ranked fourth in the world with US$39 billion, while Indonesia, Vietnam and Thailand also received significant amounts, US$14.4 billion, US$14 billion and US$9.8 billion, respectively.[150] Linkages between national payment systems, such as the connection between Singapore's PayNow, Thailand's PromptPay and Malaysia's DuitNow, allow for near real-time transfers using just mobile numbers. TThis digital transformation reduces reliance on traditional banking channels, which often carry higher fees and longer processing times, making remittances more accessible and affordable for migrant workers and their families.

   Blockchain and other distributed ledger technology are also facilitating cross-border financial transfers. Singapore-based StraitsX, for example, deploys blockchain-enabled digital payments infrastructure while utilising stablecoins such as XSGD on the Avalanche network, delivering expedited, secure and cost-efficient remittance services. Similarly, Indonesia's state-owned digital wallet LinkAja has partnered with Telcoin to develop blockchain-powered remittance solutions to target cost reduction in transactions.

   Patent trends reflect this momentum, with blockchain-related financial technology patents growing at a CAGR of 21% between 2015 and 2024, particularly in areas such as transaction security, identity verification and asset tokenisation.

2. **Verification and authentication**

   Related Challenge: Absence of formal identification documentation.

   In addition to evolving national digital systems covered in Chapter 2.1, mobile and blockchain-based systems are enabling remote verification processes that satisfy *Know Your Customer* (KYC) requirements. These solutions eliminate the need for physical paperwork and in-person procedures, lowering onboarding friction. It is particularly relevant for refugee and migrant populations who typically lack conventional documentation.

   Facial recognition and other biometric technologies are also streamlining customer authentication and reducing fraud risks. For example, Vietnam's national digital identity platform, VNeID, is moving beyond identity verification to serve as a multi-service platform, providing access to both government and financial services in line with Vietnam's broader digital transformation agenda.[151]

3. **Credit access**

Related Challenge: Exclusion from credit access due to lack of formal credit histories.

AI and big data has revolutionised credit access for individuals and MSMEs without traditional collateral or credit histories. Transitioning from retrospective to real-time data analysis has enabled financial service providers to serve previously excluded customer segments. Machine learning models now analyse alternative data points, such as mobile phone usage, utility payments and transaction history, to assess creditworthiness, which fundamentally reconfigures participation barriers within financial markets. For example, Filipino fintech company BillEase uses alternative credit scoring beyond credit bureau data to provide loans to its underserved customers.

Such data-driven underwriting capabilities are pivotal for expanding financial inclusion. By overcoming traditional credit assessment limitations, capital can be deployed more efficiently to enable access for previously-excluded populations.

Figure 15 above shows credit scoring applications growing at a CAGR of 28.5% from 2015 to 2024-more than double the overall fintech patent growth of 12.5%. This concentrated innovation activity underscores the strategic importance of alternative data approaches to expand financial access.

4. **Personalised financial services**

Related Challenge: Trust and usability for diverse populations.

In SEA's heterogeneous markets, one-size-fits-all products often fail to address the specific needs of diverse customer segments. Companies in SEA like Advance Intelligence Group and DANA, referenced in Chapter 2.1, provide AI-driven financial products tailored to individual customer needs and risk profiles. These platforms analyse customer behaviour and preferences, creating personalised financial services that align with an individual's specific needs while remaining commercially viable at scale.

5. **Microinsurance**

Related Challenge: Weak protection mechanisms for climate-vulnerable populations.

Insurance solutions for smallholder farmers, featuring efficient claims processing through digital and physical platforms, represent a key IOA in the UNDP SDG Investor Maps for The Philippines, highlighting the commercial viability of mass customisation in inclusive insurance.[152] Digitally-enabled microinsurance products are designed to be affordable, accessible and relevant, particularly in contexts where traditional insurance is unavailable.

Parametric insurance, for example, triggers automatic payments in response to predefined events. Utilising satellite data and weather analytics, payouts are automatically triggered when predefined conditions indicate a likely crop damage. This eliminates the need for traditional claims adjustment processes that were prohibitively expensive in rural agricultural contexts. Not only does this system reduce administrative costs, it speeds up disbursement and increases trust among users, thus improving customer experience. One capital provider noted that platforms such as IBISA empower insurance companies to launch targeted products for risks like typhoons or heat stress, specifically designed for smallholder farmers in countries like the Philippines and India.

6. **Decentralised finance**

Related Challenge: Limited accessibility and regulatory safeguards in emerging decentralised finance models.

Some capital providers are exploring the potential of blockchain-based finance to complement traditional investment management by increasing transparency and lowering entry barriers.

A notable example is HELIX, a platform incubated with Helicap, which tokenises private credit opportunities to unlock access for a differentiated pool of Web3-native capital. In 2024, HELIX executed pilot transactions on the Ethereum blockchain, enabling Web3 institutional and accredited investors to utilise stablecoins as a denomination to provide funding to real-world credit opportunities with Non-Bank Financial Institutions (NBFIs) in SEA. These NBFIs, in turn, lend to underserved populations, creating a new pathway for inclusive finance.

While these DeFi models represent promising innovation, their real-world impact on financial inclusion in SEA remains nascent. Adoption is largely concentrated among professional or tech-savvy users and significant risks, ranging from data security to regulatory uncertainty, must still be addressed.[153] As such, DeFi is better understood today as an emerging frontier, rather than a core solution, for inclusive finance.

Case Study 7

Moneymatch: Advancing financial inclusion through regulatory innovation and digital payment solutions[154]

MoneyMatch, a Malaysian fintech startup, has played an innovative role in advancing financial inclusion in SEA with its innovative cross-border payment solutions. The company has obtained licenses to operate in Malaysia, Singapore, Brunei, Australia and New Zealand.

Regulatory sandboxes: Facilitating innovation

In 2017, MoneyMatch received approval from Bank Negara Malaysia (BNM) to operate within its Fintech Regulatory Sandbox Framework. This environment allowed MoneyMatch to test its digital remittance platform under regulatory oversight, ensuring compliance while fostering innovation. The sandbox facilitated the development of MoneyMatch's electronic *Know Your Customer* (eKYC) process, a pioneering move in Malaysia's financial sector.[155]

It also helped MoneyMatch to refine its business model, leading to its graduation in 2019. This milestone marked MoneyMatch as the first company to successfully exit BNM's sandbox, subsequently receiving full approval to conduct remittance services.

Open banking and interoperable payment systems: Enhancing financial inclusion

MoneyMatch's integration with Ripple's blockchain network exemplifies the benefits of open banking and interoperable payment systems. By joining RippleNet, MoneyMatch connected with financial institutions globally, reducing cross-border transfer costs by up to 40% and enabling same-day settlements. This integration provided Malaysian SMEs with faster and more affordable international payment options, thereby enhancing financial inclusion.[156]

Balancing financial inclusion with risk mitigation

To promote financial inclusion while mitigating risks, MoneyMatch implemented a digital eKYC process, allowing users to verify their identities remotely. This innovation streamlined customer onboarding, making financial services more accessible while maintaining compliance with Anti-Money Laundering (AML) and Combating the Financing of Terrorism (CFT) regulations.[157]

MoneyMatch's strategic engagement with regulatory sandboxes, adoption of interoperable payment systems and efforts to balance financial inclusion with risk management have contributed to its growth in SEA's fintech landscape. Its experience highlights the role of supportive regulatory environments and technology innovation in expanding financial access. Additionally, MoneyMatch's participation in regulatory sandboxes in Malaysia and Brunei provided a structured setting to refine its services, ensuring compliance and risk management considerations were addressed before scaling operations.

3.1.2. Recommendations for further financial inclusion

SEA's digital finance ecosystem is maturing, but many innovations, from blockchain-powered remittances to AI-driven credit scoring, remain constrained in scope and scale. These technologies have demonstrated proof of concept, but moving from pilot to widespread adoption requires structural interventions that address interoperability gaps, regulatory ambiguity and underdeveloped capital pipelines.

While this section focuses on financial inclusion, many of the barriers to scale, such as capital mobilisation, data governance and ecosystem fragmentation, are not unique to this sector. More holistic recommendations on policy, business model and financing innovation are presented in Chapter 4.2. Interventions outlined here are sector-specific, but should be viewed as part of a broader, integrated strategy to advance digital sustainability across SEA.

1. **Unlock regional infrastructure for cross-border payment and ID systems**

   Scalable remittances, authentication and onboarding models depend on seamless integration between national platforms. Initiatives like Project Nexus enable interoperable instant payment systems. Moreover, shared KYC and Digital ID standards across ASEAN will simplify cross-border access for individuals and businesses. This can be achieved through regionally-aligned APIs, verification protocols and digital credential tools.[158]

2. **Establish regulatory foundations for responsible data use and AI**

   Scaling inclusive credit and personalisation models requires a foundation of trust, standardisation and safeguards. To achieve this, financial regulators and industry stakeholders should develop explainability standards, bias audits and grievance redressal mechanisms that ensure transparency and accountability in AI-based decision-making. Regulatory sandboxes for alternative data and AI, with active participation from public, private and community stakeholders, can inform policy and build trust. Open digital infrastructure, such as multilingual NLP libraries and validated scoring datasets, should be encouraged to reduce barriers for smaller innovators and support fairer market participation.

3. **Enable tailored insurance and DeFi models through adaptive regulation**

   Adaptive governance approaches can support the growth of microinsurance and responsible exploration of new models, such as DeFi. For example, modular regulatory frameworks for parametric and climate-linked financial products are guided by performance-based metrics. Responsible DeFi applications can be piloted with simplified onboarding processes, clear risk disclosures and interoperable digital wallets to ensure accessibility and trust. Regional sandbox corridors can enable multi-country testing of inclusive finance models, supporting scalability across diverse regulatory environments.

4. **Scale capital and delivery infrastructure through 4P platforms**

   Scaling inclusive financial solutions requires coordinated action across public, private, philanthropic and community actors. 4P models can support digital sustainability by pooling expertise and resources, de-risking early innovation, enabling effective scale and ensuring inclusion. Government can prioritise core digital public infrastructure and foster innovation through responsive regulation and targeted tax incentives. Private providers should align their product design with inclusive use cases and emerging regional standards to ensure broader uptake and interoperability. Philanthropic actors can de-risk early-stage ventures, fund digital literacy and fairness research, and subsidise models that prioritise inclusion. Meanwhile, community groups are essential for localising solutions, building trust and supporting onboarding and feedback that close the gap between design and adoption.

5. **Leverage finance as a cross-sector enabler**

   Financial inclusion innovation creates an essential foundation for sustainable development across other priority sectors:

   - **Food and agriculture**: Better financial access for smallholder farmers can support investment in productivity-enhancing technologies and climate-resilient practices. AI-driven credit scoring that incorporates agricultural data can help assess seasonal cash flows and weather-related risks.
   - **Healthcare**: Digital financial services enable more efficient healthcare financing through savings mechanisms, insurance products and payment systems specifically designed for health expenditures. The integration of financial and health data (with appropriate privacy safeguards) can lead to a more effective health coverage and financial protection against catastrophic health expenses.
   - **Climate resilience**: Financial inclusion is increasingly critical for climate adaptation, with digital financial services enabling faster disaster response through direct cash transfers, and innovative parametric insurance products.

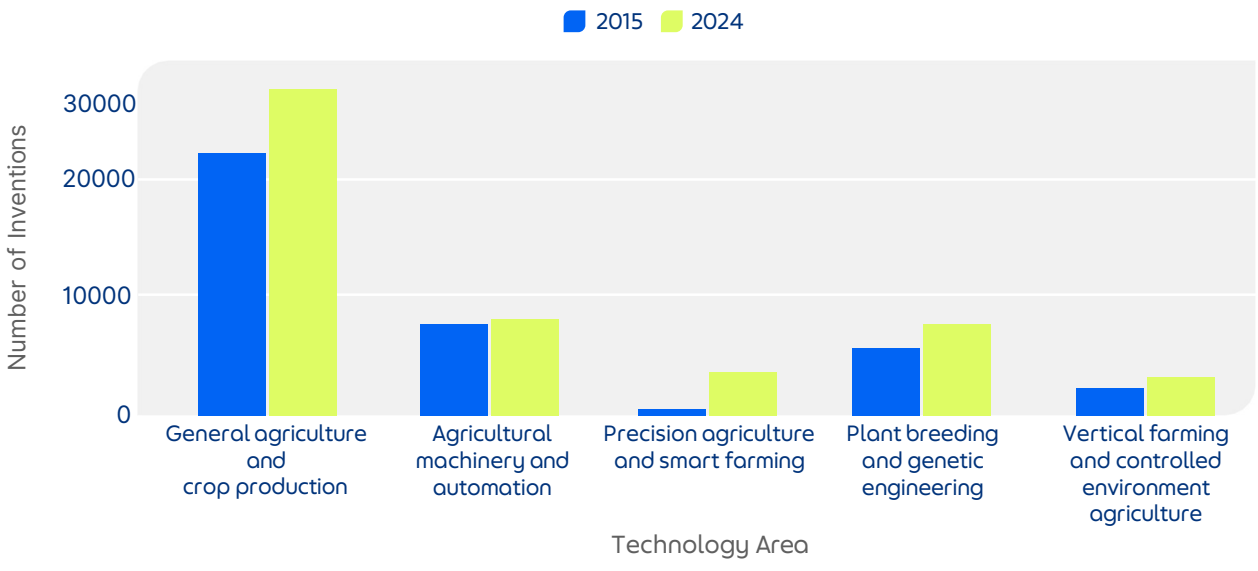
3.2. Innovation for Impact: Food and Agriculture

> "We're seeing good use cases of digital technologies in agriculture. We have seen innovative technologies helping smallholder farmers plan when to harvest their crops based on available data. IoT will be very helpful for farmers as they enter peak harvest season and are able to use IoT processes to determine when crops are closest to maturity, when storage facilities are full and when to send food to the right places. This prevents wastage of crops and ensures farmers are adequately compensated."
>
> **- Norbert Ling,**
> **Portfolio Manager – Sustainable and Impact Investing, Invesco**

Smallholder farmers are the backbone of SEA food systems. They hold a large portion of the agriculture market and produce key global commodities vital to the region's food security and economic base (see **Chapter 1.2)**. At the same time, low productivity, financial exclusion and environmental degradation challenge the sector. These are also opportunities for digital sustainability solutions.

Only 20.53% of inventions in food and agriculture from 2015 to 2024 digitally-enabled, compared to 90.12% in financial services.[159] This suggests untapped potential to significantly advance sustainable agriculture towards digital integration. Patent trends show a clear shift toward digitalisation, with precision agriculture and smart farming technologies growing at a CAGR of 28.87% over the same period (see **Figure 16**). This signals that digital agriculture is not just possible, but already accelerating. Capital providers acknowledge this trend, with many highlighting the growing role of smart farming technologies such as IoT in agriculture, supply chain optimisation and energy efficiency.

Figure 16: Food and Agriculture Inventions by Technology Area, 2015 vs 2024



Source: Patent data was retrieved from the Questel FAMPAT database and analysed by IPOS International in this project. The scope of each technology area is defined in **Appendix A**. Some inventions may be included in multiple areas.

These innovations are laying the groundwork for a new generation of solutions tailored to SEA's unique challenges. Technologies such as blockchain-enabled traceability, IoT-powered precision farming, AI-driven advisory platforms and satellite analytics actively address systemic inefficiencies across agricultural value chains. The following use cases illustrate how these digital tools are overcoming barriers in distribution and decision-making, and producing inclusive, resilient and sustainable outcomes for smallholder farmers across the region.

3.2.1. Use cases and innovation trends

The following use cases and innovation trends were highlighted in interviews as opportunities to tackle key development gaps, including supporting smallholder farmers, boosting climate resilience and improving market connectivity.

1. **Digital platforms for distribution**

   Related Challenge: Inefficient and fragmented supply chains that increase waste and suppress farmer earnings.

   Digital technologies are democratising access to agricultural knowledge, inputs and markets, making sustainable farming more viable for smallholder farmers. As such, digital platforms for distribution emerge as transformative tools across the region. By coordinating logistics, integrating seamless payment systems and enabling real-time tracking, these platforms streamline supply chains and reduce reliance on multiple intermediaries. By reducing waste and operational costs, the final price of goods can be lowered, ensuring that food reaches broader and often underserved markets.

   For instance, Surplus Indonesia uses digital distribution models to simultaneously improve efficiency and enhance market access. Its approach demonstrates the broader potential of these tools to reduce wastage, drive down prices and expand reach, ultimately improving affordability and accessibility.

   Capital providers interviewed for this study suggest that digital tools can empower smallholder farmers to bypass traditional distribution layers, secure better prices, build stronger bonds with consumers and reach bigger marketplaces. These evolving digital supply chains are not only improving logistics, it is reshaping how value is shared across agricultural ecosystems to promote more equitable and sustainable outcomes.

2. **Digital verification for supply chain traceability**

   Related Challenge: Smallholder farmers' exclusion from high-value markets due to limited traceability and verification.

   Improving transparency and traceability is a pressing need in SEA's fragmented agricultural markets. Digital verification, including blockchain-based solutions, can create a secure and verifiable record of produce origin and handling, which are critical for entering higher-value markets with sustainability or quality requirements.

   Interviews with investors highlight a growing interest in blockchain's application across supply chains, in agriculture and in other commodities. One capital provider pointed to responsible gold sourcing, in which blockchain is used to trace gold from mine to market and build trust across a complex, decentralised ecosystem. Similar principles are now being adopted in agricultural value chains.

Emerging platforms in Cambodia and Indonesia demonstrate this transition. In Cambodia, companies such as Azaylla are building B2B digital infrastructure that connects producers to buyers while supporting quality control and traceability.[160] In Indonesia, SayurBox enables farmers to access post-harvest supply chain solutions through digital platforms that facilitate direct-to-market distribution, improving visibility and pricing for smallholders.

These examples show how targeted applications of blockchain and digital verification tools can shift power dynamics in agricultural markets-supporting more transparent transactions, reducing dependency on opaque intermediaries and strengthening smallholder integration into regional and global value chains.

3. **Monitoring, forecasting and environmental impact assessment**

   Related Challenge: Limited visibility and data gaps persist across diverse and fragmented farming environments.

   Remote sensing offers a cost-effective and scalable alternative to ground-based data collection. Satellite imagery and remote sensing technologies are increasingly being deployed to enhance visibility and data accuracy across agricultural landscapes. These tools support a range of critical functions at spatial and temporal scales, including crop health monitoring, yield forecasting and environmental impact assessment.

   For example, Perennial Earth uses satellite-based remote sensing for soil and land cover measurement to significantly lower monitoring costs while improving the precision of environmental data collection. Perennial Earth is part of the broader trend of technological democratisation, shifting capabilities that were once exclusive to government agencies into the hands of private sector actors, non-profit organisations and smallholder farmers.

4. **Optimising agricultural decisions with real-time and AI-driven insights**

   Related Challenge: Low productivity, fragmented supply chains and limited access to tailored agronomic advice.

   IoT-based field monitoring and AI-powered advisory platforms help smallholder farmers make better decisions, reduce losses, and improve yields. IoT sensors provide real-time data on microclimates, soil conditions and crop health, enabling more precise application of water and fertilisers, timely harvests, and better coordination with storage and logistics. These field-level insights are increasingly being integrated with AI models, which synthesise broader datasets including weather forecasts, soil profiles and historical crop performance, to generate personalised farming recommendations.

   Biops Agrotekno, for example, is an early-stage Indonesian agritech startup offering IoT-based crop intelligence systems tailored to smallholder farmers. Their technology helps farmers monitor microclimates, optimise fertiliser use and detect crop stress early. By equipping farmers with actionable insights, Biops not only improves yield predictability but also supports sustainable resource use, illustrating how IoT can enhance efficiency and resilience across fragmented agricultural systems.

Previously-mentioned Cropin is an India-based agritech firm backed by ABC Impact and British International Investment (BII). Cropin's cloud-based platform leverages machine learning to provide real-time climate advisory and adaptive farming recommendations.[161] According to post-implementation surveys, farmers using the platform experienced a 31% increase in yields and a 38% improvement in income.[162] These outcomes clearly demonstrate the tangible benefits of digitised advisory services when aligned with local needs and capacities.

Capital providers also emphasised the importance of robust monitoring frameworks. ABC Impact, for example, tracks key performance indicators such as the number of smallholder farmers supported, farms digitised and rates of advisory adoption. This commitment to continuous feedback and adaptive learning underscores a broader insight from the field: effective technical assistance must remain responsive to farmer needs over time to drive enduring impact.

5. Localised farming system adaptation

Related Challenge: Climate vulnerability and lack of tailored adaptation options.

Interviews for this report highlighted a growing wave of agritech ventures focused on combining data-driven techniques with climate resilience. Digital technologies are helping farming systems adapt to highly localised environmental conditions and market contexts by combining traditional knowledge with modern data analytics to create approaches optimised for specific microclimates, soil types and socioeconomic conditions.

Interview insights from capital providers reinforce the sector's growing emphasis on context-sensitive innovation. ADB Ventures highlighted active investments in breakthrough technologies across agricultural domains-from Singapore-based BioDefense, which develops seafood coating solutions to extend shelf life and bridge cold chain gaps, to Thailand's UniFAHs, which offers a phage-based alternatives to antibiotic alternative for poultry production. ADB Ventures has also backed climate resilience solutions, including IBISA's parametric insurance platform, which helps protect agricultural cooperatives in the Philippines from typhoons and support dairy farmers in India facing heat stress, described in 3.1 above.

Another capital provider described observing the development of digital tools for monitoring biochar production, including equipment performance and maintenance. These tools, while relatively simple, play a crucial role in improving operational planning and verifying environmental outcomes, such as carbon impact. This example illustrates how enabling technologies, depending on its context, can support the deployment of more complex core innovations and enhance overall system performance.

From a broader investment perspective, "Agritech Solutions for Farm Production" has been identified in the UNDP SDG Investor Map for Vietnam as an IOA. Potential solutions include crop monitoring, predictive analytics and automation, with an emphasis on practical, locally-adapted implementation.[163]

Case Study 8

Rize: Transforming rice farming with data-driven technology[164]

Rize, established in 2023, is an agritech startup formed as a joint venture between Temasek, Wavemaker Impact, Breakthrough Energy Ventures and GenZero. The company is dedicated to supporting smallholder rice farmers in adopting sustainable practices to enhance their income and reduce emissions from rice cultivation.

Technology innovations and sustainable practices

Rize is redefining rice farming with precision, transparency and real-time data. Its Digital Measuring, Reporting and Verification (MRV) system replaces guesswork with GPS-stamped field insights, ensuring accurate tracking of Alternate Wetting and Drying (AWD) and Maximum Residue Limits (MRL). The Farmer Digital Footprint creates a traceable, data-backed identity for every farmer, linking verified IDs, farm locations and sustainability practices. On-the-Ground Operations seamlessly connect sales, mechanisation and compliance through real-time digital verification. At the core of Rize's business model, a powerful dashboard provides complete oversight, enabling smarter decisions and data-driven sustainability-making farming more transparent, efficient and climate-resilient.

Localised implementation and farmer engagement

Rize's platform provides farmers with management tools, financial support and tailored agronomic guidance, adapted to local agricultural conditions. To scale operations, Rize is developing a digitally-enabled agronomy model, where farmers receive support through digital tools and dedicated agronomists.

Agronomists play a crucial role in building trust with farmers and ensuring a seamless transition to sustainable practices. They also collect data using Rize's MRV platform to help bridge the digital skills gap among farmers. Each agronomist supports over 150 hectares of farmland per season, offering timely advice both in person and remotely.

Multinational Operations and Expansion

As of 2025, Rize operates across SEA, covering over 10,000 hectares and engaging more than 7,000 farmers. By the end of its seed phase, Rize had onboarded 2,500 hectares of smallholder farmland and aimed to scale up to 30,000 hectares through its Series A fundraising. The company has already significantly reduced over 4,000 tonnes of methane emissions across more than 200 targeted villages.

In May 2024, Rize secured US$14 million in Series A funding, co-led by Temasek, GenZero, Breakthrough Energy Ventures and Wavemaker Impact. This investment will enhance Rize's technological capabilities, particularly its MRV platform and support expansion into Indonesia, Vietnam and other parts of South and SEA.

Strategic partnerships and growth in Indonesia and Vietnam

In April 2024, Rize partnered with Temasek Life Sciences Laboratory (TLL) and Temasek Life Sciences Accelerator (TLA) to promote sustainable rice farming in Indonesia. This collaboration focused on implementing innovative farming techniques and leveraged Rize's technology platform to improve both sustainability and productivity.

In 2024, Rize announced plans to expand its team to over 100 agronomists, aiming to support more than 20,000 farmers. These agronomists are intended to act as trusted advisors, facilitate data collection, offer personalised recommendations and reinforce best practices.

Rize's innovative approach of combining technology, financial incentives and strong farmer relationships is transforming rice farming by driving large-scale adoption of sustainable practices. They are creating lasting environmental and economic benefits while pioneering a new model for climate-smart agriculture in Asia.

"We all know that rice is a staple crop, but few realise it's the second-largest emitter of methane globally (after livestock). It is time for all of us to see and think about rice differently. At Rize, we begin with the farmers, but we believe everyone-from traders, millers and off-takers to institutions and governments play an equally vital role in transforming the rice industry."

-Dhruv Sawhney, CEO, Rize

3.2.2. Recommendations to scale inclusive food and agriculture

SEA's agri-digital innovation landscape is growing, but many high-potential solutions-from blockchain-enabled traceability to AI-driven advisory systems-remain localised and fragmented. These technologies have shown proof of concept, yet its transition to widespread, system-level adoption is hindered by gaps in rural infrastructure, data governance, regulatory coherence and financing models.

Many of the barriers to scale, such as policy alignment, interoperability and inclusive capital mobilisation, are not unique to food and agriculture. The strategic interventions outlined below are tailored to agriculture but should be understood as part of a broader, integrated agenda for advancing digital sustainability. Broader recommendations on enabling policy, financing and cross-sector innovation are presented in Chapter 4.2.

1. Adapt digital infrastructure to enable agri-digital platforms

   Scaling agricultural distribution and traceability platforms require digital infrastructure to meet the specific needs of rural producers and supply chains. In addition to quality and affordable connectivity, integrated logistics, interoperable payments for informal economies and rural digital service hubs designed to support farmer engagement.

2. Strengthen data governance for precision and remote sensing tools

   Supporting innovation while protecting farmer data rights requires trusted agricultural data systems with privacy safeguards. Shared protocols and open-access environmental datasets further enable wide-scale deployment of IoT and remote sensing technologies.

3. Localise advisory and decision-support systems

   AI-driven advisory tools must be adapted to local conditions, languages and user needs. Co-developing these solutions with farmer cooperatives and public extension systems, and embedding them in wider agricultural services, can ensure their relevance and scalability.

4. De-risk innovation through climate-smart regulation and finance

   Scaling traceability and climate-smart practices requires targeted regulation and tailored finance. Performance-based standards, concessional funding for high-risk ventures and digitally-verifiable sustainability credits can help bring inclusive agritech models to market.

5. Enable regional standards and sandbox corridors

   Shared certification and regulatory alignment reduces compliance costs and supports cross-border growth. ASEAN-wide protocols for digital traceability, food safety and sustainability reporting, with sandbox corridors for multi-country testing, can accelerate regional adoption.

6. Embed agricultural innovation in 4P platforms

   Successful scaling depends on coordinated implementation. National food security strategies and investments in inclusive delivery channels can be advanced with philanthropic early stage support and community engagement for local relevance, trust and adoption.

Case Study 9

prisma by RSPO: Digital transformation for sustainability and traceability in palm oil supply chains[165]

The Roundtable on Sustainable Palm Oil's ***prisma* by RSPO** platform is a transformative digital system designed to modernise sustainability and traceability in the palm oil industry. By integrating certification, trade and compliance data into a single ecosystem, *prisma* by RSPO enhances transparency and efficiency across the supply chain. Built on Agridence and NGIS TraceMark, the platform consolidates information from various sources, including satellite monitoring and audit reports, which produces real-time risk assessments. This digitisation eliminates reliance on fragmented documentation, making it easier for stakeholders to track deforestation risks, land-use changes, and comply with global regulations such as the European Union Deforestation Regulation (EUDR).

Leveraging digital technology for greater accountability

prisma by RSPO represents a major shift in how sustainability is managed, moving away from manual processes toward a data-driven approach. The platform enables traceability, allowing stakeholders to monitor palm oil origins from plantations to mills, reducing risks associated with land conflicts and illegal deforestation. AI-powered alerts provide early warnings on environmental and social issues, strengthening due diligence efforts. As part of RSPO's long-term vision, *prisma* by RSPO also aims to support API accessibility, ensuring interoperability with other sustainability systems. While the current phases of *prisma* by RSPO focus on RSPO members, future expansion will explore partnerships with non-member stakeholders to broaden its impact.

Empowering smallholders for inclusive growth

A critical aspect of *prisma* by RSPO's success is smallholder inclusion, as smallholders contribute approximately 40% of palm oil production in Indonesia and Malaysia, and up to 80% in Thailand. Many smallholders face barriers such as limited digital literacy and government-imposed restrictions on data sharing. To address these challenges, RSPO is working with industry partners and policymakers to ensure smallholders are not excluded from sustainable markets. By enhancing access to traceability tools and sustainability certification, Prisma by RSPO is setting a new standard for digital transformation in agriculture, positioning SEA as a global leader in responsible commodity production.

"*Sustainability and transparency challenges are cross-sectoral issues. Collaborative, technology-driven solutions like prisma by RSPO hold immense opportunities to transform global supply chains. Ultimately, prisma by RSPO is not just about upgrading RSPO's digital infrastructure - it represents our broader mission to set a new benchmark for traceability, accountability and sustainability in the palm oil sector. Through sustained collaboration, dedication and forward-thinking leadership, I am confident that prisma by RSPO will become a formidable system in the wider sustainability industry.*"

-Nikki Gee, Chief Strategy and Digital Transformation Officer, RSPO

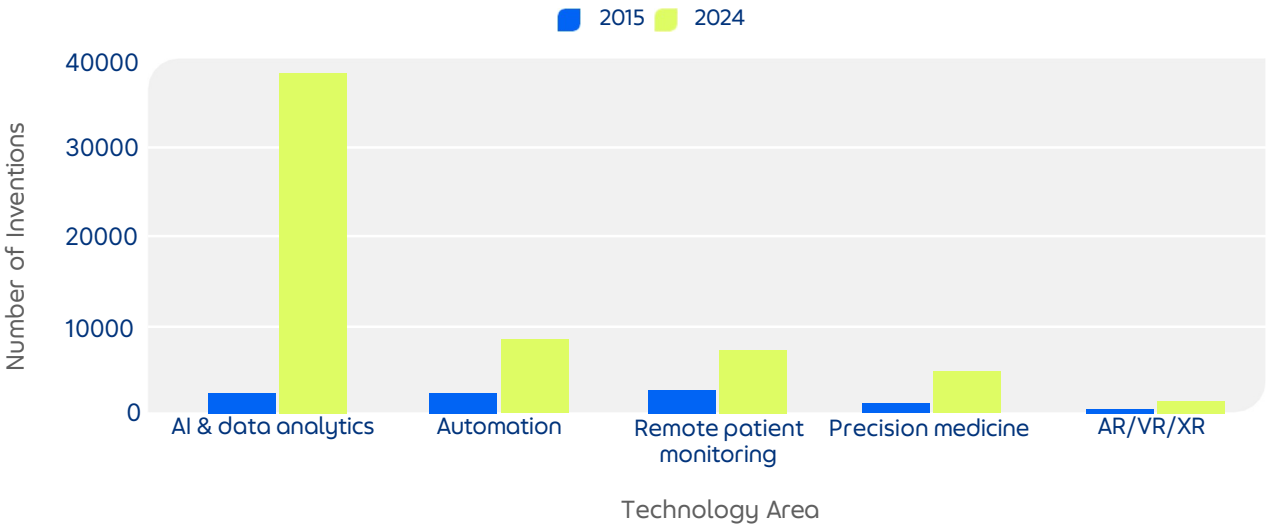
3.3. Innovation for Impact: Healthcare

> "The frontier that I find most exciting is the intersection of AI and healthcare. This powerful combination can solve very real problems in SEA and globally relating to drug discovery, healthspan expansion, management and efficiency of healthcare systems, proper insurance underwriting and ensuring affordable treatments are available to the broader community."
>
> **- Vishal Harnal, Managing Partner, 500 Global**

Lack of access to good quality healthcare, ageing populations and chronic disease management are among some of the urgent healthcare-related barriers to sustainable development in SEA (See Chapter 1.2). At the same time, the region is attracting venture capital, insurance innovation and growing medical tourism. Thus, the convergence of rising demand, digital momentum and investment appetite presents a significant opportunity to scale more inclusive healthcare systems.

Digital technologies are managing limited resources, improving access to services and making healthcare more efficient. AI and data analytics are the most rapidly growing digital healthcare innovations, with a compound annual growth rate of 34.93% between 2015 and 2024 (**Figure 17**). Investors surveyed concur, identifying opportunities to expand access through streamlined processes, automated care delivery and personalised healthcare to improve chronic disease management.

Figure 17: Digital Healthcare Inventions by Technology Area, 2015 vs. 2024



Source: Patent data was retrieved from the Questel FAMPAT database and analysed by IPOS International in this project. The scope of each technology area is defined in **Appendix A**. Some inventions may be included in multiple areas.

3.3.1. Emerging use cases and innovation trends

From telemedicine to AI-powered diagnostics, the following use cases and innovation trends were highlighted in interviews to illustrate how digital innovation is actively reshaping healthcare delivery.

1. **Access to quality health**

Related Challenge: Geographical barriers and uneven distribution of healthcare resources.

Access to quality healthcare remains a persistent challenge, particularly in rural and remote areas. The strategic importance of telemedicine is reflected in the UNDP's SDG Investor Maps, identified as IOAs in Thailand and Vietnam.[166] Patients often face long travel distances and extended wait times for brief consultations, limiting timeliness and continuity of care.

Telemedicine and other hybrid care models combine virtual consultations with physical diagnostic and prescription services, reducing geographic and logistical barriers. The adoption of telemedicine surged following the pandemic, driven in part by swift government action to improve accessibility, such as easing licensing requirements for practitioners to deliver care digitally. These shifts have largely persisted, creating a stable foundation that makes investments and innovations in this space both commercially viable and scalable.[167]

Mobile health applications have further expanded the reach of telemedicine, especially in specialised care. During the COVID-19 pandemic, for example, the Australian startup Virtual Psychologist, supported by Singtel's expansion into the region, partnered with Globe Telecom in The Philippines to deliver remote mental health counselling. This initiative offered critical support at a time of heightened psychological stress and demonstrated the adaptability of telehealth platforms to reach diverse healthcare needs.

2. **Precision medicine**

Related Challenge: Limited representation in genomic data.

Traditional healthcare systems have often relied on standardised treatment protocols that do not account for individual variations in genetics, behaviour or environmental exposure, factors that can significantly influence health outcomes. This limitation is particularly evident in SEA, where diverse populations remain underrepresented in global genomic datasets, contributing to diagnostic gaps and reduced treatment efficacy.

However, emerging technologies are beginning to address these disparities. Advances in genomic sequencing are targeting more personalised and targeted interventions. Precision medicine integrates genetic, lifestyle, environmental and clinical information to inform disease prevention and personalised treatments. AI is also increasingly used in drug discovery to support complex computations and accelerate the development of precision therapies that were previously time and cost-prohibitive.

3. Personalised care models

Related Challenge: Lack of tailored care delivery.

The demand for personalised caregiving services, spanning in-home care, medication management and support services, is growing, particularly for ageing and vulnerable populations. Identified in the UNDP SDG Investor Maps as an IOA in Malaysia, personalised care delivery can be supported and scaled through digital platforms.[168] Along these lines, LeapFrog's investment in Redcliffe Labs is transforming diagnostics in India by offering at-home sample collection through an app, making early detection and disease management far more convenient and affordable.

While there is a dearth of Asian genomic data in public databases, efforts are underway to develop genomic platforms tailored to the region's unique genetic profile. Genomic programmes are gaining momentum across the region through national bodies and networks, such as by BGSi in Indonesia, MyGenom in Malaysia, PRECISE in Singapore, Genomics Thailand and Saigon Precision Medicine Centre in Vietnam. Meanwhile, genomic and genetic startups are translating data to its services. Startup Nalagenetics,for example, uses AI to enhance diagnostic accuracy and improve clinical decision-making, such as predicting responses toward certain drugs based on a patient's genetic variant. Further, LeapFrog's Med Genome is a genomic pioneer and founding member of Genome Asia 100K, an initiative to sequence 100,000 genomes in Asia. Their solutions are available across 50 countries, democratising precision medicine andtransforming treatment.

4. Integrating patient data for interoperability and real-time monitoring

Related Challenge: Lack of interoperable systems and real-time data flows.

One of the longstanding barriers to efficient healthcare delivery in SEA is fragmented patient data as it is often stored in paper-based formats or siloed digital systems. This lack of interoperability impedes continuity of care, limits coordination among healthcare providers, and restricts a patient's ability to access and manage their health data.

In response, digital health records and interoperability frameworks are emerging as critical enablers of more connected, patient-centred systems. Health Information Management (HIM) systems and Electronic Medical Records (EMR) offer secure, centralised platforms that facilitate medical data sharing across public and private institutions. AI further supports various functions such as clinical decision support, and diagnostics and treatment planning. In the Philippines, software company Dashlabs.ai automates processes for customers, such as having small laboratories and hospitals streamline diagnostics and reporting, allowing healthcare professionals to focus on core tasks rather than manual data entry.

One capital provider interviewed for this study emphasised the strategic importance of integrating healthcare data infrastructure across institutional boundaries, particularly in settings where AI-driven analytics can improve consultation accuracy and reduce inefficiencies. Startups such as Holmusk, operating in Singapore and the U.S. apply big data analytics to enhance HIM and EMR systems, particularly in behavioural healthcare to enable more personalised and evidence-based clinical interventions.

Furthermore, interoperable data systems support Remote Patient Monitoring (RPM), increasingly important for chronic disease management and post-acute care. RPM technologies rely on the seamless flow of real-time patient data between individuals and providers, making interoperability a prerequisite for effective implementation. When integrated with EMR platforms, RPM can support early detection of health issues, enable timely interventions and reduce the burden on hospital systems.

5. **Reducing operational inefficiencies**

Related Challenge: Fragmented healthcare payments and supply chain inefficiencies.

Operational inefficiencies, particularly in payment processing and pharmaceutical supply chains, hinder service delivery, elevate costs and erode trust among patients and providers. Moreover, the UNDP SDG Investor Maps highlight "Digitising Healthcare Payments" in The Philippines as an IOA.[169] Digitally-enabled B2B applications that automate workflows contribute to system efficiency and enhance transparency.

Innovations such as MiyaHealth's MiyaPayor, a Singapore-based SaaS platform, are streamlining insurance claims and reimbursements, reducing manual errors and administrative complexity for both insurers and patients. Zuellig Pharma's eZTracker is a blockchain-enabled application that authenticates medication in real-time, ensuring its legitimacy and protecting patients from counterfeit products, a persistent issue in fragmented distribution networks.

Case Study 10

Doctor Anywhere: Advancing regional digital health through regulatory innovation[170]

Doctor Anywhere, founded in 2017, has evolved from a telehealth startup into a comprehensive digital healthcare provider operating in key SEA markets.

Regulatory sandbox participation

Between 2018 and 2021, Doctor Anywhere took part in Singapore's Ministry of Health's Licensing Experimentation and Adaptation Programme (MOH's LEAP) program, designed to support innovative telemedicine models. By working closely with MOH within the regulatory sandbox, Doctor Anywhere demonstrated meeting strict patient safety and governance standards with its digital consultation services. This participation provided valuable insights for regulatory development and enhanced patient trust in its telehealth solutions.

Multinational operations

Today, Doctor Anywhere operates in at least six countries across SEA, including Singapore, Malaysia, Thailand, The Philippines, Vietnam and Indonesia. The company's omni-channel ecosystem-integrating telemedicine, physical clinics, pharmacies and an in-app marketplace-caters to over 2.5 million users in the region. This broad presence underscores its strong ability to localise services according to each market's unique healthcare needs, regulatory requirements and patient preferences.

Participation in the LEAP regulatory sandbox has been instrumental in building a robust framework for Doctor Anywhere's telehealth services. By gaining early exposure to regulatory requirements and adopting best practices, the company is well positioned to lead the evolving digital healthcare landscape in SEA. Its success in operating across multiple markets provides a model for how regulatory innovation, when paired with technology and strategic localisation, can drive regional growth and sustainable healthcare delivery.

"*The future of healthcare lies in a decentralised approach - like our 'Hospital Anywhere' model - which makes quality care more accessible and affordable for everyone. By investing heavily in technology, we're building a future where personalised experiences and seamless access to healthcare are a reality for all. Doctor Anywhere is committed to building this future, for ourselves and our communities.*"

- Wai Mun Lim, Founder and CEO of Doctor Anywhere

3.3.2. Recommendations to scale inclusive healthcare innovation

To meet growing needs for inclusive healthcare, barriers such as fragmented data systems, unclear reimbursement pathways and underinvestment in local health infrastructure must be addressed.

While this section focuses on healthcare, many scale-related challenges, such as capital alignment, policy coordination and digital trust, are pertinent in different sectors. More holistic system-level recommendations are outlined in Chapter 4.2. These strategic interventions below are tailored to health system transformation, supporting the integration of digital innovation into inclusive, people-centred care models.

1. **Develop Region-Specific Genomic Datasets**

   Locally-relevant data ecosystems are needed to advance personalised medicine and diagnostics. This includes building regionally representative genomic datasets and establishing validation protocols for AI models trained on SEA populations. Cross-border data sharing at research and clinical levels require robust and aligned data privacy governance and systems. Public-private research hubs and shared genomic infrastructure are critical to ensure equity in precision health.

2. **Establish national and regional frameworks for telehealth integration**

   Scaling telemedicine and hybrid care models depends on regulatory clarity, integration with existing health systems and fair reimbursement. Policymakers can advance digital healthcare solutions within national health strategies, define standards for remote care delivery and ensure that virtual consultations are recognised in health insurance schemes.

3. **Build interoperable health information infrastructure**

   Clinical data infrastructure that is interoperable sub-nationally, nationally and regionally is needed to support real-time care coordination and AI-enabled analytics. This includes standardising EMR protocols, enabling secure data exchange across facilities, and supporting shared platforms for behavioural and chronic disease monitoring.

4. **Modernise claims and supply chain systems through smart contracts and AI**

   Fragmented claims processing and medicine distribution can be addressed through intelligent automation. Governments and insurers should adopt smart contract frameworks for healthcare claims, while investing in digital track-and-trace infrastructure to improve supply chain transparency and reduce fraud.

5. **Enable inclusive innovation through 4P health platforms**

   Health innovation at scale requires collaboration across public agencies, private providers, philanthropic funders and communities. Governments can lead with regulatory alignment and public infrastructure, private actors can scale innovation through service integration, philanthropic capital can fund data governance and trust-building initiatives, and communities play a critical role in digital health literacy and feedback.

Case Study 11

AI Institute for Progress (AIIP): Accelerating healthcare innovation through public-private-philanthropic partnerships in Indonesia[171]

Systemic challenges in Indonesia underscore the importance of technology adoption, particularly in the healthcare system, where limited health tech uptake and a severe doctor shortage (0.72 per 1,000 people) persist. In response, the Artificial Intelligence Institute for Progress (AIIP) was launched in 2024 by Alpha JWC Ventures and Pijar Foundation to connect AI-based solution companies with real-world public challenges.

Challenge and response

Despite national initiatives like SATUSEHAT and the Digital Health Transformation Strategy (2025-2029), AI integration in clinical settings remains low. Medical devices such as CT scanners are unevenly distributed, and late diagnosis, especially of cancer, is common. AIIP's response was to create a "sandbox" environment where emerging AI technologies could be tested in collaboration with government and healthcare partners.

A key example is Harrison.ai, which partnered with the Ministry of Health to pilot AI-powered diagnostics at Dharmais Cancer Hospital and Dr. M. Djamil Hospital. The technology helped clinicians detect cancer and other conditions earlier and more accurately, addressing diagnostic delays in Indonesia's public hospitals.

4P collaboration model

AIIP exemplifies the 4P (Public-Private-Philanthropic Partnership) model:

- **Public sector**: The Ministry of Health acted as both regulator and end-user, ensuring regulatory alignment and operational feasibility.
- **Private sector**: Harrison.ai tailored its AI tools to Indonesian data and hospital systems, complying with relevant regulations on data usage.
- **Philanthropic sector**: Pijar Foundation and Alpha JWC Ventures collaborated to run AIIP through the Sandbox Program initiative, supported coordination, and enabled technical and mentoring resources.

Programme design and implementation

From August 2024 to February 2025, AIIP ran an accelerator-like programme involving:

- A problem discovery phase with healthcare stakeholders;
- Startup selection and implementation support; and
- Scheduling mentoring, training, workshops, social mixer and a final demo day.

Throughout the sandbox phase, AIIP facilitated 30 stakeholder introductions to corporate partners including hospitals, and supported real-world AI deployment with continuous feedback from hospital partners.

Outcomes and impact

The AIIP sandbox formalised a new model for AI adoption in Indonesia's healthcare sector, strengthening institutional relationships and resulting in policy-compliant frameworks with scalable solutions. By embedding continuous feedback loops, the programme ensured that innovations were context-appropriate and user-informed. Key learnings highlight the importance of top-down support and alignment among stakeholders, as well as the value of starting from real-world innovation needs to drive solutions. This sandbox approach could be effectively adapted to other SEA contexts with strong local networking and cross-sectoral expertise to guide implementation and scale.

"*Today is more than just a celebration of achievements. It is a testament to the limitless possibilities that AI has set. The future of AI is not just about technology. It's about the people behind it, the challenges we overcome, and the impact we create.*"

- Nezar Patria, Vice Minister of Communications and Digital, Ministry of Communication and Digital of Republic Indonesia

3.4 Common Factors for Success

> "Southeast Asia isn't one marketeach country is at a different stage of growth with unique cultures. This diversity poses challenges for outsiders, but it also creates opportunities. The challenges are significant, but the opportunities are even greater."
>
> **- Atsushi Taira, Managing Director, Mistletoe**

Across financial inclusion, agriculture and food and healthcare, the most impactful solutions may not be the most advanced, but are attuned to local needs, conditions and constraints. The greatest value and impact is often realised when digital solutions adapt to the realities of the communities it serves. This is not a call to limit ambition but to recognise that relevance is a precondition for scale. In a region as diverse as SEA, fit-for-purpose solutions consistently outperform frontier technologies that lack contextual grounding.

For example, in agriculture, digital advisory tools that function reliably on basic mobile phones and low-bandwidth networks are more effective than data-intensive platforms that require high connectivity. In financial inclusion, digital wallets supported by human agents build greater adoption than app-only solutions, especially among first-time users. Inclusive healthcare platforms, particularly those designed with offline functionality and simplified interfaces, help to extend reach into rural communities with limited infrastructure and diverse user needs.

3.4.1. Connecting fragmented markets

SEA's diversity demands a contextualised approach to technology deployment. Regulatory environments, cultural dynamics, user habits and infrastructure capacity differ significantly across countries, making standardised models difficult to replicate. While markets like Indonesia, the Philippines, and Vietnam are sufficiently large to sustain domestic innovation and offer strong foundations for scale, the region is also becoming increasingly interconnected through cross-border digital platforms, regional investment flows and integration initiatives.

Firms that can adapt to local conditions and connect markets across SEA can turn diversity into strength, contributing to a more inclusive, scalable digital sustainability ecosystem.

3.4.2. Enabling local decision-making at scale

Sectoral examples in this chapter reveal that the most impactful digital solutions empower timely, localised decision-making based on real-time data. In agriculture, platforms translated satellite and sensor inputs into instant, tailored guidance for smallholder farmers. In healthcare, remote monitoring tools allowed frontline workers to adjust care plans in real time. In finance, behavioural analytics enabled instant credit assessments to underserved borrowers.

These examples show that impact is more likely to be realised with systems that distribute useful information and decision power to the end users, thus building user trust while helping services adapt to local conditions in real time.

Across all three sectors, locally-grounded approaches that integrate contextual knowledge, community relationships and physical infrastructure were more likely to succeed, suggesting that aggregation models that connect and coordinate existing players can complement a platform approach for digital sustainability.

3.4.3. Hybrid models bridge digital and human interfaces

A recurring theme across sectors is that technology alone is rarely enough to reach the most marginalised. As highlighted in Section 2.2.1, delivery models that blend scalability of digital systems with the trust and flexibility of human interactions are necessary to reach lower-connectivity, lower-literacy and lower-trust environments. These hybrid models do more than just bridge access gaps-they create a more adaptable, resilient form of service delivery.

In financial inclusion, agent networks play a critical role in helping first-time users navigate mobile wallets, build confidence and access support in real time. In agriculture, agri-extension workers help farmers interpret digital advisories, apply new techniques and troubleshoot local issues. In healthcare, telemedicine platforms are often paired with community health workers or in-person clinics to ensure continuity of care and follow-up.

3.4.4 System change requires a systems approach

The digital solutions explored in this chapter demonstrate that sustainable impact relies less on isolated sectoral innovations and more on the strength of the shared systems that support them. Digital health tools, for example, scaled faster where national eID systems enabled secure patient records. Financial inclusion efforts advanced where real-time payments and KYC regulations were in place. Agricultural platforms gained traction where connectivity infrastructure and open data policies supported timely, localised advice.

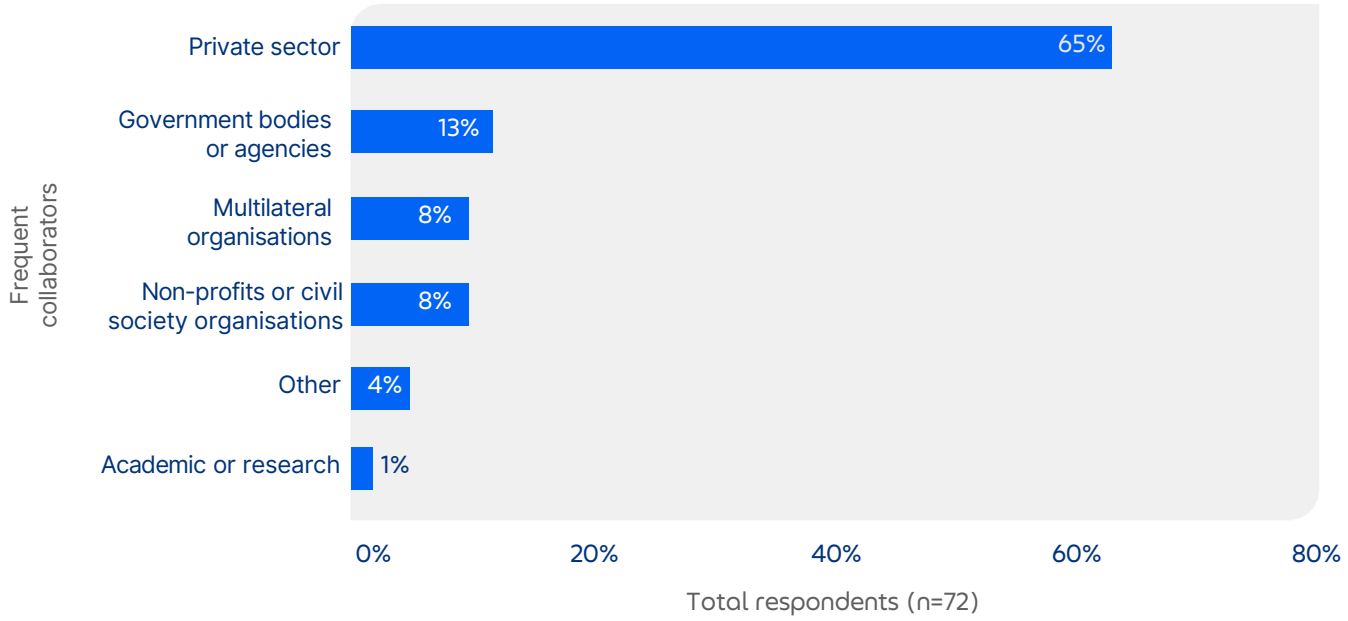
Sustainability goals are similarly interlinked. Financial inclusion enables farmers to invest in sustainable agricultural practices, which improves both environmental outcomes and household nutrition. Better nutrition contributes to improved health outcomes, and healthier populations are more economically productive, thus enhancing financial well-being. This highlights the need for governments, private sector actors and development partners to adopt a holistic approach to digital sustainability.

4.
From Readiness to Impact: Enabling Digital Sustainability

> "The biggest blocker to scaling digital sustainability is often the fragmentation and lack of collaboration within the ecosystem. Many players run siloed programmes with their own programme brand names and this can limit collective impact."
>
> **- Andrew Buay, Vice President Group Sustainability, Singtel**

Looking ahead, SEA will need interconnected avenues of action to leverage its digital momentum to advance growth and sustainability. There is much room for greater collaboration across stakeholders. Improving public-private coordination can inform policy and build readiness for innovation and adoption. In fact, while 65% of capital providers who participated in this study report frequent collaboration with other private sector stakeholders, only 13% engage regularly with government counterparts (**Figure 18**).

Figure 18: Frequent Collaborators Identified by Survey Respondents (N=72)



Source: Survey by TFGI and CIIP, 2025

Governments provide digital public goods while establishing regulatory frameworks that balance innovation with appropriate safeguards. **Innovators, solution providers** and **companies** develop and deploy technologies and business models that create commercial value and achieve sustainability impact, often serving as the primary vehicle for scaling solutions. By strategically directing capital, expertise and influence, **investors** can be powerful catalysts in supporting digital sustainability and fostering more sustainable digital economy growth. **Other funders**, such as development banks and philanthropic organisations, supply patient, risk-tolerant and early stage capital, support capacity building, and fund market validation for early-stage innovations that may not yet demonstrate commercial viability, but hold significant impact potential. **Community groups** are partners in ensuring contextual relevance and appropriateness, building trust and supporting implementation, particularly for solutions targeting underserved or marginalised communities.

4.1. Invest in Digital Sustainability Readiness

4.1.1. Strengthen digital foundations

Stakeholder interviews and survey findings underscore that infrastructure gaps, affordability constraints and fragmented DPI limit both innovation and inclusion. This challenge is not unique to the region. Globally, nearly a billion people lack official proof of identity, and legal and verifiable identity documents.[172]

Beyond technology, other digital foundations such as standards, data interoperability, human-centred design and capacity building enable inclusive and meaningful participation. Digital literacy initiatives such as Singapore's SkillsFuture, Indonesia's Prakerja and Malaysia's NADI programmes demonstrate that digital inclusion is not just about technical training, but also a social process requiring building trust and contextual relevance.

Continued partnership is required for:

- **Expanding last-mile connectivity.** 31% of surveyed capital providers cited infrastructure gaps as a top challenge for investing in digital sustainability (Figure 10, Chapter 2).
- **Designing for affordability and accessibility** to address high device costs, inflexible pricing in informal economies and limited financing options for underserved users.
- **Developing inclusive DPI** by overcoming fragmentation of ID systems and payment platforms. Examples such as Thailand's PromptPay and Vietnam's digital ID efforts point to scalable models, provided interoperability and governance frameworks are prioritised.
- **Integrating climate resilience into digital infrastructure planning.** As climate risks intensify, SEA's digital infrastructure must be designed to withstand disruptions. Future investments should prioritise adaptive network designs, resilient data centres and community based-hubs to ensure continuity of essential digital services in climate-sensitive areas.

4.1.2. Develop talent for future readiness

Capabilities will need to evolve not only to support digital sustainability but also to drive future digital economy growth. Programmes like Singapore's AI for Industry (AI4I) and TechSkills Accelerator (TeSA), for example, are increasingly important to cushion disruptions and close the talent gaps that remain a significant barrier to local development, deployment, management and adoption of digital solutions.

Interviewees stressed the acute shortage of skilled technology professionals for early-stage ventures and community-level deployments. Even where talent exists, it is often concentrated in capital cities or drawn to larger tech companies, leaving social impact organisations struggling to attract and retain qualified staff, particularly in rural and underserved areas.

Moreover, closing SEA's sustainable development gaps requires talent with both digital and sustainability skills. Combining digital competencies such as data analysis with a thorough understanding of ecological and social systems is much needed to bridge technology, business, policy and financing innovation to drive systemic changes required for sustainability. We need individuals and teams that can apply technology innovation to sustainable business models, inform effective policies with data-driven insights and mobilise financial resources towards impactful sustainable development initiatives. By transcending traditional expertise and integrated skill sets, we can create holistic and scalable solutions that address the region's complex challenges.

Recommendations include:

- **Developing digital and sustainability-linked workforce capabilities** that are aligned to the sectoral priorities detailed in earlier chapters. For example, agricultural digitalisation remains constrained by an ageing labour force and a lack of digital training.
- **Supporting local innovators** who understand market nuances and design for affordability, language access and digital trust. Case studies in Chapter 3 demonstrate how localisation drives adoption.
- **Integrating national priorities** such as economic growth, digital transformation and sustainable development. Fostering understanding of emerging technologies and business models from the private sector to help policymakers anticipate and adapt to emerging opportunities and risks.

4.2. Be a “Living Lab” for Fit-for-Purpose Solutions

SEA's digital economy growth is testament to the impact of adapting technologies and business models to local contexts, and developing solutions that are culturally sensitive, right-sized and right-priced for diverse community needs (Chapter 2).

Leveraging this digital momentum, SEA has the potential to leapfrog traditional development pathways. Adopting advanced solutions for climate resilience, sustainable resource management, circular economy approaches and smart urban development are all within reach.[173]

Thailand's "*Smart Cities and Provinces*" initiatives in Phuket and Khon Kaen offer a glimpse of how designated innovation zones can accelerate sustainable development. By combining infrastructure investments with regulatory flexibility and community engagement, these provinces have become testbeds for smart energy, transportation and water management systems. With an explicit focus on digital sustainability, expanding this model could catalyse similar innovations across the region.

Recommendations include:

- **Offering hybrid online-offline service delivery,** essential for sustaining access in environments where digital-only models remain exclusionary.
- **Supporting multi-disciplinary innovation ecosystems** focused on sustainability challenges unique to the region, actively encouraging collaborations between for-profit and non-profit organisations, and encouraging financing innovation such as blended finance for innovation.
- **Embedding inclusive co-design to ensure relevance,** especially in rural, indigenous and low-income communities.

4.3. Promote Regulatory Clarity and Align Policy Frameworks

In Chapter 2, we discussed the role of policy innovation as a key enabler of digital sustainability. The lack of enabling, predictable and coherent policy environments makes it difficult for capital providers to assess risk, price uncertainty or plan for scale.

Nearly 40% of respondents identified regulatory or policy uncertainty as a major barrier to investment (Figure 10, Chapter 2). Fragmented licensing, unclear data governance, shifting priorities, policy changes affecting incentives and ambiguous regulatory pathways contribute to an ecosystem where early-stage investment is seen as risky. At a regional level, the lack of aligned and interoperable regulatory approaches across countries further compounds the challenge.

Policy coordination is often the first step to reducing policy uncertainty. For example, embedding sustainability into digital policy frameworks can better align regional digitalisation with environmental, social and economic imperatives. Furthermore, regulatory frameworks for impact investing can support investment decisions in digital sustainability.

Beyond coordination, innovators, investors and government can work together to facilitate learning and testing, both for impact and coordinated policy outcomes. Technical standards and clearly defined goals can align innovations with sustainability objectives from inception rather than attempting to correct course after widespread adoption. Through approaches like Singapore's regulatory sandboxes for fintech and healthcare, policymakers can provide the certainty that investors seek while ensuring appropriate safeguards for consumers and communities. Other policy levers can promote digital sustainability innovation, including incentives, public procurement and R&D funding.

Recommendations include:

- **Integrating digital transformation with sustainability roadmaps** to address current disconnects identified in Chapter 1. Singapore offers instructive models that explicitly link digital and environmental strategies.
- **Implementing risk-based and outcome-focused governance** through policy tools like regulatory sandboxes, with impact-focused performance criteria. This clarifies policy intent and encourages effective implementation through context-specific solutions.
- **Considering market-driven complements to policy to encourage good governance** through co-investment platforms, technical standards and transparent data-sharing based on global reporting frameworks.
- **Supporting policy innovation** through regional sandboxes, cross-border accelerators and responsible experimentation platforms. Interviewees cited sandbox models in Singapore and Thailand as examples for policy innovation.
- **Considering industry or professional self-governance,** where appropriate, to encourage innovation and facilitate implementation.

4.4. Integrate Multiple Types of Innovation

Scaling digital sustainability across SEA requires the integration of technology, business, policy and financing innovation into a coordinated, mutually reinforcing system.

Recommendations include:

- **Integrating innovation pathways to bridge the scale gap.** Align technology pilots with fit-for-purpose business models, supported by enabling policies and tailored financing tools to ensure solutions are viable, scalable and aligned with real-world contexts.
- **Testing innovative capital instruments.** Blended finance, recoverable grants and co-investment platforms should be expanded to align capital with different innovation stages. Impact capital, often the missing link for scale, can be directed to prioritise underfunded sectors like smallholder agriculture and digital health, where early-stage risk is high but social returns are significant.
- **Mainstreaming digital sustainability within institutional investment portfolios.** Move beyond ESG compliance by embedding proactive impact criteria and prioritising high-opportunity sectors within digital sustainability to enable capital mobilisation at scale.
- **Strengthening trust-based regional ecosystems.** Promote trusted verification systems such as open government data, carbon market infrastructure and sustainable supply chain monitoring to enhance transparency, reduce risk and attract global investment.

4.5. Foster Regional Interoperability and Integration

Extending the vision of the ASEAN Economic Community (AEC) as a single market and production base, a collaborative Sustainable Development Community can establish the region as a hub for sustainability. Such a community can enable the free flow of green technologies, sustainable resources and sustainability expertise across ASEAN member states, nurturing regional value chains in areas like renewable energy, sustainable agriculture and circular economy solutions. Just as the AEC aims for a seamless market for goods and services, a Sustainable Development Community would strive for harmonised environmental standards, streamlined regulations for green investments and collaborative R&D to position ASEAN as a global hub for sustainable innovation and impact.

Regulatory alignment across the region can significantly reduce compliance costs and expand markets for digital sustainability solutions. Initiatives like the ASEAN Taxonomy for Sustainable Finance (Chapter 2) and the ASEAN DEFA (Chapter 1) demonstrate early progress toward regional alignment by establishing common principles for digital regulations while respecting national sovereignty. Extending similar harmonisation efforts to digital sustainability more broadly, particularly in priority sectors like financial inclusion, food and agriculture, and healthcare, can reduce compliance costs that currently limit regional scaling, while maintaining necessary consumer and community protections.

The ASEAN Catalytic Green Finance Facility shows the potential of such a regional approach using public and philanthropic funds to de-risk sustainable infrastructure projects. It has successfully mobilised private capital for initiatives with significant environmental impact. Similar structures could be developed specifically for digital sustainability across financial inclusion, food and agriculture, and healthcare sectors. **Appendix D** presents additional initiatives and transactions that leverage innovative financing structures to advance SDGs in SEA, which highlights how blended capital, guarantees and results-based financing are used to catalyse digital sustainability across key sectors.

Supporting these ambitions requires regional collaboration on technology assessment to facilitate shared learning and policy alignment, while surfacing new opportunities for cross-border innovation. The ASEAN AI Governance Working Group is an example of a positive step in this direction, but requires shared goals, taxonomy and resources.

Moreover, positioning SEA as a regional hub for digital sustainability can aggregate decentralised efforts, accelerate knowledge exchange, develop multi-stakeholder partnership and amplify impact across borders. Trusted verification frameworks, such as digital infrastructure for transparent carbon markets, sustainable supply chain verifications and open government data can build intra-regional credibility and encourage global participation. Creating "sandbox corridors" that enable simultaneous testing across multiple ASEAN countries could bring innovations to further cross-border scalability from inception.

Recommendations include:

- **Advancing ASEAN-level policy alignment for DPI interoperability, cross-border data governance and ESG-linked digital standards,** areas flagged by ecosystem actors as essential for regional integration.

- **Establishing cross-border collaboration mechanisms.** Create sandbox corridors for simultaneous multi-country testing and develop regional certification and mutual recognition frameworks to reduce compliance costs and facilitate regulatory alignment across ASEAN.

- **Developing regional investment infrastructure for digital sustainability.** Set up co-investment platforms, shared due diligence protocols and standardised legal documentation to lower transaction costs and accelerate capital deployment.

- **Facilitating intra-ASEAN talent mobility** to build a workforce equipped for both digital innovation and sustainable development.

- **Aligning frameworks for measuring, reporting and verifying sustainability outcomes** to provide governments, investors and solution providers with credible data for decision-making and progress-tracking.

4.6. Stakeholder-specific recommendations

4.6.1 Public sector

Governments are pivotal in setting the foundations for digital sustainability by investing in digital public infrastructure, creating an enabling environment for innovation and aligning digital economy policies with sustainability objectives.

- **Invest in digital sustainability readiness**
  - Prioritise investments in robust digital infrastructure and equitable access policies, ensuring rural and underserved communities are connected.
  - Develop infrastructure that enables seamless transitions between digital and physical interactions, particularly in rural areas. This might include community digital centres that provide physical access points for online government services, or agricultural extension offices equipped with digital capabilities for farmer support.
  - Nurture local capabilities, such as placing tech talent in rural healthcare facilities, agricultural extension services and financial inclusion initiatives.

Be a "living lab" for fit-for-purpose solutions

- Nurture an innovation ecosystem with linkages regionally and globally, including fostering entrepreneurship, investing in R&D, designing forward-looking regulations and encouraging partnerships between government, industry and academia to solve priority problems.
- Designate specific geographic areas as "Digital Sustainability Zones" and provide physical infrastructure for testing while opening relevant government data with appropriate privacy safeguards.

Promote regulatory clarity and align policy frameworks

- Establish cross-ministerial coordination mechanisms that bridge digital and sustainability portfolios.
- Adopt regional standards and/or align with global standards for sustainability measurement and reporting.
- Incorporate specific sustainability objectives into digital economy strategies, and develop integrated assessment methodologies that evaluate both digital and sustainability impact.
- Establish testing environments that explicitly incorporate both digital innovation and sustainability objectives, create fast-track approval processes for solutions with clear sustainability benefits and develop graduated regulatory pathways that allow successful sandbox graduates to scale more rapidly across the region.

Integrate multiple types of innovation

- Establish dedicated blended finance vehicles for digital sustainability.
- Implement tax incentives that encourage participation in blended structures. Singapore's Philanthropy Tax Incentive Scheme (PTIS) for family offices, for example, provides tax benefits for donations toward blended finance structures, while its Fund Tax Incentive Scheme recognises climate-related investments and blended finance structures as eligible for tax incentives.

Foster regional interoperability and integration

- Include baseline sustainability elements in the upcoming ASEAN Digital Economy Framework Agreement and other digital transformation efforts.
- Develop "sandbox corridors" that enable simultaneous testing across multiple ASEAN countries for innovations to consider cross-border scalability from inception.
- Share best practices, data and early warnings for natural disasters or extreme weather events, and information on transboundary issues such as pollution or outbreak preparedness. This should be in the same vein as the ASEAN Computer Emergency Response Team that supports multi-jurisdictional incident response and data sharing on cyber threats, attacks and online scams.

4.6.2 Innovators and solution providers

Innovators can advance digital sustainability by developing solutions that are accessible, affordable and contextually relevant, bridging gaps across sectors.

Invest in digital sustainability readiness

- Experiment with mobile-first approaches designed for affordability, diverse capabilities, low bandwidth, intermittent connectivity and basic devices.
- Design for data privacy, cybersecurity and digital safety, and engage customer base and business networks for continued digital literacy and upskilling.

Develop as a "living lab" for fit-for-purpose solutions

- Identify problems and solutions to meet local needs, emphasising inclusive design.
- Leverage emerging technologies for impact, such as remote sensing for environmental monitoring and big data analytics to optimise resource allocation.
- Sensitively deploy emerging technologies like AI, IoT and blockchain with the intention to build trust for longevity, adoption and impact.
- Work with government as a client and partner in advancing sustainability goals.
- Develop "as-a-service" models for sustainability, such as impact measurement and tracking, energy management, logistics or waste optimisation, to increase accessibility to MSMEs.

Promote regulatory clarity and align policy frameworks

- Participate in standards-setting processes and engage in policy consultations on digital sustainability.
- Actively participate in pilots and regulatory sandboxes, providing transparent data on both commercial and sustainability outcomes. Collaborate with regulators to develop appropriate safeguards based on real-world testing.

Integrate multiple types of innovation

- Adapt pricing to accommodate income fluctuations common among rural and informal workers.
- Proactively address sustainability impacts in digital products and services by monitoring and evaluating systems that capture financial and digital inclusion, and other sustainability impact metrics.
- Explore blended finance models to establish strong proofs of concept and provide assurance of good governance at different stages of the growth journey.

Foster regional interoperability and integration

- Adopt regional or global standards in product and service development, and implement region-wide sustainability reporting frameworks.

4.6.3 Capital Providers

Capital providers set the tone in mainstreaming digital sustainability in investment theses. Through their investments, they support scalable digital sustainability and can steer their portfolio companies to integrate technology and business innovation to deliver impact as well as return on investment. By participating in blended finance structures, they broaden the pool of capital available for innovation.

Invest in digital sustainability readiness

- Seek companies, startups and funds that explicitly aim to bridge the digital divide and promote digital inclusion, including those led by founders from diverse backgrounds with deep understanding of marginalised communities.
- Support affordable infrastructure and promote open and interoperable systems.

Be a "living lab" for fit-for-purpose solutions

- Support intellectual property development and technologies tailored to local needs, balancing upstream innovation with the imperative for scale and return.

Promote regulatory clarity and align policy frameworks

- Encourage portfolio companies and funds to transparently report on their sustainability impact, allowing investors to assess their contribution to this goal.
- Support participation in pilots and sandboxes by portfolio companies.

Integrate multiple types of innovation

- Develop and participate in blended finance and other new financing tools to manage risk for impact and return on investment. Such specialised investment products can be combined with different capital types, implement standardised due diligence approaches for digital sustainability ventures, and create investment committees with both financial and impact expertise.
- Private financial institutions can also create consortium approaches to digital sustainability investment, develop shared due diligence protocols that increase transparency and reduce redundant efforts, and implement collaborative funding models that distribute due diligence and transaction costs across multiple investors.

Foster regional interoperability and integration

- Support regional co-investment platforms and harmonise due diligence standards to reduce transaction costs and facilitate capital flows across borders.
- Collaborate with other funders to back digital infrastructure and standardise verification frameworks that enhance scalability.
- Pilot cross-border investments in sandbox corridors to test regulatory harmonisation and market entry feasibility from the outset.

4.6.4.Other impact funders, e.g. philanthropic sector

Impact funders are crucial in addressing funding gaps for digital public infrastructure and early-stage digital sustainability innovations. They can de-risk investments, support capability building and community building, fund research and provide an independent voice to build trust.

Invest in digital sustainability readiness

- Fund initiatives that enhance digital literacy and capacity building, targeting marginalised groups.
- Participate in 4P approaches to strengthen access and digital public infrastructure.

Be a "living lab" for fit-for-purpose solutions

- Support community engagement processes that ensure solutions address actual needs. Promote funding of impact assessment frameworks that measure both technological effectiveness and sustainability outcomes.
- Fund training, fellowship and mentorship programmes that develop specialists who combine technological expertise with sustainability domain knowledge.

Promote regulatory clarity and align policy frameworks

- Fund research on the intersection of digital transformation and sustainable development, as well as valuation methodologies that incorporate environmental and social outcomes into financial models.
- Support independent evaluation of sandbox outcomes, fund capacity building for regulators that manage digital sustainability innovation and facilitate knowledge exchange across jurisdictions.
- Support capacity building for standards implementation, fund research on standards harmonisation and facilitate dialogue between national regulators.

Integrate multiple types of innovation

- Fund independent assessment of new technologies to understand capabilities, impact and risks of emerging technology to inform policymaking and coordinated responses across ASEAN members.
- Develop and operate co-investment platforms, fund technical assistance that prepares venture capitalists for co-investment processes, convene stakeholders to design effective platform models and provide crucial first-loss capital that absorbs initial risks.

Foster regional interoperability and integration

- Fund technical assistance to help companies meet regional compliance standards.
- Support technical assistance and capacity building for regulators and innovators working on regional alignment tools, such as sustainability certification or mutual recognition frameworks.
- Facilitate regional learning exchanges and policy dialogues to support good regulatory practice.

4.6.5. Community groups

Community groups ensure that digital sustainability solutions are locally relevant, responsibly deployed and inclusively adopted, particularly among underserved populations.

Invest in digital sustainability readiness

- Facilitate grassroots engagement to ensure technology adoption aligns with local cultural and social contexts.
- Foster peer learning networks that leverage community knowledge sharing for safe and trusted adoption.

Be a "living lab" for fit-for-purpose solutions

- Organise and participate in community engagement processes.
- Develop train-the-trainer initiatives that create local expertise in rural and underserved areas.

Promote regulatory clarity and align policy frameworks

- Garner support for pilot projects that demonstrates integrated approaches and facilitate multi-stakeholder dialogues on policy alignment.

Integrate multiple types of innovation

- Support knowledge sharing regarding effective blended finance models and co-investment platforms.

Foster regional interoperability and integration

- Act as implementation or verification partners for proofs of concept in digital sustainability zones or sandbox corridors.
- Provide feedback loops to developers and regulators to ensure solutions remain accountable and trusted across different communities.
- Develop region-wide safeguards that protect marginalised groups during cross-border expansion.

4.7 Conclusion

Just as the SEA's digital economy has grown through adoption, adaptation and innovation, the region has the potential to identify use cases, develop fit-for-purpose solutions and scale digital sustainability efforts across borders. Successful implementation of these complementary avenues of action requires a concerted collaboration across stakeholders so that the region can become a living lab, launch pad and global hub for deploying digital innovation to accelerate sustainability and inclusive growth, both within the region and for the rest of the world.

Appendix A – Research Methodology

Overview

Our research methodology involved a mixed method approach to explore how SEA's digital momentum can be leveraged for digital sustainability. This includes literature reviews focusing on policy, infrastructure and digital public goods, along with patent analytics to uncover emerging digital technologies. Surveys and interviews were conducted with capital and solution providers to gain insights into current practices and innovations, while case studies of successful digital sustainability models were analysed. The study examined foundational readiness through hypotheses related to innovations in technology, business, governance and financing. Corresponding analysis methods involved assessing enabling policies and infrastructure, identifying technology trends, evaluating digitally-enabled business models, and reviewing financing mechanisms and governance structures to highlight opportunities for scalable and sustainable digital innovation in the region.

Priority sector selection

This study employed sectoral selection methodology as a tool to assist stakeholders, such as policymakers, to determine which pivotal sectors experienced accelerated digital transformation with the potential to advance sustainability goals in SEA. This methodology was designed to assess relative importance between each sector in respect to the achievement level of sustainability goals, investment and funding potential, and digital innovation potential. The study identified three sectors-financial inclusion, food and agriculture, and healthcare-that are experiencing a transformative digital acceleration, with climate-tech as a cross-cutting enabler.

The quantifiable gap to sustainable and inclusive development in each sector

We provide the following rationale to explain each sector's relevance with the associated SDGs:

Sectors	SDGs directly impacted	Rationale	Sectoral rating[205]
Financial Inclusion	1 No Poverty, 8 Decent Work, 10 Reduced Inequalities	Greater financial inclusion accelerates progress toward SDG 1: No Poverty, SDG 8: Decent Work and Economic Growth, and SDG 10: Reduced Inequalities, by equipping individuals and MSMEs with essential financial tools, services and knowledge to enhance livelihoods and drive social mobility.	4.53
Food and Agriculture	2 Zero Hunger, 3 Good Health and Well-being, 8 Decent Work, 10 Reduced Inequalities, 12 Responsible Consumption, 13 Climate Action, 14 Life Below Water, 15 Life on Land	The food and agriculture sector contributes to SDG 2: Zero Hunger, SDG 3: Good Health and Well-being, SDG 8: Decent Work, SDG 10: Reduced Inequalities, SDG 12: Responsible Consumption, SDG 13: Climate Action, SDG 14: Life Below Water and SDG 15: Life on Land by implementing sustainable agricultural practices, improving nutritional outcomes, providing employment opportunities and reducing environmental impacts across the entire supply chain.	5.89
Healthcare	3 Good Health and Well-being, 10 Reduced Inequalities	The healthcare sector drives progress toward SDG 3: Good Health and Well-being and SDG 10: Reduced Inequalities by delivering essential medical services, and preventive care and health education that improve population outcomes while addressing disparities in access and quality of care across socioeconomic groups.	5.74
Education	4 Quality Education, 8 Decent Work, 10 Reduced Inequalities	The education sector advances SDG 4: Quality Education, SDG 8: Decent Work and Economic Growth and SDG 10: Reduced Inequalities by equipping individuals with critical knowledge, skills and credentials that unlock economic opportunities, foster innovation and dismantle systemic barriers to social mobility across diverse demographic groups.	4.58
Renewable Resources and Alternative Energy	7 Affordable and Clean Energy, 9 Industry, Innovation and Infrastructure, 10 Reduced Inequalities, 11 Sustainable Cities, 12 Responsible Consumption, 13 Climate Action	Renewable resources and alternative energy drive progress toward SDG 7: Affordable and Clean Energy, SDG 9: Industry, Innovation and Infrastructure, SDG 10: Reduced Inequalities, SDG 11: Sustainable Cities, SDG 12: Responsible Consumption and SDG 13: Climate Action by accelerating the transition to low-carbon economies, creating green jobs and enhancing energy security while reducing environmental impacts.	5.03
Infrastructure	6 Clean Water and Sanitation, 7 Affordable and Clean Energy, 9 Industry, Innovation and Infrastructure, 10 Reduced Inequalities, 11 Sustainable Cities, 12 Responsible Consumption, 13 Climate Action	Infrastructure development catalyses advancement of SDG 6: Clean Water and Sanitation, SDG 7: Affordable and Clean Energy, SDG 9: Industry, Innovation and Infrastructure, SDG 10: Reduced Inequalities, SDG 11: Sustainable Cities, SDG 12: Responsible Consumption and SDG 13: Climate Action by establishing the physical and digital foundations that enable economic growth, social inclusion and environmental sustainability across urban and rural communities.	5.14

Sectors	SDGs directly impacted	Rationale	Sectoral rating
Technology and Communication	9 Industry, Innovation and Infrastructure, 10 Reduced Inequalities	Technology and communications contribute to SDG 9: Industry, Innovation and Infrastructure and SDG 10: Reduced Inequalities by developing transformative digital solutions, expanding connectivity and democratising access to information that bridge technological divides, and creating new pathways for economic participation and social inclusion.	5.19
Services	8 Decent Work, 10 Reduced Inequalities	The services sector advances SDG 8: Decent Work and Economic Growth and SDG 10: Reduced Inequalities by generating diverse employment opportunities, facilitating skill development and providing support to essential businesses that enables broader participation in the formal economy across various demographic groups.	5.37

*Calculated using the average of associated SDG rating from all of the SEA countries

The first step in the sectoral prioritisation framework quantifies SDG attainment gaps using a scoring system where achieved SDGs receive a value of 0 (indicating no immediate intervention required), challenges remaining are assigned a value of 3, significant challenges are valued at 5 and major challenges are designated with a value of 7, whilst data gaps remain unscored. This methodical assessment process aggregates performance across the relevant SDGs for each sector based on our established sector-to-SDG mapping, calculating mean values to generate comprehensive sector-specific ratings that systematically identify priority intervention areas, requiring strategic resource allocation and focused implementation efforts. By translating qualitative sustainability assessments into actionable quantitative metrics, this framework helps executive decision-makers to objectively prioritise sectoral investments that are aligned with the most pressing SDGs in the region.

The proven attractiveness of impact capital and conventional funding mechanisms

Our second step in the sectoral investment potential assessment leveraged the comprehensive UNDP SDG Investor Maps framework, developed by UNDP Private Finance for the SDGs with the support of CIIP, to systematically evaluate investment opportunity alignment with SEA's sustainable development priorities. This analytical approach identified Investment Opportunity Areas (IOAs) through multiple dimensions including primary SDG impact, associated risks, IMP classification and governmental policy frameworks, ultimately cataloguing 100 distinct IOAs across seven regional markets with varying sectoral distribution patterns.

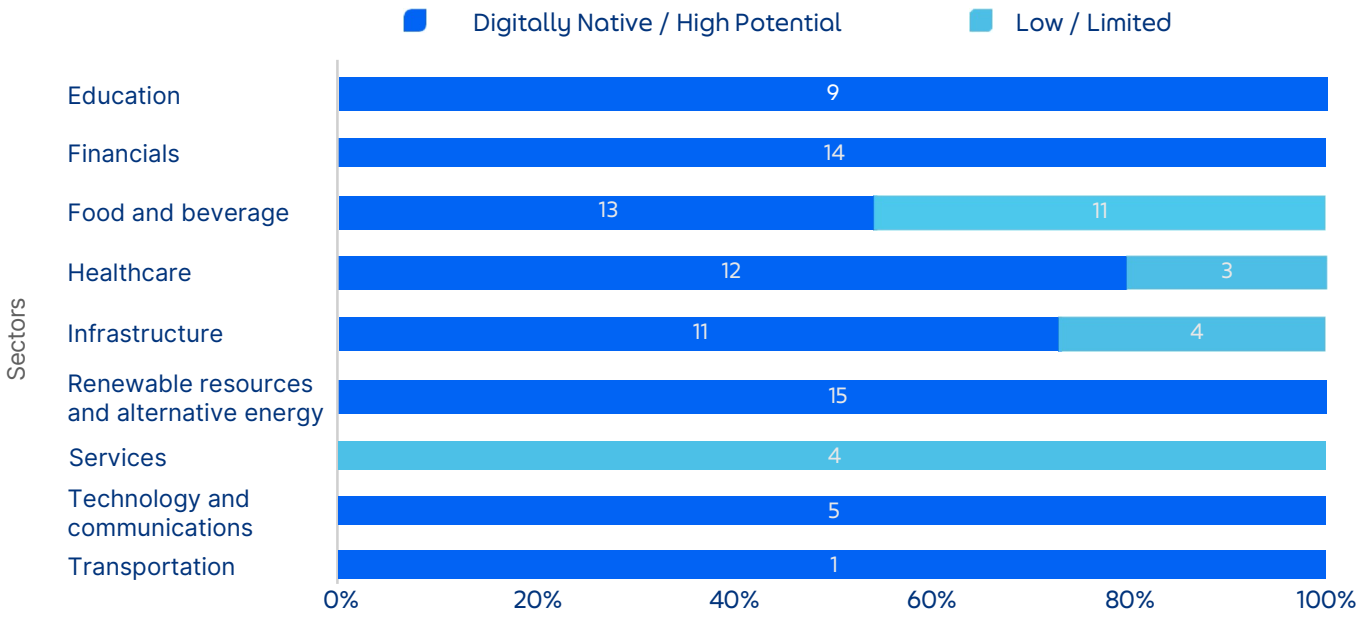
The quantitative analysis of SEA's IOAs revealed three sectors with exceptional investment potential: food and beverage (24 IOAs) emerged as the predominant sector for impact investment, followed by healthcare, infrastructure and renewable resources (15 IOAs each), with financial services (14 IOAs) completing the high-potential domain cluster. This distribution pattern provides compelling evidence for strategic capital allocation priorities, highlighting these sectors as offering the most robust opportunities for investors seeking both financial returns and sustainability impacts within the region's unique development context.

The measurable digital innovation potential and technology absorption capacity

The third methodological component employed sophisticated patent analytics by correlating IPOS data integration and SDG Investor Maps to systematically evaluate the digital innovation potential across priority sectors. This comprehensive assessment revealed significant sectoral variations in technological advancement, with healthcare demonstrating exceptional innovation scale (1.86 million patents filed between 2015-2024), followed by renewable resources (505,047 patents) and food and agriculture (452,918 patents), whilst financial services demonstrated remarkable digital concentration with 90.12% of its 186,320 patents specifically focused on digital technologies, significantly outpacing other sectors in digital transformation intensity.

Sectors	Total Inventions (2015-2024)	Digital Technology Inventions	% of Digital Technology
Education	N/A	N/A	N/A
Financial	186,320	167,910	90.1%
Food and Agriculture	452,918	92,983	20.5%
Healthcare	1,865,228	368,910	19.7%
Infrastructure	N/A	N/A	N/A
Renewable Resources	505,047	157,793	31.2%
Services	N/A	N/A	N/A
Technology and Communication	N/A	N/A	N/A

Further refinement of the innovation potential analysis examined the digital capability characteristics of 100 identified Investment Opportunity Areas (IOAs) across SEA, revealing that 78% demonstrated either digital-native characteristics (30 IOAs) or high potential for digital innovation acceleration (48 IOAs). This pattern was particularly pronounced in the financial services sector (100% of IOAs exhibited strong digital transformation potential), followed by healthcare (73.3% with high digital potential), and food and agriculture (54.2% with high digital potential)-providing quantitative validation to prioritise these sectors as optimal domains for technology-enabled sustainability interventions within the regional context.



Examples of digital IOAs from the UNDP SDG Investor Maps in Southeast Asia can be found below.

Digital x Impact Angle	Sector	Country	IOAs	Business Model
Affordability and Accessibility	**Financial Services**	**Indonesia**	**Financing solutions to promote the growth of micro, small and medium enterprises (MSMEs)**	B2C and P2P financing platforms connecting lenders/investors with MSMEs for affordable loans (invoice financing, supply chain financing, term loans and microloans).
	Food and Beverage	**Lao PDR**	**Animal feed production and distribution**	Produce and distribute sustainable, nutrient-rich animal feed using local agricultural by-products, ensuring a strong supply chain for rural farmers.
	Healthcare	**Cambodia**	**Digital healthcare service providers**	B2B/B2C tech-based companies offering digital healthcare services, including operation management systems, telemedicine and a pharmaceutical marketplace
Trust and Transparency	**Financial Services**	**Malaysia**	**Peer-to-peer (P2P) lending and equity crowdfunding (ECF) for MSMEs**	P2P lending and ECF platforms offering debt and equity assistance to MSMEs, with a focus on conventional and Islamic finance.
	Food and Beverage	**Indonesia**	**Output side digital platforms for farmers**	B2B and B2B2C agritech models provide post-harvest supply chain solutions, including farm-to-table distribution and marketplaces, to connect farmers with end-customers, and improve wholesale and retail market access.
	Healthcare	**The Philippines**	**Digital healthcare service providers**	B2B payment processing platforms streamlining claims management, reimbursements and automated payment processing for insurers

Digital x Impact Angle	Sector	Country	IOAs	Business Model
Real-time Insights	**Food and Beverage**	**Thailand**	**Smart farming and precision agriculture**	B2B/B2C models offering digital tools like automation, data analytics and forecasting to improve farming practices.
		Vietnam	**Agritech solutions for farm production**	B2B solutions for precision agriculture, including crop monitoring, predictive analysis and automation.
	Healthcare	**Indonesia**	**Pathology laboratories or testing Centres**	B2C pathology labs offering genomic and molecular testing, connected to national health data systems.
Mass Customisation	**Financial Services**	**Malaysia**	**Customised insurtech products for MSMEs**	P2P lending and ECF platforms offering debt and equity assistance to MSMEs, with a focus on conventional and Islamic finance.
	Healthcare	**Malaysia**	**Personalised caregiving services**	Insurtech firms providing B2B and direct-to-consumer insurance solutions for MSMEs, generating revenue through subscriptions, commissions, premium shares and value-added risk management services.
	Healthcare	**The Philippines**	**Digital healthcare service providers**	B2C and B2B models provide personalised caregiving, including in-home care, companionship, hygiene assistance, medication management, and specialised care for the elderly, disabled, children and long-term patients.

Summary of Sector Selection

Sector	SDGs directly impacted	Criteria	Gap to sustainable and inclusive development	Attractiveness for impact capital	Digital innovation potential
		Metric	SDG Index Score Average Rating	# Investment Opportunity Areas (IOAs)	Qualitative rating based on IPOS' tech innovation patent data & IOAs underpinned by digital business models
		Source	SDG Index (i.e., SDGs with challenges remaining across Southeast Asia)	UNDP SDG Investor Maps	IPOS' Patent Analytics and UNDP SDG Investor Maps
Education	4 Quality Education, 8 Decent Work, 10 Reduced Inequalities		4.58	10	Medium
Financial inclusion	1 No Poverty, 8 Decent Work, 10 Reduced Inequalities		4.53	14	Very High
Food and beverage	2 Zero Hunger, 3 Good Health, 8 Decent Work, 10 Reduced Inequalities, 12 Responsible Consumption, 13 Climate Action, 14 Life Below Water, 15 Life on Land		5.89	24	Medium
Healthcare	3 Good Health, 10 Reduced Inequalities		5.74	15	High
Infrastructure	6 Clean Water & Sanitation, 7 Affordable & Clean Energy, 9 Industry, Innovation, & Infrastructure, 10 Reduced Inequalities, 11 Sustainable Cities, 12 Responsible Consumption, 13 AClimate Action		5.14	15	High
Renewable resources and Alternative Energy	7 Affordable & Clean Energy, 9 Industry, Innovation, & Infrastructure, 10 Reduced Inequalities, 11 Sustainable Cities, 12 Responsible Consumption, 13 AClimate Action		5.03	15	High
Services	8 Decent Work, 10 Reduced Inequalities		5.37	4	Low
Technology and Communications	9 Industry, Innovation, & Infrastructure, 10 Reduced Inequalities		5.19	3	Very High

Source: Analysis by TFGI, CIIP and IPOS International, 2025

The sectoral prioritisation matrix methodology resulted in three priority areas identified-financial inclusion, food and agriculture, and healthcare-demonstrating exceptional potential for digitally-accelerated sustainability outcomes across SEA, each characterised by distinct regional nuances and transformation pathways.

The financial inclusion sector emerges as a critical enabler of socioeconomic development, leveraging digital innovation to enhance financial access for underserved populations throughout SEA. This sector demonstrates remarkable digital transformation characteristics, with 100% of IOAs exhibiting high digital potential and 90.12% of sectoral patents filed between 2015-2024, representing digital technology innovations. The sector's strategic importance is further underscored by its multidimensional contributions to poverty reduction (SDG 1), economic growth acceleration (SDG 8) and inequality mitigation (SDG 10) by providing essential financial mechanisms that enhance resilience and economic participation amongst vulnerable communities and MSMEs. Digital transformation within this sector-encompassing fintech innovations, digital banking platforms and strategic hybrid collaborations-creates unprecedented opportunities to develop inclusive financial ecosystems whilst simultaneously addressing persistent regional development challenges.

Concurrently, the food and agriculture sector demonstrated compelling transformation potential as a foundational economic pillar confronting critical challenges. These include productivity constraints, market fragmentation, ecological degradation and climate vulnerability. This sector exhibits extraordinary sustainability breadth through its impact across eight distinct SDGs, while commanding the highest representation in regional investment opportunities with 24 identified IOAs-54.2% of which demonstrate significant digital innovation potential. The sector's technological advancement trajectory is substantiated by approximately 452,918 patents filed between 2015-2024, establishing a robust foundation for digitally-enabled sustainability interventions. Particularly noteworthy are emerging "phygital" business models that strategically integrate digital capabilities with physical agricultural systems to enhance smallholder farmers integration, productivity optimisation and environmental sustainability throughout agricultural value chains-addressing multiple regional sustainability imperatives simultaneously through coordinated technological deployment.

Capital Provider Survey Methodology

Survey is conducted towards capital providers, including impact investors, non-impact investors and philanthropic grant givers. The data collection was finalised by 10 April 2025.

Respondent Demography

Funders survey demography (N=72).

Type of organisation	Private Investor (e.g., Private Equity (PE) / Venture Capital (VC))	42
	Philanthropic Organisation (e.g., Corporate Foundation)	13
	Asset Manager	6
	Others*	11
Regions**	Southeast Asia	62
	Broader Asia Pacific (excluding Southeast Asia)	47
	North America	24
	Europe	19
	Sub-Saharan Africa	15
	Middle East and North Africa (MENA)	14
	Latin America	11
Fund size	<$10M	7
	$10M - $50M	9
	$50M - $100M	7
	$100M - $500M	14
	Over $500M	23
	Prefer not to reply	12
Average ticket size	<$500k	12
	$500k - $5M	32
	$5M - $25M	15
	$25M - $50M	5
	>$50M	2
	Prefer not to specify	6
Impact focus	Impact Investor	49
	Philanthropic Grant Giver	11
	Non-Impact Investor	12

Primary funding approach	Concessional Investor	9
	Philanthropic Grant Provider	11
	Commercial Investor	37
	Hybrid Approach	13
	Others (Please Specify)***	2
Type of instruments deployed**	Equity	60
	Debt	45
	Convertible Debt	33
	Grant	19
	Mezzanine	11
	Revenue-Based Financing	4
	Other****	2

*Others include development finance institutions (DFIs), entrepreneur support organisations, corporates with an impact investing practice, institutional asset owners, and family offices.
**Multi-select question.
***Others include investing in synergistic/ecosystem opportunities that strengthen the overall value proposition of the group's offerings and being primarily a commercial investor, but as a corporate VC, also some strategic aspects to investments.
****Others include guarantee and blockchain-enabled financing.

List of survey questions and results

No	uestion	Option	Total respondent
1a	If your organisation falls into multiple categories, we recommend submitting a separate survey response for each one.	Asset Manager	6
		Development Finance Institution	3
		Family Office	0
		Philanthropic Organisation (e.g. Corporate Foundation)	13
		Private Investor	42
		Others [Please specify]	8
1b	What best describes your capital allocation activities? (Select all that apply)	Provide capital directly to companies and solutions	6
		Provide capital directly to companies and solutions & provide capital to funds	11
		Provide capital to funds	4

No	uestion	Option	Total respondent
2	What best describes your role at the organisation?	Consultant / Advisor / Researcher	4
		IMM / ESG Specialist	7
		Investment / Portfolio Director	26
		Investment / Portfolio Manager	20
		Other	15
3a	Region of Operations (select all that apply):	Southeast Asia	62
		Broader Asia Pacific	47
		North America	24
		Europe	19
		Sub-Saharan Africa	15
		Middle East and North Africa	14
		Latin America	11
3b	[If Southeast Asia selected] Within Southeast Asia, which countries are you active in (select all that apply):	Brunei	2
		Cambodia	19
		Indonesia	50
		Lao PDR	6
		Malaysia	29
		Myanmar	7
		Singapore	49
		Thailand	32
		The Philippines	36
		Timor-Leste	2
		Vietnam	40

No	uestion	Option	Total respondent
4	Which of the following best describes your organisation's primary investment approach? (select one):	Concessional Investor	9
		Philanthropic Grant Provider	11
		Commercial Investor	37
		Hybrid Approach	13
		Others (Please Specify)	2
5	What is your organisation's total fund size in USD?	Less than $10M	62
		$10M - $50M	47
		$50M - $100M	24
		$100M - $500M	19
		Over $500M	15
		Prefer not to reply	14
6	What is your organisation's average investment size per project in USD?	<$500K	12
		$500k - $5M	32
		$5M - $25M	15
		$25M - $50M	5
		>$50M	2
		Prefer not to specify	6

No	uestion	Option	Total respondent
7	Which financial instruments do you deploy? (select all that apply)	Blockchain-enabled financing	1
		Convertible Debt	33
		Debt	45
		Equity	60
		Grant	19
		Mezzanine	11
		Revenue-Based Financing	4
		Other	2
8	Does your organisation participate in blended finance mechanisms? (select one):	No, and we do not have an intention to do so.	15
		No, but we would like to try.	35
		Yes, we actively do so.	22
9	Do you identify as an impact investor? (select one): According to Global Impact Investing Network (GIIN) definition, impact investments are investments made with the intention to generate net positive, measurable social and/or environmental impact alongside a financial return.	Yes	53
		No	19
10	What percentage of your organisation's portfolio is allocated towards impact? *open ended question but the answer is already grouped by interval	0%	3
		1-25%	12
		26-50%	5
		51-75%	6
		76-100%	45

No	uestion	Option	Total respondent
11	What percentage of your organisation's portfolio is allocated towards digital sustainability? In this research, we define digital sustainability as digital solutions to achieve sustainable outcomes aligned with United Nation's Sustainable Development Goals (SDGs). - Indicate Percentage *open ended question but the answer is already grouped by interval	0%	5
		1-25%	24
		26-50%	15
		51-75%	13
		76-100%	14
12	Which sectors do your organisation's digital sustainability investments focus on? (select all that apply):	Agriculture and Food Security (e.g., precision farming, agri-tech platforms)	50
		Climate and Environment (e.g., digital monitoring for conservation)	52
		Financial Inclusion (e.g., digital payments, access to credit)	37
		Healthcare (e.g., telemedicine, health data platforms)	39
		Other [Please specify]	18
13	When considering investments in digital technologies for sustainability, what stage of investments do you prioritise? (select top 2):	Pre-Seed / Seed	0
		Series A / B	0
		Series C and beyond	0
		Growth / Expansion Stage	0
		IPO and Later	0
		Other [Please specify]	4
14	How do you ensure that your portfolio companies remain aligned with the goal of meeting the SDGs? (select top 2):	Implementation of Impact Measurement and Management (IMM) practices	38
		Independent third-party and verification	6
		Oversight and guidance from the board of directors	20
		Tracking progress against SDG-aligned KPIs	22
		Use of ESG and impact assessment frameworks to select investees	37
		Other [Please specify]	3

No	uestion	Option	Total respondent
15	To what extent do you agree that digital technology/innovation has the potential to accelerate delivery of impact and sustainability in Southeast Asia?	Strongly Disagree	2
		Disagree	2
		Slightly Disagree	1
		Neither Agree or Disagree	1
		Slightly Agree	8
		Agree	29
		Strong Agree	29
16	Which enabling technologies do you believe have the greatest potential to accelerate sustainability in Southeast Asia? (select top 3): *1 'Other' answer refers to 'all of the above', therefore it added 1 number for each tech for the visualisation in 2.1	Artificial Intelligence (AI)	49
		Internet of Things (IoT)	34
		Big Data Analytics	32
		Interoperable Payment Platforms	22
		5G Networks	16
		Digital Identity Systems	14
		Cloud Computing	13
		Blockchain	7
		Edge Computing	3
		Other [Please specify]	4
17	What are the main challenges does your organisation face when investing in digital technologies for sustainability in Southeast Asia? (select top 2):	High upfront costs of technology development and implementation	25
		Insufficient or unclear return of investment (ROI)	29
		Lack of digital infrastructure	22
		Lack of skilled workforce to implement or scale digital solutions	21
		Regulatory or policy uncertainty in the region	28
		Other [Please specify]	6

No	uestion	Option	Total respondent
18	What support would enhance your organisation's ability to invest in digital innovation for impact / the SDGs? (select top 2):	Access to market intelligence (e.g., SDG Investor Maps, Patent Analytics)	15
		Capacity-building and training initiatives	12
		Improved access to funding or co-investment opportunities	40
		Partnerships with local stakeholders	30
		Policy incentives and regulatory support	37
		Other [Please specify]	3
19	Do you have any additional suggestions to improve the investment ecosystem for digital sustainability in Southeast Asia? (optional)	Open-ended answer	
20	Which types of stakeholders do you collaborate with most frequently to drive digital sustainability? (select one):	Academic or research institutions	1
		Government bodies or agencies	9
		Multilateral organisations (e.g., UN agencies, development banks)	6
		Non-profits or civil society organisations	6
		Private sector companies or corporate partners	47
		Other [Please specify]	3
21	What is the primary purpose of these collaborations? (optional)	Open-ended answer	
22	Would you be willing for us to acknowledge your participation in this survey in the final report? (select one):	Yes, and the organisation name to indicate is:	
		No, I prefer to remain anonymous.	
23	Are you interested in supporting this research further? (select all that apply):	Joining a virtual workshop to validate findings.	
		Receiving updates on research outcomes.	

Expert Interview Methodology

The research methodology further incorporated in-depth interviews with capital and solution providers to garner rich perspectives on how SEA can strategically leverage its digital momentum to advance regional sustainability objectives, whilst simultaneously contributing to global sustainable development efforts by functioning as a living laboratory and global hub for digital sustainability innovation. In the interview, digital sustainability is defined as the use of digital solutions, driven by innovation, to achieve sustainable outcomes aligned with the United Nations' SDGs.

Interview question for capital providers

Section 1: Funding Focus

1. Could you explain briefly your key markets in Southeast Asia and the specific focus of your funding activities there?
2. What are the key sector(s) for your digital sustainability funding and why are these areas a priority for you?
3. At what stage of funding maturity does your organisation typically participate in (e.g., seed, early, growth, mature, public) and why are these stages particularly important for your strategy?
4. How do you ensure your portfolio companies align with the SDGs and how do you measure the impact of your funding (e.g., internal metrics, external frameworks, or third-party evaluations)? Could you share examples of frameworks, IMM tools, or metrics you rely on?

Section 2: Perspectives on Digital Sustainability and Innovation

5. Which sectors or technologies do you believe will be game-changers for sustainability in Southeast Asia over the next 5-10 years? Follow-up: How do you see the role of (impact) investors evolving in driving digital sustainability in the region?
6. As an investor, how do you determine whether a solution is ready to move from the innovation stage (e.g., pilots, smaller scale deployment) to scaling? What factors or metrics guide your decision? Follow-up: Have you encountered situations where scaling a solution prematurely impacted its success or sustainability? What were the key lessons learned?
7. Which stakeholders do you collaborate with most frequently to drive digital sustainability? For example, governments, private sector, or NGOs. What is the primary purpose of these collaborations? Follow-up: Are there opportunities for stronger collaborations with governments, corporates, or other stakeholders?

Section 3: Ecosystem Needs and Challenges

8. What challenges does your organisation face when investing in digital technologies for sustainability in Southeast Asia? For example, regulatory hurdles, high upfront costs, or lack of viable projects?
9. What do you think needs to change in the investment ecosystem to better support digital sustainability in Southeast Asia?

Interview question for solution providers

Section 1: Solutions and Technology Focus

1. Could you describe your primary solutions or initiatives and how they contribute to achieving sustainable development goals (SDGs) in Southeast Asia?
2. What type of digital technologies do you use or focus on in your solution or initiative?

Section 2: Impact and Scaling

3. How do you ensure your solutions create measurable and meaningful impact and what tools or metrics do you use to track progress? What factors or conditions do you consider before scaling your solutions across new communities, markets, or sectors? Follow-up: Have you encountered challenges when scaling and what key lessons have you learned?
4. What kind of support-whether from investors, policymakers, or other stakeholders-would most help accelerate the adoption and scaling of your solutions?

Section 3: Perspectives on Digital Technologies

5. What digital technologies do you think have the potential to address sustainable development challenges in Southeast Asia today? What pain points does the region face that can be addressed by digital technologies?
6. What emerging trends or technologies do you believe have the greatest potential to transform digital sustainability in the next 5-10 years (in the region and globally)?
7. What role do you see your organisation playing in shaping the future of digital sustainability in Southeast Asia?
8. What advice would you give to others in the solution-provider space who are looking to contribute more effectively to sustainability outcomes?

Section 4: Ecosystem and Collaboration Needs

9. How would you assess Southeast Asia's readiness to adopt digital technology solutions? What are key gaps and what's needed to address?
10. What ecosystem barriers (e.g., regulatory hurdles, funding gaps, technological limitations) do you believe must be addressed to better support the adoption of your solutions in Southeast Asia?
11. Who are your key collaborators (e.g., governments, private sector, NGOs) and how do these partnerships enhance the reach or impact of your solutions? Follow-up: Are there areas where stronger collaboration could help you amplify your impact?

Patent Analytics

Patent analysis was conducted to generate insight on the trend of emerging technologies and prioritised sectors, including financial, food and agriculture, and healthcare. Patent data was also used as criteria for priority sector selection.

Dataset

The final dataset was retrieved on 23 Feb 2025 and comprises worldwide patent applications published from 2015-2024. The data was retrieved from the Questel FAMPAT database.

Counting of inventions

Inventions are counted based on unique patent families.
A patent family represents a group of patent applications linked to the same invention. Analysing unique patent families provides a more accurate reflection of innovation productivity, as counting individual patent applications can result in double counting. This occurs when multiple publications are filed for the same invention across various jurisdictions.

Grouping of inventions into technology domains and areas

Individual inventions were classified into the respective technology categories, domains and areas using a combination of patent classification codes, text-mining and semantic analysis of the patent specifications, particularly claims, titles and abstracts.

Strings AI

Main keywords used:

- artificial intelligence, machine learning, supervised learning, unsupervised learning
- (neural, Hopfield, feedforward, Kohonen, self-organising, recurrent, echo state, Siamese) and network, backpropagation, perceptron, autoencoder, neural radiance field, learning vector quantisation, ANFIS, neuro-fuzzy inference
- (deep, depth, residual, deep belief, adversarial, generative) and (learning, network, model), convolutional neural network, long short-term memory, LSTM, deep Boltzmann machine, generative adversarial network, generative AI
- (linear, non-linear, logistic, polynomial, multi-variate adaptive, local, moving, non-parametric, kernel, kernel ridge, segmented, piecewise, least square, ridge, lasso, least-angle, elastic net) and regression, regression and (analysis, algorithm, model), scatterplot smoothing
- bayesian, bayes, averaged one-dependence estimators, AODE
- (instance-based, memory-based, locally weighted, lazy) and learning, k-nearest neighbour, kernel and (machine, method), support vector machine, radial basis, RBF and (network, learning)
- k-means, (EM, expectation-maximisation) and (algorithm, clustering, method), (hierarchical, DBSCAN, gaussian, density-based) and clustering, mean shift, gaussian mixture model, clustering and (algorithm, analysis, method)
- (decision, CART, classification and regression) and tree, iterative dichotomiser 3, ID3, random forest, C4.5, chi squared automatic interaction detection, CHAID, ensemble and (learning, method, algorithm), adaboost, (adaptive, gradient) and boosting, xgboost, bootstrap aggregation, stacked generalisation

- expert system, genetic algorithm, computational intelligence, rule-based learning, (bio-inspired, biologically-inspired, neuro-inspired, neural-inspired, nature-inspired) and (learning, computing, algorithm, network, intelligence, architecture, clustering), swarm intelligence, (ant, bee, fish, locust, whale) and (algorithm, intelligence)
- (reinforcement, temporal difference) and learning, deep Q-network, DQN, Q-learning, Q-table, state-action-reward-state-action, SARSA, TD learning, (positive, negative) and reinforcement, actor-critic, A3C, TRPO, PPO, DDPG TD3, QR-DQN, I2A, MBMF, MBVE, epsilon-greedy, multi-armed bandit, trust region-guided proximal policy optimisation, deep deterministic policy gradient, model-based value expansion, chauffeurnet
- (federated, alliance) and (learning, model, AI, horizontal, vertical, longitudinal, averaging, aggregation), blockFL, FedSGD
- transfer learning, TLlib
- (zero-order, zero-shot, zero-sample, data-less, one-order, one-shot, few-shots, few-orders) and (learning, inference)
- natural language, speech-to-text, text-to-speech, text-to-phoneme, (speech, voice) and (analysis, recognition, synthesis), text and (classification, analysis), sentiment analysis, word2vec, word segmentation, fastText, sentence encoder, textual entailment, entity typing, large language model, LLM, BERT, XLNet, multi-lingual, bi-lingual, machine translation
- computer vision, (vision, visual) and processing, object detection, image and (classification, recognition), scene and (reconstruction, restore, transform, parse, recreate, understand), (facial, iris, target) and (detect, recognition, authenticate, verify), SLAM algorithm, locality mapping, VGG, Xception, ResNet, ImageNet
- XAI, XNN, XGNN, explainable, interpretable, SHAP, shapley additive explanations, LIME, local interpretable model-agnostic explanations, partial dependence plot, layer-wise relevance propagation, contrastive explanation, concept activation vector
- accelerator, chip, chipset, system-on-chip, processor, hardware, neuromorphic, FPGA, CPU, GPU, TPU, tensor processing unit, neural processing unit, vision processing unit

Main IPC/CPC used:
- G06N 3/02, G06N 3/0475, G06N 3/0464, G06N 3/092, G06N 3/096, G06N 3/098, G06N 5/045
- G06K 9/003, G06F 18/23, G06F 18/27, G06N 20/20, G10L, G11C 11/54
- G06V 10/00, G06V 20/00, G06V 30/00, G06V 40/00

Computer Technologies

Main keywords used:
- Computer, computing, program, algorithms
- Database, server, medium, memory
- Main IPC/CPC used:
- G06C, G06D, G06E, G06F, G06J, G06K, G06K, G06M, G06N, G06T
- G10L
- G11C
- G16B, G16C, G17Y, G16Z

Digital Communications

Main keywords used:
- Digital communication, modulation, demodulation, bit error rate, signal to noise, SNR, LDPC codes, turbo codes, packet switching, data multiplexing, encoding, decoding, compression, bandwidth, latency, signal processing TCP/IP, OFDM
- Serial communication, parallel communication, transceiver, repeater, gateway, streaming
- Main IPC/CPC used:
- H04W, H04N 21/00, H04L

Telecommunications

Main keywords used:
- Wireless communication, DSL, FTTH, base station, radio access network, RAN, backhaul, fronthaul, circuit switching, beamforming, software defined networking,
- VoLTE, terahertz, 3G, 4G, 5G, 6G
- Main IPC/CPC used:
- G08C
- H01P, H01Q
- H04B, H04H, H04J, H04K, H04M, H04N 1/00, H04Q

Fintech

Main keywords used:
- Blockchain, digital wallet, distributed ledger, smart contract, digital token, on-chain, off-chain, NFT,
- Cryptocurrency, bitcoin, Ethereum, altcoin, stablecoin, crypto mining, decentralised exchange
- Main IPC/CPC used:
- G06Q 40/02, G06Q 40/03, G06Q 40/04, G06Q 40/06, G06Q 40/08
- G06Q 40/10, G06Q 40/12

Digital Health

Main keywords used:
- Digital health, eHealth, mobile heath
- Diagnosis, surgery, therapy, therapeutic, medical, hospital, clinical
- Pharmaceutical, medicine, medicament, drug, adjuvant, bacteria, virus, antibody, antibiotic, antioxidant
- Telemedicine, telehealth, telecare, tele doctor, tele diagnosis, telemetry medicine
- Remote patient monitoring, remote patient care, remote diagnosis, remote health, remote therapy, vital sign monitoring
- Sensors, biosensor, wearable, smart device, smartphone, mobile device, mobile application, health app
- Online doctor, online physician, online surgery
- Home-based doctor, home-based therapy, home-based rehabilitation
- Precision medicine, precision healthcare, precision treatment, precision therapy, personalised medicine, personalised healthcare, personalised treatment, personalised therapy
- Pharmacogenomics, genomics, pharmacogenetics
- Disease management, chronic care,
- Main IPC/CPC used:
- A61B, A61C, A61D, A61F, A61G, A61H, A61J, A61K, A61L, A61M, A61N, A61P
- G16H 10/00, G16H 15/00, G16H 20/00, G16H 30/00, G16H 40/00, G16H 50/00, G16H 70/00, G16H 80/00,
- H05G

Agriculture

Main keywords used:
- Agriculture, farming, plant, fruit, flower, rice, corn, soybean, seed, breeding, sowing, fertilisation, irrigation, harvesting, mowing
- Pesticide, pest, biocidal, herbicide, greenhouse, horticulture, aviculture, apiculture, pisciculture, aquaculture, aquaponics
- Main IPC/CPC used:
- A01B, A01C, A01D, A01F, A01G, A01H, A01J, A01K, A01L, A01M, A01N, A01P

Renewable

Main keywords used:

- Solar cell, solar power, solar farm, photovoltaic, PV module PV panel, perovskite
- Hydrogen, fuel cell, SOFC, PEMFC, hydrogen station, power-to-gas
- Biofuel, biomass fuel, bioethanol, biomethane, bio-methanol
- Hydropower, hydroelectric, penstock, water energy, hydro turbine, Francis turbine, Kaplan turbine, Pelton wheel, wind turbine, wind power, wind farm, geothermal, tidal energy, wave energy, nuclear power, fission reactor, fusion reactor
- Main IPC/CPC used:
- Y02E 10/10, Y02E 10/20, Y02E 10/30, Y02E 10/40, Y02E 10/50, Y02E 10/60, Y02E 10/70, Y02E 60/30, Y02E 60/50
- H01L 31/00
- E02B 9/00
- G21C, G21B, G21D,
- F03G 4/00, F24T

Appendix B – Green Finance

Green finance plays an increasingly important role in supporting environmentally sustainable projects and business practices, such as encouraging the development of green projects or minimising the impact on the climate of regular projects.

Examples of green finance projects include renewable energy and energy efficiency, green buildings, circular economy initiatives, and sustainable use of natural resources and land. Such financing can be extended to an array of recipients, from small- and medium-enterprises looking for financing to support the development of sustainable practices and reporting capabilities, to large infrastructure projects.

Common green finance instruments include:

- Green bonds, which are financial instruments that finance green projects and provide investors with regular or fixed income payments. The green bond market has also seen substantial growth globally. The International Capital Market Association has issued Green Bond Principles, a set of voluntary guidelines that outline that bonds should adhere to stringent criteria concerning project evaluation and selection, the management of proceeds, and offering detailed reporting. For example, In 2020, the Indonesia-headquartered Star Energy Geothermal (Dajarat II) Ltd issued a US$790 million green bond, with proceeds used to finance and refinance geothermal projects and assets.

- Sustainability-linked bonds, by contrast, are financial instruments that are structurally linked to the issuer's achievement of climate or broader sustainable development goals. Progress, or lack thereof, toward achieving these predetermined goals can increase or decrease an instrument's coupon. For example, in 2023, WHA Corporation issued the first sustainability-linked bond under the ASEAN Sustainability-Linked Bond Standards. The bond raised TH 4 billion (US$117 million) and is linked to KPI achievements, including Scope 1 and 2 greenhouse gas emission intensity reduction, raw water consumption reduction and reducing reliance from natural sources by increasing reclaimed water production.

- Green sukuks are Shariah-compliant financial instruments that are also used to fund green projects. Unlike bonds, sukuks are interest-free and generate returns to investors through an agreed share of profits generated by underlying assets. Green sukuks are also compliant with green bond standards. For example, in 2017 Tadau Energy issued the world's first green sukuk linked to sustainable and responsible investment at RM250 million (US$56 million) in Malaysia. The sukuk was used to finance large-scale solar photovoltaic plants in Kudat, Sabah.

- Green loans are a form of financing that enables borrowers to use the proceeds to exclusively fund projects that make a substantial contribution to an environmental objective. For example, BDO Unibank issued a PH 2 billion (US$34) million green corporate loan to Alternergy Holdings Corporation in 2023, financing its renewable energy construction projects in Rizal, Quezon, and Bataan in The Philippines.

- Sustainability-linked loans, by contrast, are loans where margins are linked to predetermined sustainability performance targets on the part of the borrower, not to the asset or purpose of financing. These targets are pre-selected, core, and material to the borrower's business. For example, in 2023, City Developments Limited (CDL) received a sustainability-linked loan from OCBC, with interest rate incentives pegged to annual decarbonisation targets. The £200 million (US$258 million) sustainability-linked revolving credit facility will be used for refinancing, general corporate funding and working capital purposes, while being aligned with CDL's commitment to achieve operational net zero by 2030 for its new and existing wholly-loaned assets and developments under its direct operational and management control.

In the digital sustainability space, green financing can play a key role in funding digital solutions that address pressing environmental and climate challenges, such as AI-powered smart grids for renewable energy management, blockchain-enabled carbon tracking systems and IoT-based precision agriculture to reduce resource consumption. Green finance can bridge the gap between digital innovation and environmental sustainability, and create scalable impact while meeting the growing demand for impactful investment opportunities. As both fields continue to evolve, its convergence offers promising pathways to accelerate the transition toward a sustainable and inclusive economy.

Appendix C – Distinguishing Impact Financing from ESG

An essential element to impact financing is the notion of the theory of change. A theory of change refers to the ways investors articulate outcomes they intend to affect with their investments and anticipate ways to increase their likelihood of success.[206] Key to the theory of change is additionality, or the idea that an investment has a positive societal impact that would not have occurred without that capital. Additionality is assessed across three dimensions:

- **Output**: Products or services provided by an organisation that directly influence stakeholder outcomes;
- **Outcome:** Social, environmental or economic improvements experienced by stakeholders that result from the organisation's activities, products or services;
- **Impact:** Measurable change in outcome experienced by stakeholders - positive or negative -caused by the organisation.

Delivering impact at scale requires systematic measurement of output and outcomes over time, validating the theory of change. Tracking outputs are essential as it provides immediate, short-term indicators of progress, such as the number of products distributed, services delivered or individuals reached. While it does not guarantee impact, outputs serve as early signals of whether an initiative is on track, allowing investors and organisations to identify gaps, adjust strategies and allocate resources effectively. Contrastingly, outcomes take time to materialise and reflect the real-world effects of an intervention on stakeholders, offering a clearer picture of whether meaningful social, environmental or economic improvements are occurring. Since impacts can be both positive and negative, continuous tracking is critical to refining business models and mitigating harm. Given the time required to assess outcomes, impact investors and organisations must implement robust systems to monitor both outputs and outcomes over the long-term. This ensures sustained accountability, reinforces commitment to impact, and provides vital insights during periods of rapid growth or strategic change.

Case Study 12

EPIC Intelligence: Transforming customer insights into measurable impact

EPIC World Private Limited is driven by the belief that capital should be strategically deployed to build businesses that serve **Entrepreneurial Households**-households that enhance their income through investments in businesses and high-priority goods and services. While not affluent by traditional income measurement standards, these households demonstrate strong economic vitality through their transactions and commitment to growth. Despite their significant economic potential, Entrepreneurial Households are often overlooked or inadequately served by traditional service providers, creating a gap that specialist businesses can fill.

Specialist businesses are companies that develop tailored solutions for Entrepreneurial Households in non-discretionary sectors such as healthcare, financial services, education and small business support-areas where traditional providers often fall short of meeting their specific needs. Understanding customer outputs, outcomes and impact is essential for these businesses targeting this segment of customers. EPIC World estimates that India alone is home to **247 million Entrepreneurial Households that lack formal access to such sectors at scale.**[208]

Data innovation for deep customer impact understanding

For businesses serving Entrepreneurial Households-a resilient and high-growth segment in the Global South-understanding customer impact is critical. These households drive local economies, yet require tailored solutions in healthcare, financial services, education and small business support.

To address this need, EPIC World developed **EPIC Intelligence**, a data product leveraging hyperlocal signals, AI and data science to generate deep insights into population dynamics (Entrepreneurial Households - EH), economic activity (Core Transaction Value - CTV) and market readiness (Curated Points of Interest - PoI).

Currently covering over **250,000 villages across 200+ districts in rural and semi-urban India**, with nationwide coverage expected soon, EPIC Intelligence enables businesses to **track service delivery (outputs), real-world customer changes (outcomes) and broader socioeconomic shifts (impact).**

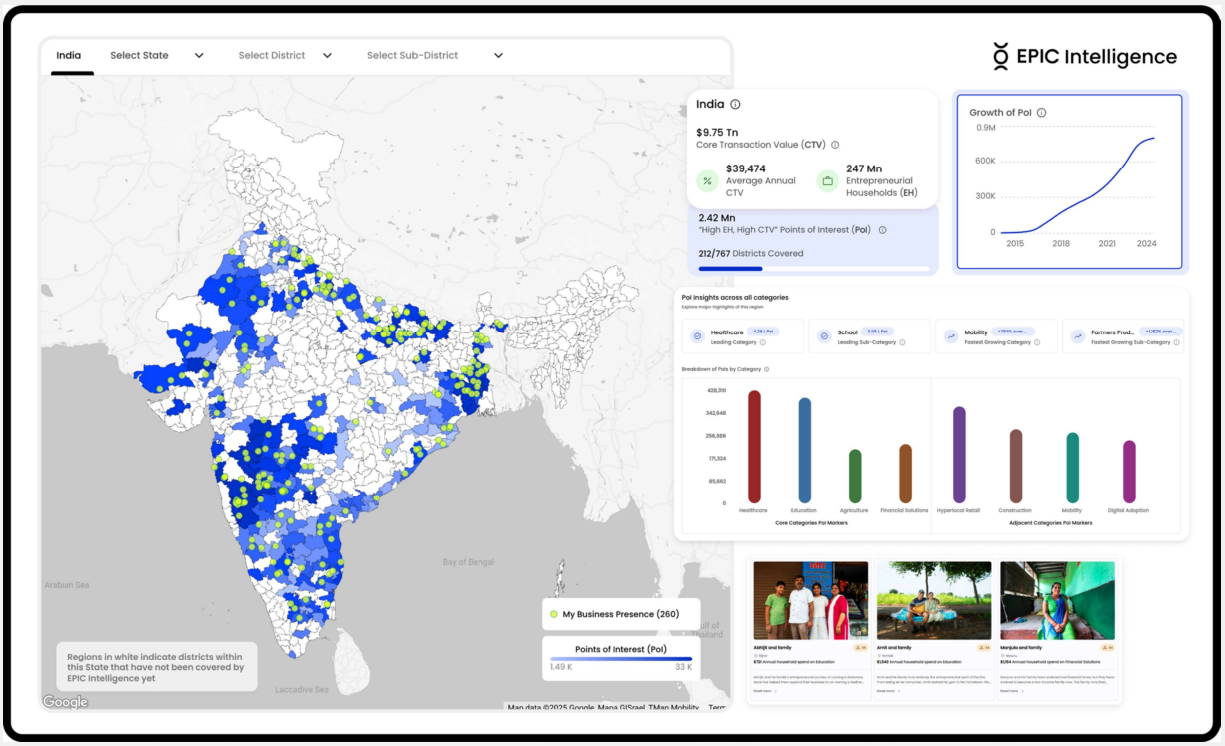


Figure 19. The EPIC Intelligence Product. For more information, please visit epicworld.com/intelligence.

Expected impact - Scalable, hyper-tailored services for entrepreneurial households

For specialist businesses, up to 70% of operational costs are for distribution. EPIC Intelligence empowers specialist businesses to optimise expansion, enhance operational efficiency and refine products based on real-world impact data. By addressing major distribution challenges and cost barriers, it can significantly **reduce operational expenditure for these businesses.** Clients leverage EPIC Intelligence to:

1. **Expand services to underserved areas**
   - A rural healthcare provider uses EPIC Intelligence to identify optimal clinic locations and supply chain partners for expansion, improving accessibility and affordability.

2. **Enhance hyperlocal lead generation**
   - A financial services company uses unbiased market insights from EPIC Intelligence to refine field execution, improve customer prospecting and business funnel performance, while delivering tailored financial solutions to communities.

3. **Optimise micro-market customer discovery and organisational design**
   - An affordable education company maps ideal product locations and strategically places relationship managers based on localised customer needs.

Innovative financing for sustainable growth

EPIC World operates as a for-profit entity with revenue streams from EPIC Intelligence and services. However, alongside its founders and private individual investors, **its largest shareholder, EmValu Corporation, is a nonprofit organisation.** Philanthropic funding received by **EmValu supports research and initiatives that drive broader market understanding on Entrepreneurial Households.**

Going forward: Expansion into Southeast Asia

EPIC Intelligence is designed for global scalability, **with Southeast Asia identified as the next target market due to its strong digital adoption and government support** for digital initiatives. By offering a data-driven and scalable framework, EPIC Intelligence offers businesses in the region to measure, adapt and maximise its impact on Entrepreneurial Households in a sustainable and quantifiable way. While localisation and strategic partnerships are essential to ensuring country-specific data rigour, the product's modular architecture and data abstraction capabilities facilitate rapid deployment to market.

"EPIC Intelligence is the quantitative voice of Entrepreneurial Households, revealing economic potential beyond traditional metrics. Access to these powerful, data-driven customer insights allows businesses to hyper-tailor products and solutions to the diverse needs of traditionally overlooked Entrepreneurial Households, unlocking new opportunities for impact and growth."

- Kartik Parija, Co-Founder, EPIC World

This is what differentiates impact financing from environmental, social and governance (ESG) factors in decision making. Today, many investors and companies refer to ESG factors to set the baseline and minimum threshold for responsible investments and to avoid doing harm through its business activities. This compliance-driven approach is shifting as more frameworks and regulations begin to adopt double materiality - accounting for the impact of businesses on society and environment, in addition to financially material ESG factors.

Beyond merely acting to avoid harm as prescribed by ESG factors, leading investors and companies are starting to go further as they contribute to solutions that address our social and environmental challenges, in tandem with their pursuit of profits. This is the heart of impact- the intentional deployment of capital towards addressing or creating a solution for the environment and underserved customers.

Appendix D – Initiatives and Transactions with Innovative Financing Structures to Advance SDGs in Southeast Asia

The table below is an analysis conducted by our research partner, the Centre for Impact Investing and Practices (CIIP), based on a synthesis of various sources.

Initiative Name	Key Partners	Year	Objective of Initiative	Innovative Financing Structure
Transition Credits for Coal Phase-Out	ACEN, GenZero, Keppel Ltd., Mitsubishi Corporation, Diamond Generating Asia, Ltd. (DGA)	2025	Develop transition credits to finance the early retirement of coal-fired power plants in Asia, accelerating renewable energy.[208]	Transition credits
Financing Asia's Transition Partnership (FAST-P)	Monetary Authority of Singapore	2023 / 2024	Launched at COP28 and advanced at COP29, the partnership aims to support Asia's decarbonisation and climate resilience. The Singapore Government pledges up to US$500 million as concessional capital to match dollar-for-dollar concessional capital from its partners, including other governments, multilateral development finance institutions and philanthropies.[209]	Blended finance initiative that brings together international public, private and philanthropic partners

Initiative Name	Key Partners	Year	Objective of Initiative	Innovative Financing Structure
Just Energy Transition Partnership (JET-P)	Various countries making up the International Partners Group (IPG)	2021	A partnership that was rolled out in the region, financing energy transition away from coal. Established in Indonesia and Vietnam for decommissioning coal-fired power plants, supporting workers affected by these changes and building renewable energy infrastructure.	Financing cooperation mechanism that pools public and private funds
ASEAN Catalytic Green Finance Facility (ACGF)	ADB	2019	A regional initiative, the ACGF supports ASEAN governments with technical assistance and access to over US$1 billion in co-financed loans. It helps identify and prepare commercially viable green projects, while its loans cover upfront capital costs, reducing risks and attracting private investors.[210]	Establishing a blended finance investment vehicle, for green infrastructure projects across SEA
MGTC-PLUS Solar projects	Malaysian Green Technology and Climate Change Corporation (MGTC) and PLUS Malaysia Berhad (PLUS)	2018	An agency of the Ministry of Natural Resources and Environmental Sustainability, the MGTC works closely with companies to further deploy of nation-wide sustainability products. MGTC collaborated with PLUS to oversee the installation and commission of PLUS' Solar Photovoltaic System project on the North-South Expressway, and the first Solar Electric Vehicle Charging Station at PLUS' Ayer Keroh Overhead Bridge Restaurant.[211]	Public Private Partnership (PPP) between a private company and the local authority for nation-wide sustainability projects
Trade Finance Risk Mitigation	ADB and Swiss Re	2011	Insure US$250 million in trade finance to enhance exports and imports in developing Asian countries by mitigating financial risks.[212]	Blended structure through various risk-sharing products
PT. Indonesia Infrastructure Finance (IIF)	Indonesian Government, World Bank (WB), Asian Development Bank (ADB) and other multilateral institutions	2010	Established by the Indonesian government, WB, ADB and other multilateral institutions, IIF is a private national company providing infrastructure financing and advisory in services, which aims to catalyse private participation in infrastructure development in the country.[213]	Establishing a blended finance investment vehicle to further populate private sector participation in projects

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