Consolidated Strategy
on the Fourth Industrial Revolution for ASEAN

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ASEAN: A Community of Opportunities for All

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List of Abbreviations

3D	Three Dimensional
4IR	Fourth Industrial Revolution
A4IR-TFG	ASEAN 4IR Task Force Group
ACRF	ASEAN Comprehensive Recovery Framework
AEC	ASEAN Economic Community
AI	Artificial Intelligence
AMS	ASEAN Member States
APEC	Asia-Pacific Economic Cooperation
APSC	ASEAN Political-Security Community
ASEAN	Association of Southeast Asian Nations
ASCC	ASEAN Socio-Cultural Community
CERTs	Computer Emergency Response Teams
COVID-19	Corona Virus Disease 2019
GDPR	General Data Protection Regulation
ICT	Information and Community Technology
IoT	Internet of Things
JCM	Joint Consultative Meeting
KPIs	Key Performance Indicators
ML	Machine Learning
MSMEs	Micro-, Small-, and Medium-Sized Enterprises
PPP	Public-Private Partnership
R&D	Research and Development
TVET	Technical and Vocational Education and Training
UBIN	Unique Business Identification Number
VSM	Virtual Student Mobility
WHO	World Health Organization

Executive
Summary
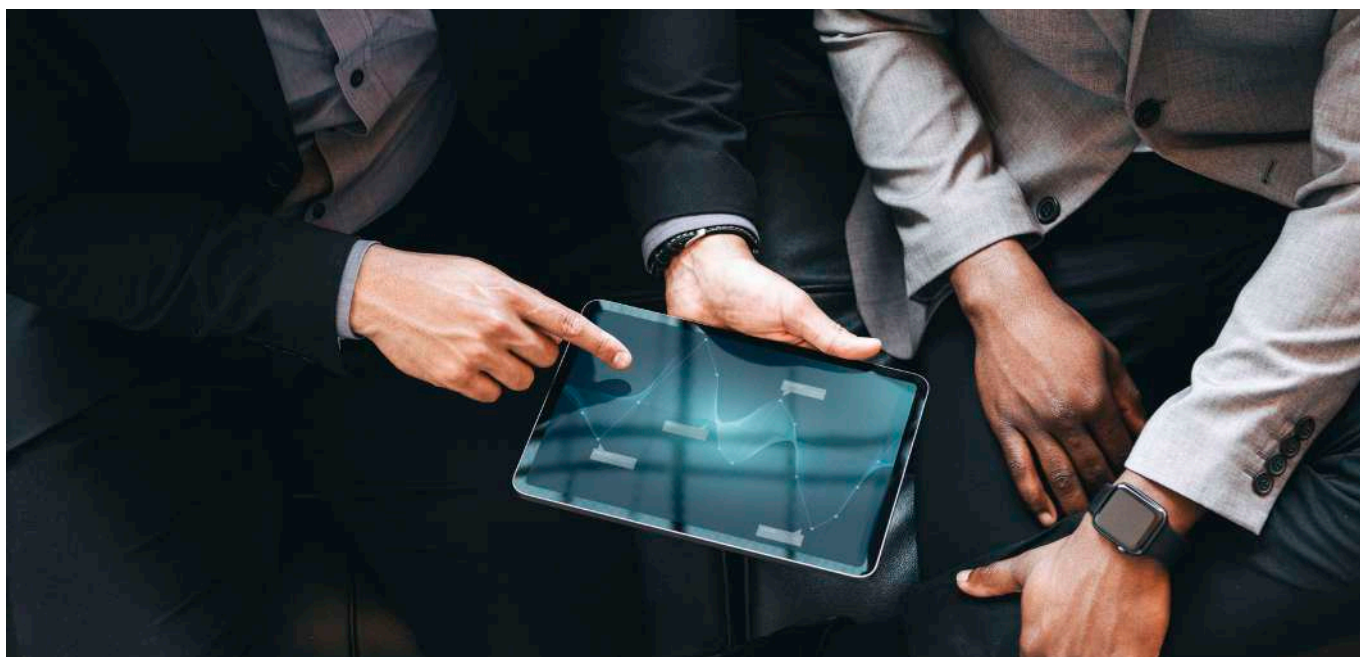
Dubbed as the inevitable convergence of the physical and digital worlds, the Fourth Industrial Revolution (4IR) is reshaping economies and societies around the globe. The opportunities arising from its evolution in ASEAN are limitless. The 4IR offers people the opportunity to grow better connected, helps economies grow and become more competitive, empowers ASEAN's citizens and improves their livelihoods through digitalising the provision of basic social services, and helps society decarbonise to meet sustainable development challenges confronting the region.

Turning these opportunities into reality requires that stakeholders work to develop and implement coordinated initiatives to embrace fully the 4IR while addressing potential risks that might arise. Leveraging the 4IR's technological advances and building on existing initiatives across the region, the Consolidated Strategy on the 4IR for ASEAN aims to provide policy guidance in building the ASEAN Digital Community across the three Pillars of ASEAN: the ASEAN Political-Security Community (APSC), the ASEAN Economic Community (AEC), and the ASEAN Socio-Cultural Community (ASSC).

With various 4IR-related initiatives already in place across the region, it is imperative that ASEAN's 4IR strategy further develop the visions of these initiatives and present a unified outlook to build the foundation of a Digital ASEAN Community. Accordingly, the Consolidated 4IR strategic framework for a Digital ASEAN Community has the following three visions:

1. A digital ASEAN that is open, secure, transparent, and connected while respecting privacy and ethics in line with international best practices;

2. A digital ASEAN that harnesses technologies to build a resilient, inclusive, integrated, and globally competitive economy; and

3. A digital ASEAN that embraces innovation in transforming society and contributes to social progress and sustainable development.

The visions for a Digital ASEAN Community will be pursued through three Focus Areas:

Technological Governance and Cybersecurity

This strategy identifies four components of technological governance and cybersecurity: good governance through e-government, technological governance, data governance, and cybercrime and cybersecurity legislation and commitment, across ASEAN. The four components are important to the development of 4IR, since governance gives business – and by extension people – a better and transparent understanding of regulations related to privacy and ethics, while cybersecurity initiatives provide a secure operating environment for providers and users alike.

Digital Economy

Digital economy refers to activities and transactions driven by the public and private sectors as well as citizens to produce, adopt, and innovate digital technologies and services in relation to socio-economic functions for enhanced wealth creation, productivity, and quality of life.[1] With new technologies enhancing trade facilitation in the region at unprecedented rates, ASEAN, as a digitally trading economy, is increasingly competitive and attractive in the global space. To further realise ASEAN's long-term vision in this regard, the region must capitalise and capture opportunities in line with five strategic priority areas: digital trade; Industry 4.0; service sectors of the new economy; smart agriculture; and micro-, small-, and medium-sized enterprises (MSMEs).

Digital Transformation of Society

At the pace that the 4IR is changing the region's socio-economic landscape, there is a risk of leaving certain social groups and populations behind. To achieve ASEAN's long-term vision in this regard, five strategic priorities have been identified: forward-looking human resource development, digital inclusion, expanded cultural development, social welfare and protection, and innovative environmental sustainability. These priorities will ensure coverage of all of ASEAN's socio-cultural aspects, ensuring that the Consolidated Strategy has a whole- of-society approach.

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[1] *https://mdec.my/about-mdec/what-is-digital-economy/*

To realise ASEAN's 4IR vision, six enablers have been identified to support and facilitate the fruition of strategic initiatives across all three focus areas:

Digital Infrastructure

Comprising the backbone of 4IR globally, digital infrastructure is a key enabler for 4IR in ASEAN. It is needed to ensure affordability and access for all, and will allow every facet of the ASEAN Community – from governments to business and individuals – to take part in the region's 4IR agenda. This becomes particularly critical in ASEAN Member States, where varying levels of readiness have been observed, highlighting the need for new digital infrastructure models to collectively improve spectrum availability and knowledge sharing in the region.

Capability Building

Capability building means ensuring that an adequate human resource pool is built and readied, so that potential talents in ASEAN are supported to their fruition. ASEAN must tap into its existing institutions and activate its deep pool of talent in the public and private sectors to promote continuous capability development within the broader ASEAN Community.

Institutions and Governance

Focusing on institutions will encourage Sectoral Bodies to exercise an even stronger sense of ownership and dedication to the initiatives, while Bodies that have yet to explore the 4IR will be encouraged to establish institutional setups that can close gaps for the seamless implementation of the Consolidated Strategy.

Resource Mobilisation

Building a digital ASEAN requires that resources be mobilised from multiple sources. For the strategic priorities with the largest requirements, ASEAN must explore how mutually beneficial partnerships – whether with development partners or the private sector – can support furthering the 4IR in the region.

Cooperation and Collaboration

Due to the cross-Pillar nature of ASEAN's 4IR strategy, cooperation within and among AMS, Sectoral Bodies across the three Community Pillars, and broader stakeholders is critical for realising ASEAN's 4IR vision. This means putting in place the right mechanisms to facilitate effective communication and collaboration in every area, so that the region's resources may be better optimised and reallocated to Community-wide capability development and capacity building.

Effective Monitoring

Finally, proper monitoring must be at the core of every initiative included in ASEAN's 4IR strategy. It is essential that progress be tracked in a comprehensive way so that ASEAN has access to Community-wide perspectives as it pursues the 4IR. An additional benefit will be the identification of gaps, overlaps, or inconsistencies that might lead to implementation challenges. Recommendations and follow-ups will be made, including through cross-Sectoral and cross-Pillar collaborations.

To operationalise the key focus areas, the following immediate, medium-term, and longer-term priorities for cooperation are proposed:

1) Immediate priority area for cooperation

Operationalisation of the 4IR Consolidated Strategy requires a cross-Pillar governing mechanism to coordinate implementation and monitor progress of related initiatives. This institutional mechanism might involve forming a cross-Pillar task force (e.g., the ASEAN 4IR Task Force Group, a.k.a., A4IR-TFG) under the Joint Consultative Meeting (JCM) that would include key representatives from the ASEAN Community, including the APSC, AEC, and ASCC. Tasked with coordinating with all Sectoral Bodies in implementing the Consolidated Strategy's priority initiatives, the task force would be responsible for monitoring and evaluating execution at the Focus Area-level, especially for key performance indicators.

2) Medium-term priority area for cooperation

ASEAN must regularly revisit the 4IR Consolidated Strategy, as well recommendations resulting from strategy development. This will involve a determination by the cross-Pillar task force of whether progress has been observed equally and equitably across all strategic priorities, and the flagging of implementation bottlenecks and other areas for improvement.

3) Long-term priority area for cooperation

ASEAN must consider reviewing in detail and upgrading the 4IR Consolidated Strategy every five years at least to incorporate new technologies, applications, and strategic priorities not covered sufficiently by earlier versions. This will ensure that the strategy remains relevant given rapid changes in the Digital ASEAN Community. At the same time, the 4IR Consolidated Strategy should also serve as a reference for developing the ASEAN Community's Post 2025 Vision, given the expected growing imperative of digitalisation and new technologies going forward.

Undoubtedly ambitious yet realistic, the implementation of the Consolidated Strategy toward a Digital ASEAN Community is one that is true and consistent with the underlying principles of the 4IR: elevating competitiveness, pushing for creativity and innovation, and creating opportunities. These are principles that are well-aligned with the characteristics of the ASEAN Community. With the right technologies and mechanisms in place, implementing such region-wide initiatives – starting with the Consolidated Strategy on the 4IR for ASEAN – should only become simpler, more effective, and more frequent in occurrence.

Chapter 1:

A Consolidated Fourth Industrial Revolution Strategic Framework for a Digital ASEAN Community

1.1. The Fourth Industrial Revolution (4IR) and what it means for ASEAN

The Fourth Industrial Revolution is reshaping economies and societies around the globe through unprecedented, rapid, transformative, and irreversible changes to the way we produce, work, live, and interact. It presents new opportunities and challenges to governments, businesses, and societies at large. For governments, the advent of the 4IR requires a paradigm shift in policy and regulatory responses, governance, financing, capability development, and infrastructure investment. For business, the 4IR presents opportunities to increase productivity, reduce labour costs, and introduce new business and market opportunities. Simultaneously, the 4IR offers a better experience to workers by saving time, improving their organisational skills and productivity, and providing a better work-life balance. For societies, the rise of the 4IR will require enhanced skillsets, trustworthy digital content, and up-to-date social welfare guidelines to ensure inclusivity in the digital space, while providing tools and solutions for improved social services delivery to different segments of society.

4IR adoption is moving at an accelerated pace globally. In ASEAN, the 4IR has been advancing, too, albeit more slowly.[2] However, there is still ample time for the region to catch up. By and large, the opportunities deriving from the 4IR in ASEAN are limitless, as new technologies allow people to stay connected, help the region's economies to grow and become more competitive, and empower ASEAN citizens and improve their livelihoods through digitalising the provision of basic social services, such health and education. More importantly, 4IR technologies offer opportunities for ASEAN societies to decarbonise as the region advances toward a zero-carbon future, which is key to the survival of humanity.

Figure 1.1. 4IR and its implications for the ASEAN Community

Physical	Digital

4IR is the convergence of the physical and digital worlds
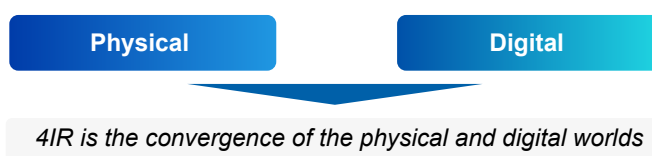
4IR
Implications

For Governments
The 4IR requires a paradigm shift in policy and regulatory responses, governance, financing, capability development, and infrastructure investment

For Business
The 4IR presents opportunities that allow for delivering improved offerings and operations to wider audiences. It requires platforms to generate the awareness and aid needed to overcome adoption barriers.

For Societies
The 4IR requires enhanced skillsets, trustworthy digital content, and up-to-date social welfare guidelines to ensure people's inclusion in the digital space, while providing opportunities to offer improved tools and solutions in different Sectors and societal spaces.

[2] *Refer to Annex 1 for details of global and regional trends for the 4IR.*

This potential, however, can be turned into reality only if all stakeholders in the region work to develop and implement 4IR initiatives in a coordinated way. Coordination might mean ensuring sustained investment in digital infrastructure to realise accessibility for all; building dedicated capability development programmes to ensure continued innovation on all fronts; or cultivating the right mind-set for institutions to mobilise resources in a timely and proactively way. ASEAN must realise a unified vision if the 4IR's benefits are to fully materialise. While a unified approach might be considered ambitious in conventional times, the near-limitless aspirations of the 4IR must be met by timely and ambitious action from governments in the region, especially in light of the rapid development of the Digital ASEAN Community.

This document presents ASEAN's strategy in approaching 4IR as a Community to maximise opportunities; maintain openness, transparency, and security; foster economic growth and connectivity; and promote inclusive and equitable economic development, all while bolstering numerous initiatives already underway.

1.2. Toward a consolidated 4IR strategic framework for a Digital ASEAN Community

Figure 1.2 ASEAN's 4IR Consolidated Strategy builds upon all ongoing and future initiatives
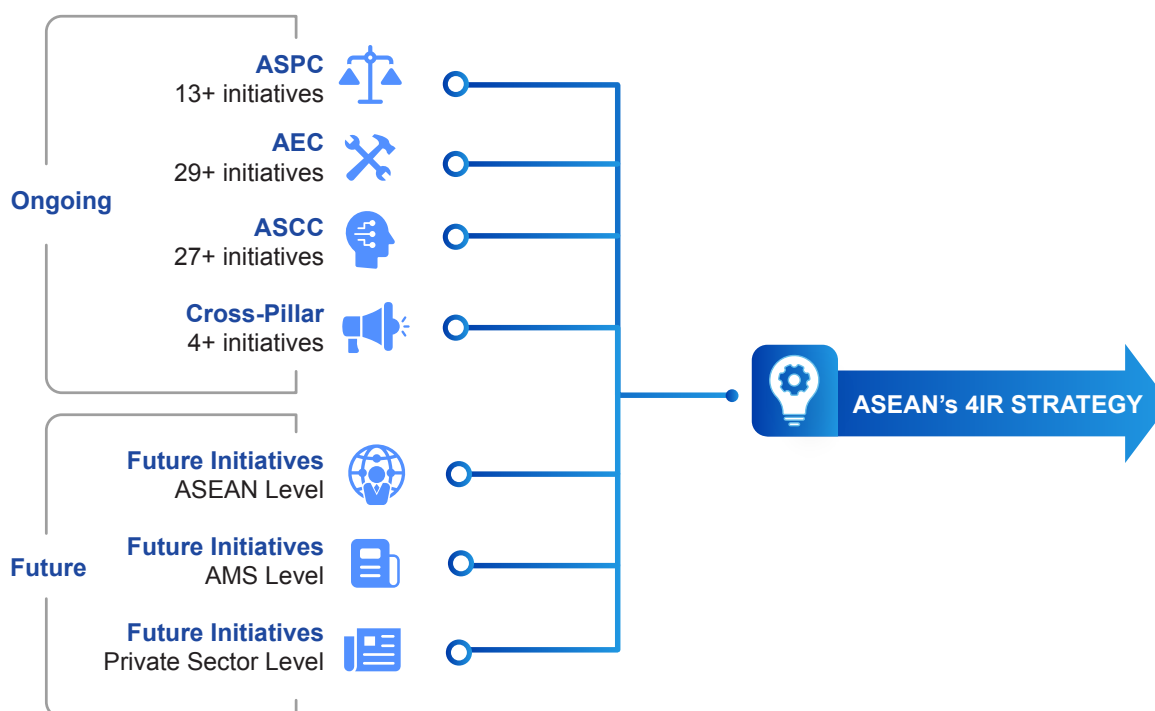
The 4IR first received political recognition at the 30th ASEAN Summit on 29 April 2017 in Manila, where ASEAN Leaders acknowledged a need for the region to be ready and able to maximise the opportunities of the 4IR, so as to foster the region's economic growth and promote inclusive and equitable economic development. Since then, ASEAN has seen a proliferation of 4IR-related initiatives and activities, with milestones such as the promotion of cybersecurity dialogues, cooperation, and policy development under the ASEAN Political-Security Community;[3] the launch of the ASEAN Declaration on Industrial Transformation to Industry 4.0 under the ASEAN Economic Community; [4] and the ASEAN Socio-Cultural Community's consideration of inclusive and sustainable work in the 4IR era.

Most recently, COVID-19 has hastened the region's digital shift, as digital technology has proven to be a critical driver of economic activity during the pandemic. To that end, the recently launched ASEAN Comprehensive Recovery Framework (ACRF), ASEAN's whole-of-community exit strategy to recover from COVID-19, identifies the acceleration of inclusive digital transformation as one of five Broad Strategies to take the region through the recovery process toward long-term resilience.

With more 4IR-driven activities under each Pillar, and a new reality of increased digital dependence by societies in ASEAN, greater synchronisation through a Consolidated Strategy is needed to drive 4IR in a region that has varying levels of digital readiness. A holistic approach will allow the 4IR to be a source of sustained economic growth as a stimulus for developing a competitive edge for the region.

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[3] https://asean.org/storage/2019/07/APSC-Outlook_Volume1_No1_2019.pdf

[4] https://asean.org/storage/2019/11/1-issued-ASEAN-DECLARATION-ON-INDUSTRIAL-TRANSFORMATION-TO-INDUSTRY-4.pdf

1.3. Principles in approaching the 4IR for ASEAN

To allow ASEAN to reap the full benefits of 4IR throughout the region, a Community-wide, cross-Pillar approach must be employed as a baseline. This includes using Community-wide rather than Pillar-specific lenses, in both substance and process, so that the ASEAN Community as a whole is reinforced and progresses with the 4IR.

Second, the Consolidated Strategy must be strategic and forward-thinking to provide guidance in identifying areas where an ASEAN-wide approach could generate the greatest value for the Community. It must create long-lasting impacts by inspiring a trickle-down effect in the socialisation and operationalisation of 4IR initiatives in ASEAN.

However, to ensure inclusivity in each AMS, the Consolidated Strategy must consider the varying levels of development between Member States. This would ensure the Consolidated Strategy's relevance to all AMS and to all of ASEAN's institutions, enterprises, and societies, allowing ownership and a sense of responsibility among stakeholders.

Finally, the Consolidated Strategy must be practical, actionable, realistic, and offer clear next steps to the whole ASEAN Community, allowing stakeholders throughout the region to identify concrete ways to translate the Strategy into action.

1.4. ASEAN's 4IR visions

With many 4IR-related initiatives already in place,[5] it is imperative that ASEAN's 4IR strategy take into consideration the visions of these initiatives to present a unified outlook and direction to form the foundation of a Digital ASEAN Community. Accordingly, the ASEAN Community envisions the following:

1. A digital ASEAN that is open, secure, transparent, and connected while respecting privacy and ethics in line with international best practices;

2. A digital ASEAN that harnesses technologies to build a resilient, inclusive, integrated, and globally competitive economy; and

3. A digital ASEAN that embraces innovation in transforming society and in contributing to social progress and sustainable development.
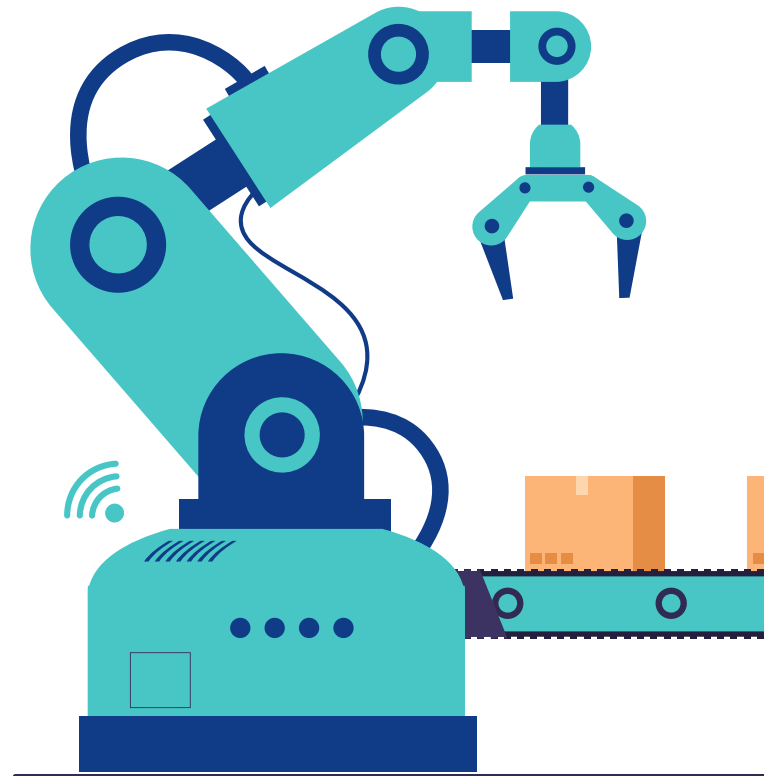
[5] Annex 2 provides details on ongoing 4IR-related initiatives across the three Pillars of the ASEAN Community.

1.5. ASEAN's 4IR focus areas

The vision of a Digital ASEAN Community will be pursued through three focus areas, namely:

1. **Technological governance and cybersecurity;**
2. **Digital economy; and**
3. **Digital Transformation of Society.**

These areas reflect the structure of ASEAN's Community Pillars. The first focus area, technological governance and cybersecurity, lays the foundations for a Digital ASEAN Community (APSC). The second area, digital economy, aims to maximise economic opportunities presented by the 4IR (AEC). The third focus area, Digital Transformation of Society, impels ASEAN to capitalise on the 4IR to address socio-economic challenges that persist in the region and ensure that no one in ASEAN is left behind (ASSC).

Technological Governance and Cybersecurity. This strategy identifies four components of technological governance and cybersecurity: good governance through e-government, technological governance, data governance, and cybercrime and cybersecurity legislation and commitment, across ASEAN. The components are important to the development of 4IR because governance gives business – and by extension, people – a better and transparent understanding of regulations, in particular as they relate to privacy and ethics, while cybersecurity provides a secure operating environment for providers and users.
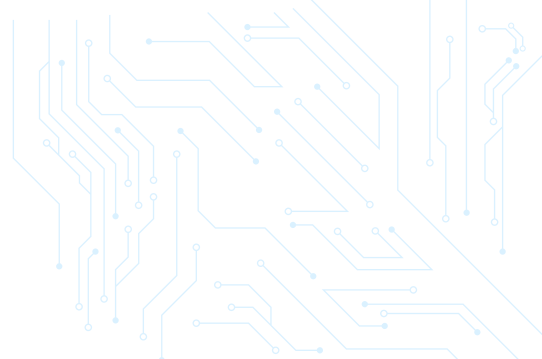
Digital Economy. Digital economy refers to activities and transactions driven by the public and private sectors, as well as citizens, to produce, adopt, and innovate digital technologies and services in relation to socio-economic functions for enhanced wealth creation, productivity, and quality of life.[6] With new technologies enhancing trade facilitation in the region at unprecedented rates, ASEAN, as a digitally trading economy, is increasingly competitive and attractive in the global space. To further realise ASEAN's long-term vision in this regard, the region must capitalise and capture opportunities in line with the Consolidated Strategy's five strategic priority areas: digital trade, Industry 4.0, service sectors of the new economy, smart agriculture, and MSMEs.

Digital Transformation of Society. Given the pace that 4IR has been changing the socio-economic landscape of the region, there is a real risk in leaving behind certain social groups and populations. To achieve ASEAN's long-term vision in this regard, five strategic priorities have been identified: forward-looking human resource development, digital inclusion, expanded cultural development, social welfare and protection, and innovative environmental sustainability. These strategic priorities will ensure coverage of all of ASEAN's socio-cultural aspects, ensuring that the Consolidated Strategy deploys a whole-of-society approach.

1.6. ASEAN's enablers in embracing the 4IR

Six enablers have been identified to facilitate the fruition of strategic initiatives across the 4IR's focus areas.

Digital Infrastructure

Comprising the backbone of 4IR globally, digital infrastructure is a key enabler for 4IR in ASEAN. It advocates for affordability and access for all, allowing every facet of the Community – from governments to businesses to individuals – to take part in the region's 4IR agenda. This is critical in AMS, where varying levels of readiness have been observed, highlighting the need for new digital infrastructure models that can collectively improve spectrum availability and knowledge sharing in the region.

Capability Building

Capability building means ensuring that an adequate human resource pool is built and readied, so that the potential and talents that ASEAN's peoples have been fostering come are realised. ASEAN must tap into existing institutions and activate its deep pool of talent in both the public and private sectors to promote continuous capability development in the broader ASEAN Community.

Institutions and Governance

Focusing on institutions will encourage Sectoral Bodies to exercise an even stronger sense of ownership and dedication to the initiatives, while those that have yet to explore the 4IR will be encouraged to establish institutional setups that can close gaps to ensure seamless implementation of the Consolidated Strategy.

Resource Mobilisation

A digital ASEAN requires that resources be mobilised from multiple sources. For the strategic priorities with the largest requirements, ASEAN must explore how mutually beneficial partnerships – whether with development partners or the private sector – can support furthering the 4IR in the region.

Cooperation and Collaboration

Due to the cross-Pillar nature of ASEAN's 4IR strategy, cooperation within and among AMS, Sectoral Bodies across the three Community Pillars, and stakeholders is critical for achieving intentional and consistent progress to realise ASEAN's 4IR vision. This means putting in place the right mechanisms to facilitate effective communication and collaboration in all areas, so that resources in the region may be better optimised and reallocated to Community-wide capability development and capacity building.

Effective monitoring

Finally, proper monitoring must be at the core of every initiative of ASEAN's 4IR strategy. It is essential that progress be tracked in a comprehensive way so that ASEAN has access to Community-wide perspectives as it pursues the 4IR. An additional benefit will be the identification of gaps, overlaps, or inconsistencies that might lead to implementation challenges. Recommendations and follow-up actions will be made, including through cross-Sectoral and cross-Pillar collaborations.

Chapter 2:

ASEAN's 4IR strategic priorities

This chapter takes a deep dive into ASEAN's 4IR strategic priorities, shedding light on the deeper rationales behind, and the desired outcomes for, each strategic priority.

2.1. Technological governance and cybersecurity

The 4IR is a key driver of socio-economic development. However, at the same time, cyber-attacks have been proliferating, while cybersecurity challenges and privacy and ethical concerns have been increasing as adoption rates rise and new technologies are introduced.

To maximise the 4IR's opportunities to foster regional economic growth and promote inclusive and equitable economic development, ASEAN must minimise or eliminate these potential risks, taking reference from global practices.[7] ASEAN's 4IR Vision for Technological Governance and Cybersecurity reflects this, aiming for a digital ASEAN that is secure, transparent, connected, and integrated, and that also respects privacy and ethics in line with in international best practices.

This 4IR Consolidated Strategy identifies four components for its focus on technological governance and cybersecurity:
1. good governance through e-government;
2. technological governance;
3. data governance; and
4. cybercrime and cybersecurity legislation and commitment.

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[7] https://www.weforum.org/centre-for-the-fourth-industrial-revolution

2.1.1. Mainstreaming good governance through e-government

Good governance is a fundamental building block of the greater adoption and promotion of 4IR opportunities for the public and private sectors. It comprises, according to the World Bank Worldwide Governance Indicators, six dimensions: voice and accountability, political stability and the absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption.[8]

E-government, also referred to as digital government, can enhance the six dimensions by enabling a more secure, transparent, integrated, and inclusive way to deliver public information and services. Concurrently, e-participation initiatives can use 4IR technologies to reach businesses, government entities, and citizens while improving government transparency and effectiveness and reducing costs. For example, the cost of digital government transactions are a fraction of physical ones. However, digital divides, such as a lack of access, infrastructure, and skills by poor and vulnerable populations, are obstacles to realising greater progress in e-government delivery and uptake.[9] The challenges of enhancing digital inclusion range from inadequate infrastructure to boosting skills and usage.[10] Overcoming these barriers and mainstreaming good governance via 4IR hold great promise for realising e-government's benefits, as illustrated by ASEAN's previous efforts

According to the United Nations E-Government Development Index, which comprises an Online Service Index, a Human Capital Index, and a Technical Infrastructure Index to assess overall readiness, leading countries have several things in common. Recent findings suggest leading countries demonstrate a strong support of digital policy and its coordination and implementation. These countries have taken a whole-of-government approach to create national e-government portals, in addition to citizen-centred portals focused on e-participation and open data. These characteristics are a good benchmark for nations working to implement e-government.

ASEAN bodies have previously acknowledged a need to enhance the capacities and capabilities of their civil services to maximise the possibilities of e-government.[11] However, promoting a culture of good governance and e-governance in the public sector must also extend to the population at large to ensure that people can take full advantage of e-government by providing feedback on services through e-participation. To meet international norms, a review of the level of enforcement of existing polices and continued improvement through e-government and e-participation initiatives is imperative for creating a more transparent and inclusive process, as well as for bridging digital divides.

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[8] *https://databank.worldbank.org/source/worldwide-governance-indicators*

[9] *https://publicadministration.un.org/en/Research/UN-e-Government-Surveys*

[10] *https://theinclusiveinternet.eiu.com/*

[11] *ASEAN Statement on Promotion of Good Governance: https://asean.org/asean-statement-promotion-good-governance-acceleration-agile-civil-service-digital-economy/*

2.1.2. Promoting technological governance taking into account global best practices

The importance of technological governance, which is defined by the OECD as 'the process of exercising political, economic, and administrative authority in the development, diffusion, and operation of technology in societies',[12] continues to rise as new and emerging technologies are introduced. In ASEAN, as elsewhere in the world, this primarily relates to the use of cloud computing and artificial intelligence (AI), including machine learning (ML),[13] in the adoption and use of 4IR technologies. In both instances, there are cybersecurity concerns and global benchmarks, including those from the Asia Cloud Computing Association[14] and the Oxford Insights Government Artificial Intelligence Readiness Index.[15]

New technologies can improve economies of scale and create new opportunities, ranging from business effectiveness to socio-economic development. AI, for example, which may contribute up to USD 15.7 trillion to the global economy by 2030, needs to be carefully implemented due to associated cybersecurity and ethical risks.[16]

Reviewing existing or potential regulations on new and emerging technologies, as well as creating initiatives to guide the future planning of the 4IR is important in order to seize the opportunities afforded by AI, big data, cloud computing, and other emerging technologies, digital applications, and platforms. Appropriate planning will create an open, secure, transparent, and connected technological environment that respects privacy and ethics in line with international best practices. Regulatory efforts to keep pace with international standards and the technological implementation of the 4IR will be key in creating ASEAN's digital ecosystem.

2.1.3. Observing data governance that respects privacy and security

The need to harmonise data standards across borders and improve data management and interoperability is increasingly important, given the rise of e-commerce. This has implications for cybersecurity and data privacy, as evinced by the European Union's adoption of the General Data Protection Regulation (GDPR) in 2016 (with implementation in 2018) to standardise personal and institutional data protection.[17] The Cross-Border Privacy Rules and Privacy Recognition Processors system of the Asia-Pacific Economic Cooperation (APEC) also protect the exchange of personal data by certified organisations in participating APEC economies. Harmonised protection regulations benefit businesses by creating an equal environment for competition and can attract international platform and service providers while protecting consumers, including those in ASEAN.[18]

Effective tools to ensure compliance are also necessary. Under the GDPR, for example, a fine of up to EUR 20 million (about USD 24 million), or 4% of annual global turnover, whichever is greater, can be levied for infringements, regardless of a company's origin. The World Bank Digital Business Indicators track progress in connectivity, data privacy and security, logistics, payments, and digital market regulations, highlighting their importance with regards to the balance between data governance and business opportunities.[19]

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[12] http://www.oecd.org/sti/science-technology-innovation-outlook/technology-governance/

[13] Refer to Annex 3 for definitions of various 4IR technologies.

[14] https://asiacloudcomputing.org/research/

[15] https://www.oxfordinsights.com/government-ai-readiness-index-2020

[16] https://www.ibm.com/downloads/cas/WWR6MK0X

[17] https://eur-lex.europa.eu/eli/reg/2016/679/oj

[18] https://aicasia.org/2019/07/03/new-aic-report-digital-platforms-and-services-a-development-opportunity-for-asean-3-july-2019/

[19] https://www.doingbusiness.org/; https://www.worldbank.org/en/research/brief/digital-business-indicators

2.1.4. Fostering cooperation and harmonisation in combating cybercrime and addressing cybersecurity

Cybersecurity addresses major threats to the region's digital development. Approximately USD 750 billion of value is at risk for listed companies alone, a figure expected to increase as the 4IR is implemented.[20] A lack of comprehensive cybersecurity policies across the region may therefore be costly to ASEAN business. The global benchmark for legislation and commitment is the ITU Cybersecurity Index, which measures a country's level of development or engagement in five areas: legal measures, technical measures, organisational measures, capacity building, and cooperation. Based on ITU's Global Cyber Index 2020, four AMS have been ranked in the top-30 globally: Singapore (4th), Malaysia (5th), Indonesia (24th), and Viet Nam (25th). [21]

In view of the region's increasing connectivity and rapidly developing digital economy, ASEAN reaffirmed the importance of a rules-based cyberspace as an enabler of socio-economic progress and agreed to confidence-building measures deemed essential for stability and predictability. [22] Despite differences in the level of implementation between AMS, steps have been taken to seize opportunities and address challenges stemming from the 4IR, although most existing approaches have been Sector-specific. A consolidated strategy to respond to cyber threats and a coherent, inclusive, and accessible regional cybersecurity plan as it relates to 4IR is needed.

[20] *Cisco: ASEAN Fourth Industrial Revolution, January 14, 2018*

[21] *https://www.itu.int/en/ITU-D/Cybersecurity/Pages/global-cybersecurity-index.aspx*

[22] *See, for example, Joint Statement of the 16th ASEAN Telecommunications and Information Technology Ministers meeting in 2016 at: https://asean.org/ joint-media-statement-the-16th-asean-telecommunications-and-information- technology-ministers-meeting-and-related-meetings/*

2.2. Digital Economy

Digital economy refers to activities and transactions driven by the public and private sectors to produce, adopt, and innovate digital technologies and services to further enhance wealth creation, productivity, and quality of life.[23] Growing 2.5 times faster than global GDP over the previous 15 years, the digital economy had most of its value produced in only a few economies – the United States (35%); the European Union plus Iceland, Liechtenstein, and Norway (25%); China (13%); and Japan (8%) – countries that have reaped the most digital dividends (e.g., 'net 4IR value additions/benefits'). [24]

ASEAN's digital economy has been shaped by the rapid growth of internet users, and benefits from the region's large and literate young population and growing middle-income class. The internet economy in ASEAN's six largest markets – Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Viet Nam – is estimated to reach USD 309 billion by 2025, up from USD 32 billion in 2015.[25] With the rest of the region likely to experience similar growth, the ASEAN economy is poised to be accelerated by the 4IR. With new technologies to enhance the region's trade facilitation at unprecedented rates, ASEAN, as a digitally trading economy, will become increasingly competitive and attractive in the global space.

ASEAN's strengths and gaps in the digital economy focus area span three strategic priorities: digital trade; Industry 4.0 (advanced manufacturing); and the services sectors of the new economy. This area also gives special focus to two areas important to the AEC: smart agriculture and micro-, small-, and medium-sized enterprises (MSMEs).

2.2.1. Maximising the potential of digital trade

As digital transformation accelerates, digital trade, which refers to 'digitally-enabled transactions of trade in goods and services that can either be digitally or physically delivered',26 is gaining momentum and changing the way goods and services are traded. Digital trade involves at least four dimensions: digital goods and services (e.g., apps or software); tangible goods and services delivered digitally (e.g., online grocery shopping); digital enablers of trade transactions (e.g., e-payment solutions, single window initiatives, e-signatures, digitalisation of trade documents); and emerging transformative digital technologies (e.g. AI or blockchain). [27]

Digital trade allows firms to deliver products and services to a larger number of customer around the globe, and thus increases the scale, scope, and speed of trade. At the same time, digitalisation reduces the cost of international trade by allowing firms to use new and innovative digital tools to overcome physical barriers, to better access financing and banking facilities, and to enable better collaboration between firms in different countries. New technologies are also changing the way goods and services are being produced and supplied, blurring distinctions between goods and services, and introducing new combinations of goods and services and new modes of delivery.

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[23] *https://mdec.my/about-mdec/what-is-digital-economy/*

[24] *Massachusetts Institute of Technology (MIT) Technology Review, 2017*

[25] *https://www.bain.com/globalassets/noindex/2020/e_conomy_sea_2020_report.pdf*

[25] *Assessment of ASEAN Readiness for Industry 4.0 by the ASEAN Secretariat, July 2018*

[26] *https://www.oecd.org/trade/topics/digital-trade/; Note, however, despite this, there are different definitions to the term digital trade. The definition used here is one of widely recognised definitions of the term*

[27] *https://www.dfat.gov.au/sites/default/files/australia-singapore-digital-trade-standards-presentation.pdf*

Underpinning the digitalisation of trade is the growing e-Commerce economy, which is projected to top USD 4.9 trillion globally,[28] including USD 67.7 million in ASEAN,[29] in 2021. While small compared to other economies, e-Commerce in ASEAN is promising. By leveraging 4IR technologies, ASEAN can capitalise enormous e-Commerce growth opportunities and innovate beyond the current models of the digital economy. The benefits of e-Commerce will create immense business opportunities for MSMEs and contribute to social cohesion and regional integration.
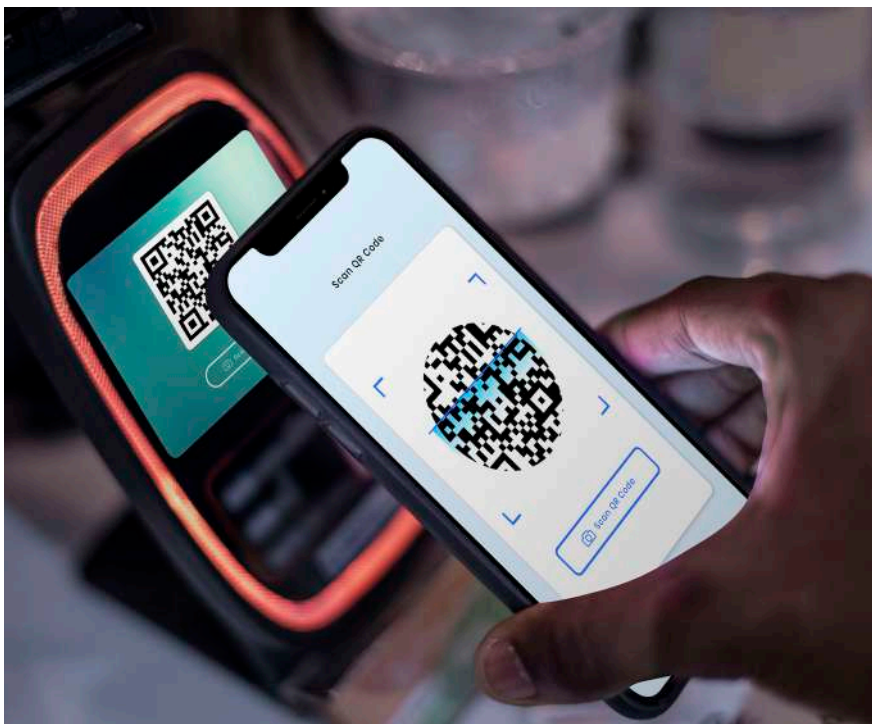
Digital trade can also reduce transaction and logistics costs. To this end, the application of new technologies in ASEAN's trade facilitation initiatives is critical for boosting trade and supporting AMS to fully exploit the benefits of ASEAN's markets. To identify key digital trade initiatives that might be rolled out, current challenges need to be addressed (e.g., disjointed trade digitalization efforts and an inability of platforms to connect with each other), which leads to complicated and costly navigation for both governments and businesses alike. For the latter (i.e., those that relate to MSMEs), which leverage manual-based processes

and vast amounts Digital trade can also reduce transaction and logistics costs. To this end, the application of new technologies in ASEAN's trade facilitation initiatives is critical for boosting trade and supporting AMS to fully exploit the benefits of ASEAN's markets. To identify key digital trade initiatives that might be rolled out, current challenges need to be addressed (e.g., disjointed trade digitalization efforts and an inability of platforms to connect with each other), which leads to complicated and costly navigation for both governments and businesses alike. For the latter (i.e., those that relate to MSMEs), which leverage manual-

based processes and vast amounts harmonisation. It is imperative to have the right standards to regulate and connect the various platforms and processes in line with technical, legal, and governance requirements. Various regional initiatives are currently taking place vis-à-vis piloting digital currencies and blockchain-based technologies that will accelerate trade digitisation and drive interoperability and legal harmonisation in the region. [30]

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[28] *https://www.statista.com/statistics/379046/worldwide-retail-e-commerce-sales/*

[29] *https://www.statista.com/outlook/243/643/ecommerce/southeast-asia*

[30] *Note the arrangement between the Digital Standards Initiative, an independent entity overseen by the International Chamber of Commerce; the Government of Singapore; and the Asian Development Bank to develop open trade standards to facilitate interoperability among various blockchain-based networks and technology platforms that have surfaced over the past few years. Another key reference is the United Nations Commission on International Trade Law, which has developed relevant model laws and cross-border legal frameworks to facilitate international e-commerce and digital trade. These frameworks consist of model laws, conventions, legal and legislative guides, and rules and practice notes to advance the progressive harmonisation and modernisation of the law of international trade in relation to e-commerce and digital transactions, digital contracts, electronic transferable records, electronic authentication and signature methods, online dispute resolution, and arbitration, among other things.*

2.2.2. Embracing digital technologies for Industry 4.0

Mechanisation, electrification, and computerisation have influenced ASEAN radically. Industry 4.0 is the next logical step for ASEAN, and this can be understood as the full integration and digitalisation of the region's industrial value creation.

ASEAN can leverage Industry 4.0 to boost its competitiveness by increasing innovation, moving up value chains, creating higher skilled jobs with improved workforce capabilities and skills, lowering capital needs, and increasing product customisation. Industry 4.0 can help emerging ASEAN Member States industrialise at the local level by enabling more win-win cooperations with the industrialised world using the principle of co-localisation. In the context of advanced manufacturing, Industry 4.0 opens up opportunities for MSMEs in ASEAN in specialised technologies, such as sensors, robotics, high-performance computing, control systems, platform technologies, additive manufacturing, and sustainable and green technologies, to name a few areas. Industry 4.0 will reduce the impact of high labour costs and result in a reduced workforce through automation, autonomy, and efficiency gains.

To promote Industry 4.0, however, enabling policies and tools are needed, such as innovation systems, research and development, standards and conformance, intellectual property, competition, consumer protections, and human capital, among other things. Consulting with the private sector will be key, as it is the main actor in Industry 4.0. To move forward, there must be a clear alignment on the Industry 4.0 vision and a common strategy that is in line with 4IR modernisation. It is also imperative to secure funding for programmes at the ASEAN and AMS level, as well as for public-private partnerships (PPP) that centre on the technologies in the context of advanced manufacturing. Strong commitment and support from ASEAN governments and the private sector to high-tech development and spending, such as grants, in-house training, incubators, and technology transfers, would further offer incentives to companies and organisations to embrace the early adoption of new technologies.

2.2.3. Enhancing Services Sector competitiveness in the new economy

As the ASEAN economy shifts to the digital world, so must the services that support the region's output. In 2019 alone, the Services Sector contributed more than half, or 50.6%, of the region's total GDP of USD 3.2 trillion, and 46.9% of total employment in the region. Services comprised ASEAN's largest share of FDI inflows in 2020 at 80.5%, or USD 110.5 billion.[31]

ASEAN has long sought to enhance its cooperation in services through the ASEAN Framework Agreement on Services, signed in 1995,[32] which calls for a gradual removal of formal restrictions in the services market through packages of Services Commitments. Services integration has recently been elevated by the full signing of the ASEAN Trade in Services Agreement in 2020, which covers domestic regulations and facilitates an obligation to transition to negative listings, while incorporating Sectoral annexes on Financial Telecommunication and Air Transport Services. As the 4IR both digitalises and revolutionises traditional services such as health care, banking, retail, logistics and distribution, and tourism, among others, and gives rise to new services sectors or sub-sectors, it is critical that this new dimension be understood in greater detail, in particular with regard to how it might further contribute to the free flow of services.

In the Services Sector, six sub-sectors are a priority:
1. **Health Services,**
2. **Finance,**
3. **Logistics,**
4. **Education,**
5. **Tourism, and**
6. **Other Professional Services.**

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[31] *ASEANStats*

[32] *https://asean.org/storage/2012/05/AFAS-10.pdf*

2.2.3.1.
Health services technology

Despite high economic growth and health expenditure increases in Southeast Asia, health carematurity levels vary greatly within ASEAN. The increasing prevalence of communicable and chronic diseases, combined with a rising aging population, increases the burden of disease prevention and health careprovision for governments. While health carein both public and private systems are in high demand, healthcare's GDP share and doctor ratios remain low. Tackling these challenges requires more efficient health systems with greater accessibility and enhanced regional cooperation.

In the context of 4IR, health caretechnologies are essential for increasing the quality of health careservices, simplifying health caredelivery, promoting equal access to health carewithin ASEAN, enhancing resource allocation efficiency, and ultimately mitigating health risks to the population. The private sector's expertise in the application of specialised technologies[33] will contribute to a more robust health system. ASEAN Governments can additionally explore sustainable funding systems and explore fiscal measures to promote healthy lifestyles. Taken together, efforts must be made to expand health careservice coverage to underdeveloped areas and to address the most urgent health issues through platform technologies that emphasise accountability and convenience, enable much-needed services, and deliver solutions speedily, efficiently, and at scale. As such, there should be greater coherence between national and regional efforts to complement the rollout strategies on leveraging the 4IR to improve health careservices and systems.

[33] *Examples: AI-enabled forecasting in new drug development, precise diagnostics based on medical data tracking via telemedicine, additive manufacturing in printing tailored biomaterials, and robotics services for neuroscience applications*

[34] *https://fintechnews.sg/43665/funding/south-east-asia-fintech-investment/https://blog.dealroom.co/the-future-of-fintech-in-southeast-asia/#:~:text=Fintech%20is%20Southeast%20Asia's%20largest,grown%20by%207x%20since%202015*

[35] *https://theaseanpost.com/article/banking-southeast-asias-unbanked-0*

2.2.3.2.
Financial technology (fintech)

With growing markets, talent, capital, and relative political stability, ASEAN is positioned to ride the global fintech wave. Fintech companies in ASEAN witnessed a higher growth rate of venture capitalist investments compared to the global context. There is at least USD 10 billion of unrealised value in venture capital- backed fintech start-ups in ASEAN. ASEAN startups have a faster journey to exit than their peers in Europe or the US. In fact, 76% of exited startups were founded one to six years ago, compared to 53% in Europe and 46% in the US. In 2019, USD 1.6 billion was invested in fintech startups, compared with only USD 0.2 billion five years ago. Investment in Southeast Asian fintech startups, driven by foreign investors, has grown seven times since 2015.[34]

In the region, fintech is the largest venture capital investment category by number of backed ventures. However, with only 27% of ASEAN's 650 million population banked, reaching out to the unbanked and increasing financial inclusiveness remains on top of ASEAN's digital agenda.[35] Fintech, as one of the digital technologies of the 4IR, can be an important enabler of financial inclusion. It forms one of the three Pillars of ASEAN's financial integration agenda. Recent advancements in fintech cover several areas including banking, insurance, regulatory compliance, lending, wealth management, equity crowdfunding, and blockchain. Innovative 4IR technologies will enable the reach of payment mobile solutions to include more income groups, improve access to MSME financing, and promote intra-regional trade through applications.

To achieve greater financial inclusion and integration, relevant infrastructure must be in place. By increasing data affordability and accessibility, consumers can get on board and benefit from fintech products. In addition, enabling regulatory framework and space is also needed, such as the use of a sandbox approach, while risks will be managed by the better convergence of regulatory and supervisory technology. Moving forward, increasing cooperation between banks and fintech companies requires Open Banking initiatives to provide convenience, reduce costs, offer more personalised services, and enable improved decision making to improve financial services for citizens across ASEAN.

2.2.3.3.
Logistics technology

As an important part of global supply chains and trade flows, ASEAN will continue to enjoy a logistics boom in the near future. Growing affluence in the region coupled with the trend of offline-to-online have resulted in new opportunities for business model innovation rooted in supply chains.

The Logistics Sector in ASEAN is primed for technology disruption. The growth of logistics companies in ASEAN has been matched by infrastructure challenges in terms of scale, network, and innovation. The market structure of the Sector is dominated by third-party firms that are asset heavy and face labour-intensive challenges. The complex geography and dispersed locations of gateways make last-mile delivery services inefficient and have driven up transportation costs in the region.

With 4IR technologies, the Logistics Sector can benefit from shorter delivery times and reduced warehousing costs through three-dimensional (3D) printing by generating parts on demand. Some finished goods that were previously produced in other markets can be manufactured locally. 3D printing also allows lower inventory levels and customised builds, potentially creating great advantages for MSMEs. Meanwhile, freight forwarders can locate goods and trace in-transit status with higher efficiency via radio-frequency identification and the Internet of Things (IoT), whereas the exchange of sensitive data can be secured by blockchain techniques. Packages can be delivered precisely at speed using autonomous vehicles and augmented reality can enhance and optimise warehousing. Overall, logistics processes have the potential of becoming semi-automatic.

Trade-facilitative instruments will be helpful for improving trade efficiency. ASEAN will need to promote the improvement of end-to-end logistics operations by accelerating the pace of adopting logistics technologies, infrastructure development, and the growth of urbanisation in the region. The public and private sectors should connect to better match supply and demand and bring greater transparency and convenience to consumers.

2.2.3.4. Tourism

Traditionally, tourism has been a key growth sector in ASEAN. As a culturally diverse and fascinating destination, ASEAN continued to see an increase in visitor arrivals, from 135.3 million in 2010 to 143.5 million in 2019. Growth in tourism has had positive economic impact on the region. Despite the COVID-19 pandemic, the Tourism Sector made a significant contribution to ASEAN's economy in 2020: USD 180.1 billion (5.8% of GDP), which was of course much lower than the USD 380.2 billion (12.1% of GDP) in 2019, and created 35.5 million jobs (11.2% of total employment) in 2020, as opposed to 42.3 million jobs (13.3% of total employment) in 2019.

Although tourism has been hit hard by the COVID-19 pandemic, the Sector continues to demonstrate high potential for the region. ASEAN's continued focus on sustainability and community involvement has been identified as a key contributor to the long-term potential of the Sector. The ASEAN Comprehensive Recovery Framework (ACRF) has identified the acceleration of the Tourism Sector's recovery as one of its key priorities.

Broadly speaking, digital tourism relates to the use of digital technologies to enhance the tourist experience before, during, and after a trip. Given rising uncertainties during the pandemic, ASEAN has expedited various initiatives using its digital platform, including posting travel restriction and quarantine information on the ASEAN Tourism Website, as well as optimising ASEAN Tourism social media channels to share Member States' private sector initiatives to give reassurance to travellers and business partners alike in future travel planning.

ASEAN can further accelerate digitalisation in the Tourism Sector by determining an appropriate strategy for the deployment of digital tools to organise, manage, and create enhanced experiences for travellers and local tourism communities. This is already being piloted in some AMS, where digital tourism has been leveraging digital tools to change how ASEAN citizens travel and how the Sector itself operates.

2.2.3.5.
Other professional services

As the digital economy evolves, ASEAN is experiencing a growth in demand for professional services firms that provide tailored solutions to commercial systems and consumer markets, particularly in business consulting, accounting, tax and legal services, advertising, marketing, customer service, and computer-related services. Considering the increased need for high-value talents, underinvestment in human capital remains a major challenge for ASEAN.

Professional services that adopt 4IR technologies will be able to turn data into business insights and feed industry players with new business models. With upgraded human capital capabilities, ASEAN can expand from labour-intensive professional service sectors to more high-value, high-expertise areas such as legal services, cybersecurity, fraud analytics, banking insurance, equity research, and web design and development. With regard to legal applications, for example, technology can be leveraged to bridge ASEAN's low lawyer-to-population ratio (1:2599). So-called LegalTech would enable lawyers to provide more efficient and modern legal services to a wider population, while law firms could leverage innovative technologies such as AI algorithms, advanced document analytics, and knowledge management platforms, to standardise and automate labour-intensive practices.

2.2.4. Special focus 1: Stimulating the adoption of smart agriculture

Agriculture plays a crucial role in ASEAN's economy, comprising between 10% and 12% of ASEAN's GDP over the last decade. It is the main source of food, income, and employment for the region's rural populations. However, improvements in agriculture and land use have been deemed necessary, as these are fundamental for achieving food security, poverty alleviation, and sustainable development.

In light of the 4IR, smart agriculture is imperative for improving agricultural yields and traceability, reducing potential environmental risks, and automating field management, among other things. Ultimately these things will enhance efficiency and agricultural productivity, while saving time and costs across agricultural value chains.

Moving forward, there is a need to have focused policies on smart farming and technology-led innovation to transform traditional practices and raise productivity. It is critical to introduce incentives to alleviate the high cost of technologies and mitigate low affordability, thus ensuring that a vast majority of farmers can access technologies. Governments can drive incentive programmes in the form of grants, subsidies, preferential loan rates, usage-based payments, or tax deductions in concert with strong private sector support. In addition, there will be a need for training and skills development programmes to facilitate the understanding and application of relevant technologies to optimise their deployment and maximise their effects. This would inherently foster support from the grassroots, more specifically from local, sole smallholder farmers, to ensure the equal distribution of technologies to all farming segments.

2.2.5. Special focus 2: Digitally enabling MSMEs to be globally competitive

Rising consumer demand, changing manufacturing supply chains, and digital finance will open new opportunities for MSMEs that make up much of the corporate landscape in ASEAN. Hence, integrating MSMEs into ASEAN's digital and 4IR agenda is imperative, as this segment forms the backbone of ASEAN's economy. To illustrate, in the European Union, SMEs comprise 67 percent of employment and generate 60% of GDP; whereas in ASEAN, MSMEs comprise between 51.7% and 97.2% of total employment, but only generate between 30% and 53% of GDP. If nothing is done, this could lead to unintended consequences, such as increased unemployment, lower productivity and efficiencies, and income inequality.

One desired outcome is to foster innovation among and within MSMEs by promoting the use of e-Commerce platforms to encourage market expansion, enable access to innovation and technologies, allow seamless access to funding, and leverage digital capability building. The end goal of these enablers is to ensure that MSMEs can adopt disruptive technologies to achieve efficiencies, improve competitiveness by providing customised goods or services, access new markets to facilitate cross-border trading, and cater to increased customer demands while ensuring consumer protection.
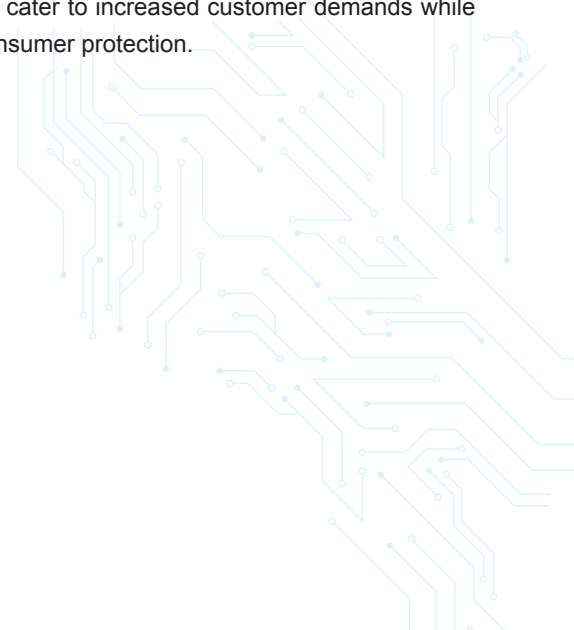
2.3.
Digital transformation of society

With over 650 million inhabitants (8.5% of the world's population) in ten Member States that have achieved varying degrees of development, 11 official languages, hundreds of dialects, and 4.5 million km2 of land mass; ASEAN requires a digital economy that is culturally and ethnically diverse. There is a need for a holistic response to technology's already strong presence in society – one that cuts across all its socio-cultural aspects, such as education, sports, the arts, culture, social justice, and the environment. At the pace that 4IR has been changing the socio-economic landscape globally and in the region, the risk of having certain social groups and population clusters left behind is as real as ever.

The digital transformation of society refers to social, cultural, and organisational changes in society realised through the smart integration of digital technologies, processes, and competencies across all levels and functions.

2.3.1. Promoting forward-looking human resource development through formal and continuing education

Human resources development is an important investment in an economy's talent base that will ultimately produce a stronger and more effective workforce. When an economy or society develops its talents, it is strengthening its assets and making these talents even more valuable. This makes forward-looking human resource development a strategic priority for ASEAN, referring to learning interventions at the various stages of education, namely early, secondary, higher, vocational, and continuing education programmes. It is imperative for digital transformations to occur at every stage to ensure that the future of a digital ASEAN is people-oriented, people-centred, and in line with the ASEAN Vision 2025 and beyond. The future that is fostered by a digital ASEAN must promote safety and an ethical, digitally savvy society that does not jeopardise ASEAN's cultures, ethics, and values.

2.3.2. Establishing digital inclusion to minimise digital divides

With the evolution of new technology, the 4IR aims to increase labour productivity by a massive exploitation of technology and reduce the region's need for a semi-skilled and unskilled workforce. ASEAN nations excel in different sectors, most of which are labour intensive. Multinational companies that have technology but need low-cost labour can excel and achieve growth in ASEAN, which is open to foreign direct investment.

2.3.2.1. Youth

ASEAN must not miss an opportunity to foster a future-ready generation of leaders and a workforce that can contribute to regional and global development, as well as ASEAN integration.

With technological disruptions already significantly affecting younger workers, it is increasingly alarming that the United Nations International Labour Organisation additional. ly cites that the career prospects of those aged 18 to 29 years old have been the ones greatly affected by the COVID-19 pandemic. This calls into question the readiness of youth to participate fully in the 4IR, given persistent challenges, such as the middle-income trap and a continued focus on efficiency, rather than innovation. Considering that youth are generally already adept with technology, the first step is to transform this agility into something productive for the economy, society, and environment. This is in line with the priorities of the forthcoming ASEAN Work Plan on Youth 2021-2025, which includes activities to promote innovation; health and well-being in mental, emotional and social contexts; and increased employment and opportunities, among other things. This means gradually addressing youth skill gaps, including in technical IT skills, 21st century skills (e.g., problem solving, critical thinking, fostering creativity and innovative mind-sets), and building proficiencies in new technologies (e.g., AI, big data, etc.).

There is also a growing need to emphasise adult training and lifelong learning. Given disruptions to the job market brought about by the 4IR, many workers in the future will need to acquire multiple jobs. Online education and training will provide youth access to the educational opportunities and multiple skills required to thrive under the 4IR. Likewise, more effort must be made to expand existing credit transfer systems between universities in ASEAN to help build the cross-border personal and professional networks that are crucial for tomorrow's workers.

2.3.2.2. Women

In ASEAN, 39% of technology majors are women, compared to 56% in other fields, while in the workforce, women comprise only 32% of the region's Technology Sector, compared to their share of 38% of ASEAN's workforce.

According to a study by the McKinsey Global Institute, global GDP could increase by USD 28 billion by 2025 if women could participate in the economy on an equal footing with men. Moreover, the United Nations Industrial Development Organisation stated that women could enable greater economic growth if given greater access to the digital economy through capacity-building and training programmes, networking, and knowledge sharing.

To achieve this, women must be equipped with the digital skills needed to realise the technological and economic restructuring of society that is underway. To ensure that women are not under-represented or excluded from technological fields, investment must be made in women's technopreneurship, their access to continuous learning must be increased, and remote-working platforms created so that barriers to equal opportunities are reduced for women, especially those from rural and underserved communities. Additionally, efforts are needed to investigate the intersection of gender equality and the 4IR to explore the implications of the 4IR and disruptive technologies for women and to find suitable solutions to strengthen women's economic empowerment in ASEAN.

2.3.2.3. Senior citizens

The proportion of the ASEAN population aged 60 or above was 11.0% in 2019. According to the World Health Organization (WHO), this figure will increase to 13.7% by 2030 and 20.3% by 2050. Given their low use of computers and the internet, senior citizens do not fully capitalise on 4IR innovations, such as online health careand digital social services. Developing basic digital literacy skills for senior citizens and their caregivers should be promoted, especially as technology continues to present ways to improve their well- being. This can be achieved through smart assistive equipment or assistive wearable technologies, such as wheelchairs, autonomous vehicles, or remote caregiver platforms, thereby resulting in more accessible and more efficient senior care services overall.

In all cases, digital training programmes will be necessary to improve digital literacy and assist older workforce members in re-orienting their mind-sets to technology and providing them with needed skills to participate in the 4IR. Work is also needed to ensure that the 4IR will ensure that older persons have better access to the physical environment, transportation facilities, information and communications, social protection schemes, as well as other social facilities and services.

2.3.2.4. Individuals with disabilities

Approximately 15% of the world's population live with some form of disability, including 90 million people in the region. ASEAN has an action plan to achieve disability inclusion that includes expanding anti-discrimination laws and the means for independent living to develop accessible education, healthcare, and especially work.

As persons with disabilities (PWD) often have difficulties accessing jobs in the Production Sector, discussions must take place to mainstream their rights and to assess the tools, machinery, and technologies that might be adopted to address their challenges. These dialogues must eventually lead to solutions that will enable PWD to rightfully become full-fledged workers or technopreneurs in society. As in the case of senior citizens, efforts are needed to explore how the 4IR might improve the access of PWD to the physical environment, transportation facilities, information and communication, social protection schemes, as well as other social facilities and services.

2.3.2.5. Informal or gig economy workers

The gig economy is a labour market based on short-term, freelance, or contract jobs completed by people from anywhere in world as individuals. The estimated number of gig workers in Southeast Asia is more than 100 million. Informal or gig workers are usually not protected by their effective employers. This includes those who lost work opportunities during the pandemic. No specific government assistance was available to support them, despite the pandemic's severe economic impact. The 4IR's contribution to such workers should therefore be human-centric, ensuring that labour rights are not compromised after the shift to digital avenues.

Gig workers deserve protection and should also be treated as part of the formal workforce. Lacking both formalisation and protections, gig workers have no motivation to convert their opportunities into long-term or sustainable professions, while at the same time they are exposed to the risks of unemployment. To help counter this, adequate measures, such as laws, must be formulated to protect gig workers from exploitation, such as non-payment for their services; allow access to insurance, medical benefits, and retirement savings programmes; support them in connecting with other market stakeholders; facilitate more seamless processes to manage obligations such as tax payments; facilitate opportunities for training, upgrading skills, learning, and development; and allow gig workers to organise to advance their common interests, among other things.

2.3.2.6. Other marginalised groups

It is important for other marginalised, poor, or vulnerable groups in ASEAN to participate better in socio-economic opportunities by capitalising on the 4IR. A critical first step toward inclusion is working to develop policies and programmes that help marginalised individuals (e.g., urban, rural, indigenous, and underserved communities) gain access to basic connectivity and skills development resources. This might include digital education systems, training, and certifications for highly valuable skills in the context of 4IR cybersecurity, IoT, and cloud computing, on top of basic digital literacy. Accordingly, internet accessibility must be prioritised for the marginalised, poor, and vulnerable so they might participate democratically, engage in online commerce, and learn or offer high-value skills such as technopreneurship.

2.3.3. Fostering expanded cultural development, especially of digital content, sports, culture, and arts

Expanded cultural development refers to the strategic planning and implementation of initiatives to explore and harness the local community's unique assets. To achieve its full growth and economic potential, ASEAN should give priority to sectors involving digital content, sports, culture, and the arts to bring socio-economic benefits to the ASEAN Community.

2.3.3.1. Digital content

Digital content is any content that exists in the form of digital data. It includes information that is digitally broadcast, streamed, or contained in computer files. In ASEAN, social media penetration rates exceed 60%, while about 80% of consumers get information on products or services from social media. This proliferation exposes ASEAN citizens to a wide variety of information, which inherently involves false information as well.

In embracing the 4IR, citizens must have sufficient digital literacy to properly identify and handle the false information that they encounter. Measures must be in place to govern and oversee digital platforms so that the environment that they support remains open, ethical, trustworthy, and protective of people's well-being. An environment should be cultivated to encourage institutions and other stakeholders (e.g., MSMEs) to only develop quality digital content for the purposes of entertainment, inspiration, education, advocacy, marketing, and sales. To achieve this, education for digital skills, such as web development, social media marketing, and responsible digital content development, among other things, should be available and accessible to all and must be complemented by policies and regulations that maximise the trust of digital products and services by society.

2.3.3.2. Sports

Sports have been used as a platform to foster interaction and relationships, encourage healthy lifestyles, and promote a culture of excellence in the region. In advancing 4IR technologies, society's preference for recreation has evolved and traditional sports are on the verge of disruption. Whereas traditionally, a large share of the global population has been involved in traditional sports, this share has decreased as more individuals adopt e-sports, video games, and other digitally enabled pastimes. The intensity of this disruption has been accelerated by the COVID-19 pandemic, which has led to the cancellation of many sporting events in ASEAN. In response, and to ensure that sports remain germane to regional socio-cultural development, some 4IR priorities will be aligned with those of the ASEAN Sports Sector in the next five years. Specifically, there must be an examination of how ASEAN might collaborate and provide platforms to exchange experiences in the Sports Tourism and Sports Industry, as we await for the post-pandemic recovery.

Data analytics is changing how sports is played, streamed, viewed, and consumed across the world, including ASEAN. For instance, on-demand data-driven motion analysis; virtual assistive refereeing; such as those adopted by FIFA (International Federation of Association Football); and artificial intelligence are refining how traditional sports are played and judged. AI simulations help athletes pursue mental games, such as chess, to train more effectively and at a much faster pace, while cloud-based applications allow competitions to be held virtually. Equally important are organised video gaming events and tournaments, or eSports, which have grown during the COVID-19 pandemic. With the number of mobile online gamers in ASEAN expected to top 250 million by 2021, eSports will play a greater role in the cultural development of the region. While acknowledging potential downsides such as gaming addiction, the ASEAN Sports Sector must ensure that the proliferation of gaming is not inimical to nurturing a healthy and active ASEAN citizenry.

2.3.3.3. Culture and the arts

The promotion of the region's cultural identity and facilitation of intercultural dialogues through the arts are key goals for ASEAN. Essential for the humanisation of 4IR, culture and the arts must be continuously integrated with the 4IR, especially since digital technology has transformed photography, film, graphic arts, and architecture. Digital technology will continue to make culture and the arts more accessible to the public in every ASEAN Member State and will lead to the creation of new art forms that might one day replace the centrality of traditional visual art forms.

The 4IR makes it possible for anyone to be an art producer or artist. The nature of art and its audience have changed dramatically in the era of digital reproduction. With new technology, a new genre of artists has emerged, with young graphic designers becoming design experts, for example. AMS must strive to help emerging artists, designers, and experts adopt to changes in the media used to cultivate culture and the arts in the region. With the use of 4IR technologies, ASEAN should strive to train and educate communities on traditional and non-traditional art forms using technology; ensure popular access to emerging design software; develop policies to protect intellectual property; and harness individual creativity, which will be an in-demand skill in the future. Integrating the arts into science, technology, engineering, and mathematics (STEM) education is a laudable and necessary strategy to reduce the skills gap faced by the next generation.

2.3.4. Improving well-being through digitalisation of social welfare and protections

Social welfare and protection are defined as preventing, managing, and overcoming situations that adversely affect people's well-being. The advent of 4IR allows for the digitalised administration of social welfare and the technical environment, such as the proliferation of internet connections and broadband accessibility. Game-changing digital technologies in the Manufacturing and Services Sectors are also making their way into every aspect of social care and social welfare, from policy design to the actual delivery of services to users. Societies today have recognised the persistence of socio-economic disparities, especially for socially vulnerable groups. It is imperative for this divide to be addressed, and for ASEAN to examine how 4IR technologies and digitalisation might accelerate closure of these divides.

2.3.5. Accelerating innovation that contributes to environmental sustainability

Sustainable development has been defined by the World Commission on Environment and Development as development that meets the needs of current generations without compromising the ability of future generations to meet their own needs. ASEAN has been affected by enormous environmental stresses resulting from global warming, urban excess, deforestation, water scarcity, overfishing, and pollution. 4IR technologies, such as artificial intelligence, machine learning, the Internet of Things, big data, blockchain, robotics, etc., can help tackle these issues and lead the region to a zero-carbon future. The application of 4IR technologies to promote ASEAN's ambitions for a low-carbon future can unlock economic opportunities for the region and improve ASEAN citizens' lives and livelihoods through job creation and business competitiveness.

ASEAN recognised the importance of sustainability in its ASEAN Community Vision 2025 and aims to develop the region with reference to the UN 2030 Agenda for Sustainable Development. Through digital transformation via the 4IR, ASEAN can foster innovation in products, processes, and strategies, while leveraging strong collective contributions from enterprises to support local environmental sustainability and the efficient use of resources. These innovations might take the form of drone technology, the internet of trees, the internet of things, big data, and cloud computing – all of which might be used to effectively monitor and manage deforestation, air and water pollution, endangered or protected animals, marine life, e-waste, carbon footprints, decarbonisation, and electrification, etc. The development of Southeast Asia's green economy might generate USD 1 trillion in annual economic opportunities by 2030 that can, in turn, reinforce societal development in the region.

2.4. ASEAN's post-pandemic recovery 4IR priorities

The World Health Organization (WHO) declared the Coronavirus Disease 2019 (COVID-19) outbreak as a global pandemic on 11 March 2020. Since then, lives have been upended and economic activities have been disrupted around the world. Due to disruptions in value chains and a drop in consumption and business activities, 2020 saw ASEAN's economy contract by an estimated 3.3%, while regional trade and FDI fell by 5.5% and 24.5% respectively. As the number of vaccinated people in the region increased, the economy has reopened slowly, with ASEAN's GDP expected to grow by 4.4% in 2021, and 5.1% in 2022. However, vaccine delays, recurrent waves of infection, and new variants of the virus continue to present great uncertainties for the regional economy.

The Consolidated Strategy on the Fourth Industrial Revolution for ASEAN was developed during the pandemic. While challenging, the crisis offers momentum for ASEAN to forge ahead and accelerate its agenda, incorporating the 4IR into its recovery strategy. The ASEAN Comprehensive Recovery Framework (ACRF), which was adopted at the 37th ASEAN Summit in November 2020, identifies 'Accelerating Inclusive Digital Transformation' as one of its Broad Strategies, and identifies the Consolidated Strategy as one of its deliverables. The idea is to leverage the momentum of digital transformation and realise the enormous opportunities presented by digital technologies to boost the economic recovery and people's well-being in the post-COVID-19 world.

Notwithstanding the advancement of numerous digitalisation initiatives over the years, ASEAN's 4IR-related work remains limited. ASEAN must go beyond its existing work and start looking at initiatives that can use 4IR technologies to increase the region's competitiveness, well-being, inclusiveness, and sustainability. Four potential 4IR-related quick-wins should be part of ASEAN's immediate post-pandemic, priorities: digitalisation of trade documents; digital accessibility and affordability; digital infrastructure, including 5G infrastructure; and the move to a low-carbon economy. Leveraging existing ASEAN's initiatives, implementation of these immediate priorities reflects the visions and focus areas identified in the 4IR Consolidated Strategy.

To start, digitalisation of trade documents is key for ASEAN to further reduce trade costs, enhance participation in regional and global value chains, and contribute to sustainable development. While supply chain finance has made steady progress in digitilisation, traditional or documentary trade requires both physical paper and manual intervention. Further, more can be done to further facilitate the digitalisation of trade to ensure that the region's trade facilitation initiatives are fit for purpose in the post-COVID-19 environment. For example, in addition to continuously improving ASEAN's trade facilitation public information platforms (e.g., the ASEAN Trade Repository), more work is needed to ensure that electronic administrative documents are considered the legal equivalents of their print counterparts.

Second are efforts to address digital divide across the region, which requires giving greater attention to the following:

1 **The promotion of a digital identity system.** Considered the foundation of an inclusive digital economy, a digital identity system is expected to enable every individual to fully participate in society and the economy, from opening a bank account to accessing health care services and social benefits, and from seeking legal protection to safely engaging in online transactions.

A digital identity system is also key for boosting cross-border trade and collaborations. For example, a regionally harmonised Unique Business Identification Number (UBIN), which can be operationalised through an online portal, could ease doing business across ASEAN by reducing the time required to conduct due diligence, improving corporate transparency, and making ASEAN a generally attractive trade partner and investment destination. In the longer term, UBINs could stimulate development of digital identities for ASEAN businesses. The ASEAN Work Programme on Starting a Business, which was adopted in 2016 and is slated for implementation over ten years as part of the ASEAN Strategic Action Plan on SME Development 2025, is already looking into UBINs and digital identities. Acceleration of this imperative proposal is under consideration.

2 **Making technology more affordable and accessible.** Although digital technologies have become cheaper and more accessible to almost everyone, affordability – which is very much an urban/rural issue – remains the principal barrier to accessibility. Seven metropolitan areas, which hold 15% of the region's population, still account for more than 50% of the internet economy in the region. The two major expenses of digital connectivity – availability and the cost of physical infrastructure – are affected by geographic location, often to the disadvantage of rural areas. To make digital technology more affordable throughout the region, ASEAN may consider promoting initiatives, including policies and regulations, to encourage healthy competition and lower barriers to entry in the digital market. Another priority is to accelerate development of the next generation Universal Service Obligation (USO 2.0), which is one of the key initiatives under Broad Strategy 4 of the ACRF, to provide more equitable access to technologies and services for citizens and geographical locations that markets often overlook, such as remote, rural, and underserved areas.

3 **Public-private partnerships.** To further enhance digital inclusion, ASEAN should consider leveraging partnerships with the private sector, a key driver of digitalisation and the 4IR, to improve, among other things, the region's digital infrastructure and tools, as well as relevant skill sets, enabling those left behind (e.g., senior citizens, women, youth, rural population, etc.) to take advantage of the opportunities offered by digital technologies.

The third post-pandemic 4IR-related priority is digital infrastructure, a crucial foundation for digitizing trade documents and reducing the digital divide. Digital infrastructure is a key enabler of the 4IR Consolidated Strategy, with 5G highlighted as foundational enabler. 5G adoption has been relatively strong across the region, with AMS such as Singapore, Viet Nam, the Philippines, Malaysia, and Thailand leading the way. The technology has been at the forefront of the region's digital transformation amid unprecedented use of remote technologies and digital services, such as mobile tracing, telemedicine, and video and online chat during the pandemic. The promotion and development of 5G infrastructure, and ensuring its interoperability, will be key for ASEAN in developing an economic ecosystem that reinforces the regional economic recovery effort and promotes sustainable and inclusive growth. Coordinated efforts, however, are required from all stakeholders, including regulators, operators, and enterprises, for ASEAN to capture the maximum value of 5G.

Finally, the 4IR can be used in developing a low-carbon economy or a system that aims to minimise greenhouse gas emissions while functioning as a typical economic programme. While presenting opportunities to advance environmental sustainability, 4IR technologies typically require a large amount of energy. Hence, the transition to renewable energy must be accelerated if ASEAN is to fully capitalise on the digital revolution without undermining its sustainability agenda. This is consistent with ASEAN's 4IR Consolidated Strategy's Strategic Priority 5 (accelerating innovation that contributes to environmental sustainability) of Focus Area 3 (Digital Transformation of Society), underscoring ASEAN's pursuit of a whole-of-community approach in leveraging 4IR technologies to advance its environmental sustainability agenda. ASEAN's work can build on existing initiatives, such as the energy efficiency and conservation and renewable energy programmes under the Energy Sector; sustainable finance initiatives (e.g., the Roadmap for ASEAN Sustainable Capital Markets, ASEAN Sustainability Bond Standards, ASEAN Green Bond Standards, and developing a green finance taxonomy for ASEAN); sustainable transport initiatives (e.g., the ASEAN Regional Strategy on Sustainable Land Transport and the ASEAN Green Ship Strategy), as well as the recent initiative to develop the Framework for Circular Economy for the ASEAN Economic Community.

Chapter 3:

Way forward to a Digital ASEAN Community
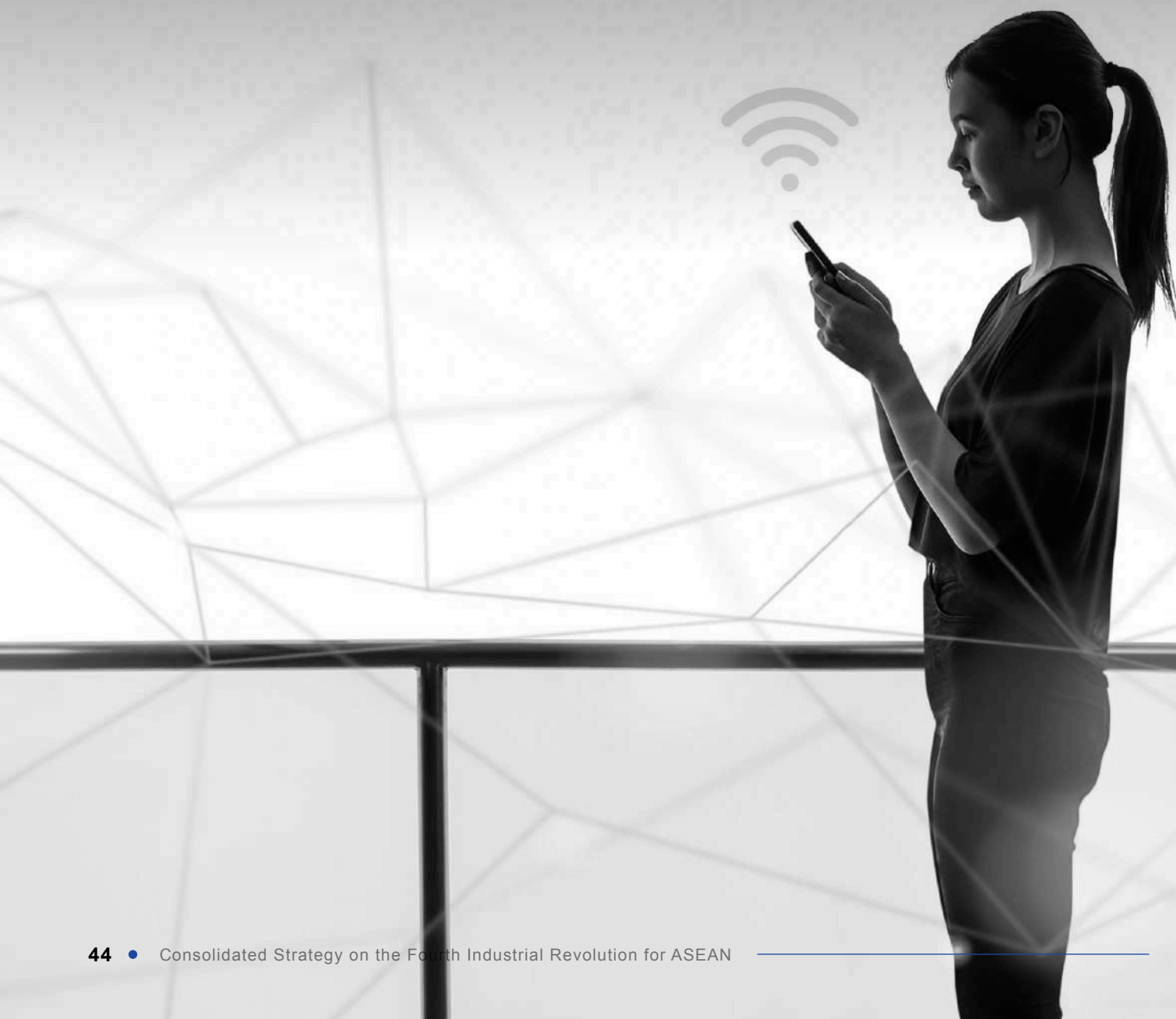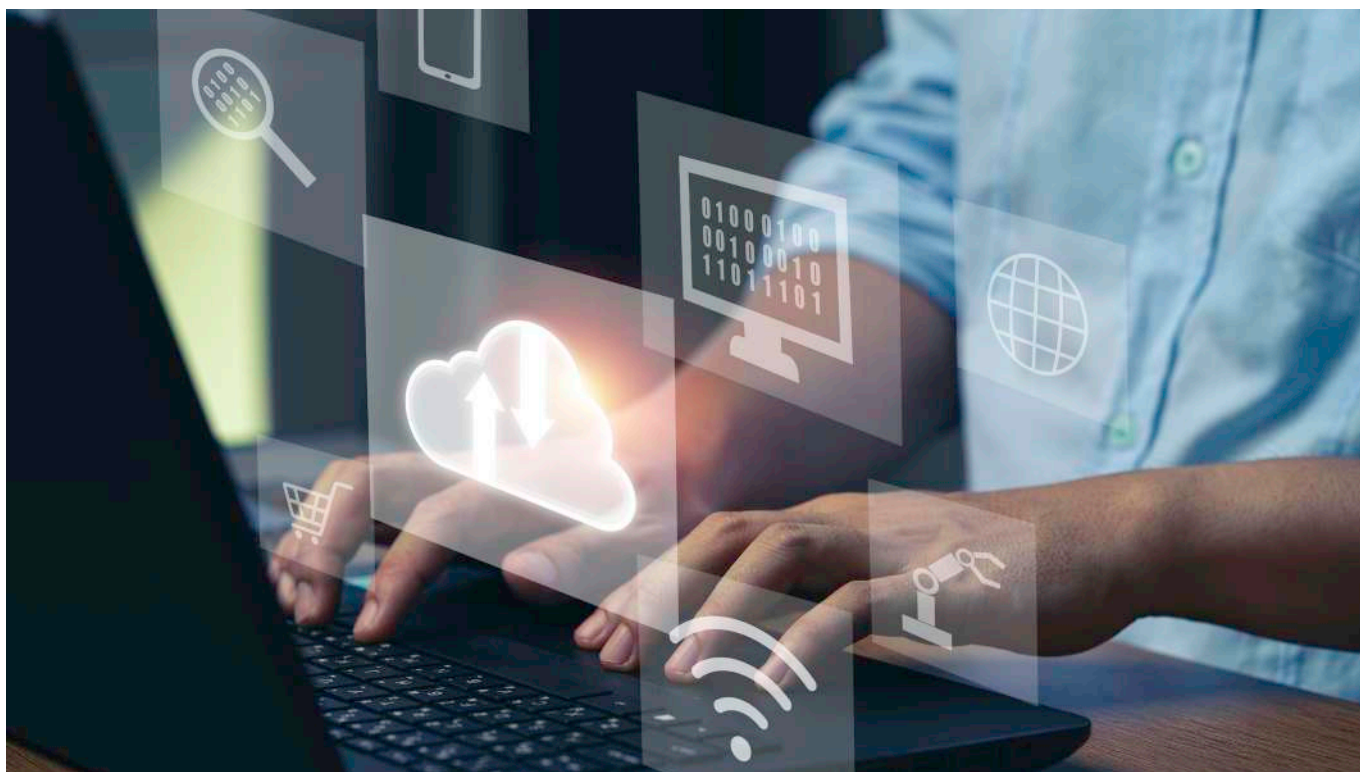
The Consolidated Strategy on the Fourth Industrial Revolution for ASEAN provides strategic direction for using the 4IR to foster a Community that maximises opportunities; maintains openness, transparency, and security; fosters economic growth and connectivity; and promotes inclusive and equitable economic development during the convergence of the physical and digital worlds.

The Consolidated Strategy offers a Strategic Framework that envisions creating a Digital ASEAN through three focus areas: promoting technological governance and cybersecurity that is open, secure, transparent, and connected, and respects privacy and ethics in line with international best practices; developing a digital economy that harnesses technologies to build a resilient, inclusive, integrated, and globally competitive economy; and fostering a digital transformation that embraces innovation in transforming society and contributes to social progress and sustainable development.

The Consolidated Strategy identifies six enablers to support the strategic initiatives:
1. digital infrastructure;
2. capability building;
3. cooperation and collaboration;
4. institutions and governance;
5. resource mobilisation; and
6. effective monitoring.

As a way forward, the Consolidated Strategy recommends immediate, medium-term, and long-term priorities for each focus area, as well as key performance indicators to monitor progress.

3.1. Technological governance and cybersecurity

The importance of technological governance and cybersecurity will increase with the accelerated adoption of the 4IR. Emerging technologies will require new and swift decisions relating to their governance, while increased technology adoption and use will increase the importance of cybersecurity. Accordingly, several recommendations were identified for this focus area, as highlighted in Table 3.1.

Table 3.1. Recommendations for technological governance and cybersecurity

	Immediate term	Medium term	Long term
Strategic Priority #1: Mainstreaming good governance through e-government.	Greater cooperation and collaboration for effective progress monitoring to improve regional good governance in the region. The UN E-Government Development report, which provides a snapshot comparison of countries and regions around the world, for example, can be a starting point to track progress.	Open Government Data can support transparency, accountability, and government effectiveness, as well as create new opportunities and identify key datasets.	Promote of digital adoption and skills to bridge digital divides.
Strategic Priority #2: Promoting technological governance, taking account of best practices.	Better sharing of information, experiences, and best practices to raise awareness and understanding.	Development of regional policies, norms, and principles on adopting and using new technologies.	Support the wider digital ecosystem, ranging from the private sector and civil society to the general population.
Strategic Priority #3: Observing data governance that respects privacy and security.	Ensure compliance with the existing framework across the region and identify differences in regulations between AMS.	Institutionalise data protection authorities or create a data protection office and cross-border cooperations and agreements.	Establish a task force or assign an existing body to monitor ongoing data governance in the region and globally.
Strategic Priority #4: Fostering cooperation and harmonisation in efforts to combat cybercrime and address cybersecurity.	Capacity building, awareness raising, and technical support initiatives to improve regional collaboration (e.g. to support the upcoming ASEAN Computer Emergency Response Team (ASEAN-CERT) and individual AMS-CERT, as well as relevant Critical Information Infrastructure protection) by holding more frequent exercises and enhance support and communication across AMS.	Institutionalise data protection authorities or create a data protection office and cross-border cooperation and agreements.	Enhance cooperation with the international community and private sector.

Three key performance indicators (KPIs) are proposed for the focus area on technological governance and cybersecurity (Table. 3.2.).

Table 3.2. Technological governance and cybersecurity KPIs

	KPIs	Description
1	Number of regional e-government initiatives.	Measures the number of regional initiatives introduced to promote e-government in the region.
2	Extent of competitiveness.	Measures drivers of productivity and the potential for economic growth, including in areas such as ICT adoption, skills, and innovation capability to assess the potential for using emerging technologies.
3	Level of cybersecurity commitment.	Measures the development or engagement level for cybersecurity, including areas such as legal affairs, technical concerns, and cooperation agreements to prepare for cyber threats.

3.2. Digital economy

Accelerated by the COVID-19 pandemic, digital is likely to account for a greater share of economic activity in the coming years, while the use of 4IR technologies and applications in ASEAN's economy is expected to increase in depth and complexity. ASEAN can only remain competitive globally if it remains ahead of the curve. Several recommendations for this focus area are highlighted in Table 3.3.

Table 3.3. Recommendations for digital economy

	Immediate term	Medium term	Long term
Strategic Priority #1: Maximising the potential of digital trade.	• Expedite rollout of ASEAN's digital-based trade facilitation initiatives (e.g., expanding the list of documents exchanged on the ASEAN Single Window, onboarding remaining AMS to the ASEAN Customs Transit System, ratifying the ASEAN Agreement on E-Commerce, etc.) and developing mobile-ready applications and solutions.	Promote the development of regulatory frameworks to facilitate cross-border data movement by formalising scope, rules, and governance.	Work toward a broader framework on the ASEAN Digital Economy, including by acknowledging the importance of forming seamless alliances via collaboration and more effective monitoring with periodic updates to the ASEAN Secretariat and reporting mitigative actions where required.
Strategic Priority #2: Embracing digital technologies for Industry 4.0.	Intensify engagement and interaction among AMS to unify Industry 4.0 initiatives and centralise ASEAN's government structure to advance work on Industry 4.0; and establish a platform to address regional industrial cooperation that would allow participation relevant agencies from AMS (e.g., industry ministries or agencies in charge of 4IR).	Arrange for adequate funding to facilitate strong government and private sector commitment to high-tech development and spending.	Develop favourable regulatory frameworks in collaboration with the private sector, especially for advancing industry-specific needs.
Strategic Priority #3: Enhancing Service Sector competitiveness in the new economy.	Promote the exchange of experiences and best practices on the application of 4IR technologies for Sectoral Bodies dealing with selected high-potential sectors (e.g., health services technology; telecommunications, media, and technology; financial technology; logistics technology; education services technology; tourism; and other professional services).	• Establish a public-platform dialogue, such as an ASEAN Services Dialogue, to exchange best practices for applying 4IR technologies; • Help develop a services facilitation roadmap focused on key service sectors that takes into consideration 4IR technologies; and promote alignment of national and regional work to design support systems (e.g., funding and tax incentives) to facilitate policy implementation.	Work toward a broader framework on the ASEAN Digital Economy, including by acknowledging the importance of forming seamless alliances via collaboration and more effective monitoring with periodic reporting to the ASEAN Secretariat on status, progress, and mitigative actions where required.

	Immediate term	Medium term	Long term
Strategic Priority #4: Stimulating the adoption of smart agriculture (Special Focus 1).	• Introduce the right agri-policies and programmes in line with the 4IR mandate previously rolled out by most AMS. • Explore relevant incentive schemes (e.g., grants, subsidies, preferential loan rates, usage-based payments, and tax deductions) to reduce high costs to help farmers access and adopt new technologies.	Continue introducing relevant training, best practices, and skills development programmes (upskilling and reskilling), targeting sole farmers and smallholders.	Promote harmonised value chain development via PPP-type partnerships (e.g., 'living laboratories' covering production, materials, and digital science innovation and human capital, among other things) to demonstrate the capabilities of relevant technologies to companies, researchers, authorities, and users, such as the farming community.
Strategic Priority #5: Digitally enabling MSMEs to be globally competitive (Special Focus 2).	• Continue to roll out programs to ensure that MSMEs can adopt disruptive technologies. • Further strengthen the ASEAN SME Academy through improvements in content and delivery (e.g., outreach, language support, etc.). Roll out more digitally enabled trade facilitation initiatives to address MSME cost disadvantages. Encourage AMS to optimise the ASEAN Access portal to support MSME digitalisation.	Institute appropriate financial stimuluses (e.g., incentives or funding, such as digital finance mechanisms, subsidies etc.), which can be done by facilitating discussions of best practices on how appropriate stimuluses can be promoted or institutionalised.	Facilitate cross-functional support programmes where more advanced AMS can support emerging AMS via synergies, sharing leading practices, outreach, and apprenticeship programmes.

Four key performance indicators (KPIs) are proposed for the focus area on digital economy (Table. 3.4.).

Table 3.4. Digital economy KPIs

	KPIs	Description
1	Number of regional initiatives formulated and implemented.	Measures the number of regional initiatives introduced, rolled out, or adopted, and provides regular updates on progress and implementation.
2	Degree of adoption of capability development programmes.	Measures uptake and adoption of capability development programmes (e.g., training, knowledge-sharing sessions, technology transfer initiatives, and incubating programmes), to enhance digital upskilling and reskilling.
3	Level of stakeholder engagement in capacity and capability development programmes.	Number and type of consultations or partnerships initiated across the strategic priorities with industry players, businesses, universities and educational institutions, and civic organisations.
4	Number of digitally banked citizens in ASEAN.	Measures financial inclusion and how ASEAN citizens are using digital avenues to participate in the digital economy.

3.3. Digital transformation of society

To ensure that no one is left behind on ASEAN's 4IR journey, the following recommendations are highlighted in Table 3.5.

Table 3.5. Recommendations for digital transformation of society

	Immediate term	Medium term	Long term
Strategic Priority #1: Promoting forward-looking human resource development through formal and continuing education.	Accelerate preparation of a skilled workforce and increase adoption of digital literacy skills training for secondary and vocational programmes, as these groups will join the workforce in few years. Work to close the digital divide. Boost the preparedness of traditional education systems.	Ensure early, higher, continuing, and other forms of education are given priority, as they form the outer layer of the education system and are important in supporting successful 4IR skills adoption.	Deliver digital training across the broad spectrum of education institutions and continuing professional education providers.

	Immediate term	Medium term	Long term
Strategic Priority #2: Establishing digital inclusion to minimise digital divides.	Promote broad basic and intermediate digital skills, focusing on youth, women, and informal and gig workers, as such skills can greatly enhance marketability and employability in the region and the world.	Build an inclusive regional workforce database in collaboration with private entities as a shared resources platform for the marginalised to access short- and long-term employment opportunities in the region.	Develop and roll out policy frameworks that focus on improving inclusivity via education and employment opportunities centred around marginalised groups.
Strategic Priority #3: Fostering cultural development, especially of digital content, sports, culture, and the arts.	Encourage and facilitate dialogues among stakeholders to enable digital content development, which has been growing exponentially as consumers search for valuable, trustable, and reliable digital content during the COVID-19 pandemic.	Facilitate development of effective and harmonised policies and regulations to spur cross-border enforcement to mitigate implications from potential intellectual property infringements.	Focus on e-Sports science and sustainable athlete development programmes (high-growth sectors). As this is a highly customised area where niche digital literacy skills are required, ASEAN can prioritise specific areas, such as animation, 3D prototyping, and gamification, ideally through public-private partnerships.
Strategic Priority #5: Accelerating innovation that contributes to environmental sustainability.	Roll out capacity and capability development and awareness programmes on environmental sustainability.	Develop policies to ensure the use of 4IR technologies to monitor the protection of natural resources and combat climate change, especially for the largest Sectors (e.g. energy, transportation, manufacturing, etc.).	Develop an ASEAN sustainability framework and index tailored to individual AMS.

Five KPIs are proposed for the focus on the digital transformation of society (Table. 3.6.).

Table 3.6. Digital transformation of society KPIs

	KPIs	Description
1	Number of Special Target Group or general participants trained and certified.	Measures the total number of participants trained and certified in 4IR training programmes.
2	Number of industry collaborations within each AMS and between AMS.	Measures the number of multi-stakeholder collaborations led by ASEAN and created with industry partners and non-governmental organisations.
3	Degree to which the economically active population has digital skills.	Measures the extent to which the economically active population possessess sufficient digital skills (e.g., computer skills, basic coding, digital reading).
4	Proportion of ASEAN's citizens working in areas related to science, technology, engineering, or mathematics.	Measures the number of scientifically and technologically inclined youths, as a potential proxy to measure the number of ASEAN's future-ready workforce members.
5	Degree of digital connectivity.	Measures the number of internet subscribers and mobile-broadband users among ASEAN citizens in the region.
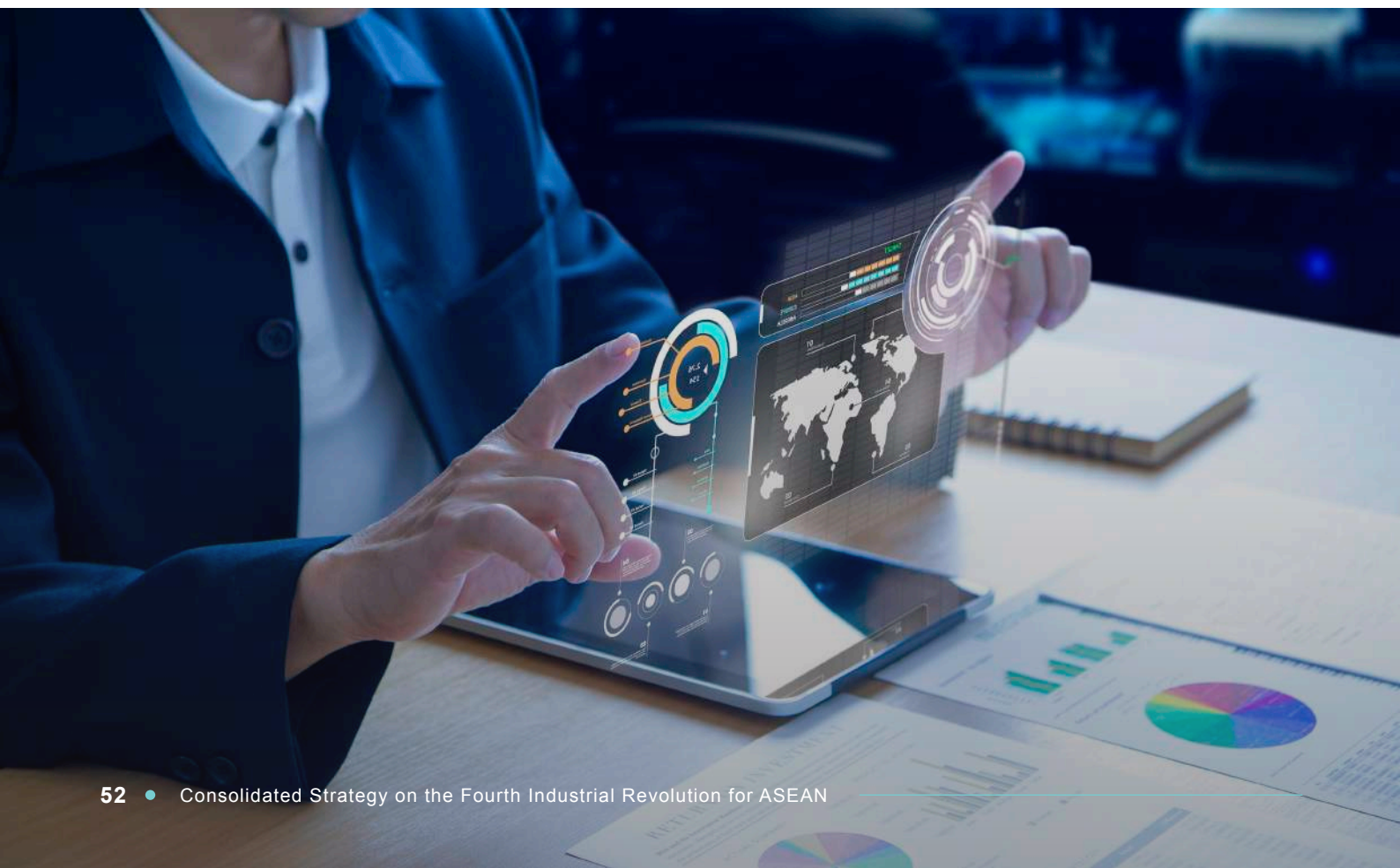
3.4. Cross-Pillar recommendations

The following are recommendations that are Cross-Pillar in nature:

1   **Immediate priority area for cooperation:**

The most pressing cross-Pillar issue is to set up a clear institutional mechanism, as detailed in sub-section 3.5, to oversee all three focus areas of the 4IR Consolidated Strategy, and to coordinate implementation and monitor progress, since many initiatives will cut across ASEAN's different Sectors and Pillars, and affect the ASEAN Community as a whole. This institutional mechanism may involve forming a cross-Pillar body or task force composed of representatives from the APSC, AEC, and ASCC.

2   **Medium-term priority area for cooperation:**

Progress reviews of the ASEAN 4IR Consolidated Strategy's priorities and initiatives must be planned every two years. ASEAN must ensure it regularly revisits the Consolidated Strategy, as well as its recommendations. This might be achieved through the cross-Pillar body or a task force formed as an immediate priority, and will involve evaluation of whether progress is observed equally and equitably across all strategic priorities. Implementation bottlenecks and other areas for improvement must be flagged.

3   **Long-term priority area for cooperation:**

ASEAN must consider reviewing in detail and upgrading the 4IR Consolidated Strategy every five years at least to incorporate new technologies, applications, and strategic priorities not covered in detail by earlier versions. This would ensure that the Strategy remains relevant in light of rapid changes in the Digital ASEAN Community. The 4IR Consolidated Strategy should also serve as a key reference in developing the ASEAN Community's Post 2025 Vision, given the increasing importance of digitalisation and new technologies in the future.

3.5. Institutional mechanism

The impacts of the 4IR are expansive and multifaceted, cutting across different Sectors and permeating every aspect of people's lives. The 4IR requires a comprehensive cross-Sectoral and cross-Pillar approach for it to be managed effectively.

In ASEAN, the Joint Consultative Meeting (JCM) has been given a mandate to address cross-Sectoral and cross-Pillar issues at the senior official level. Comprising the members of the ASEAN Senior Officials Meeting, the Senior Economic Officials Meeting, the Senior Officials Committee for the ASEAN Socio-Cultural Community, and Committee Permanent Representatives, the JCM has the following functions:

1 Providing recommendations to the ASEAN Community Councils, the ASEAN Coordinating Council, and the ASEAN Summit to address strategic cross-Sectoral and ASEAN Community-building issues, as well as challenges to the Community-building process;

2 Promoting policy coherence and effective coordination among the ASEAN Community Pillars, including by identifying a lead Sectoral Body to coordinate implementation of appropriate cross-Pillar matters and working closely with AMS on relevant issues; and

3 Following up implementation of decisions by the ASEAN Community Councils, the ASEAN Coordinating Council, and the ASEAN Summit on cross-Sectoral and cross-Pillar issues.

While the JCM handles a wide range of cross-cutting issues, ASEAN's management of 4IR issues, including implementation of the Consolidated Strategy, requires technical expertise to represent the interests of AMS and Sectors across ASEAN's three Pillars. Given that there is no ASEAN Sectoral Body handling 4IR-related issues holistically, the JCM will consider establishing a new task force to coordinate ASEAN's 4IR work. Intended to report to the JCM, the proposed ASEAN 4IR Task Force Group (A4IR-TFG) will be staffed based on nomination by AMS, and may include 4IR National Focal Points or key institutions tasked with coordinating and overseeing national 4IR policies and their implementation. The A4IR-TFG may also conduct regular consultations with stakeholders and relevant Sectoral Bodies across the three ASEAN Community Pillars, and provide updates to other relevant platforms, such as the coordinating conferences of the three Pillars and the High-Level Task Force on ASEAN Post 2025 Vision, once it is established.

While many of the Consolidated Strategy's recommended initiatives can be undertaken by existing Sectoral Bodies, the A4IR-TFG may coordinate or implement selected initiatives, especially for initiatives involving multiple Sectoral Bodies.

The A4IR-TFG will also monitor the progress of ASEAN's 4IR initiatives, leveraging on, rather than duplicating, existing monitoring mechanisms of the three Pillars, with the added value of tracking and helping to ensure progress on priorities that may not fall under a specific Sector or Pillar. Progress can be periodically reported to the JCM and other appropriate platforms, and can offer input to ASEAN as it develops its post-2025 vision. Any monitoring role should be aimed strategically to ensure progress across all focus areas, while avoiding onerous reporting requirements and duplication of efforts.
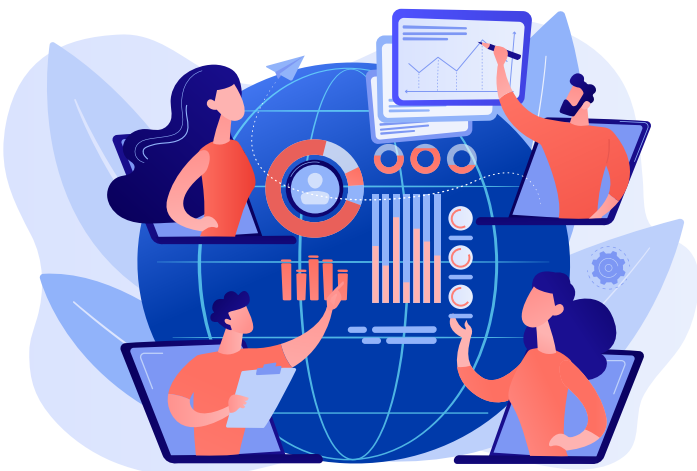
3.6. Conclusion

As in the rest of the world, the convergence of the physical and digital worlds – also known as the 4IR – is now an inevitable reality within ASEAN. As the development of the 4IR reaches its peak in the region in the next decade, it is crucial that ASEAN reap the 4IR's benefits in their entirety by maximising opportunities; maintaining openness, transparency, and security; fostering economic growth and connectivity; and promoting inclusive and equitable economic development.

All these things can only be achieved by employing a Community-wide, cross-Pillar approach, as the 4IR presents shared opportunities and challenges for governments, business, and societies alike. This calls for all parties and stakeholders to work to leverage six 4IR enablers – digital infrastructure, capability development, cooperation and collaboration, institutions and governance, resource mobilisation, and effective monitoring – identified in this Consolidated Strategy. Doing so will contribute to the furthering of most or all of ASEAN's 4IR Focus Areas and Strategic Priorities. These enablers are anchored by KPIs identified in each Focus Area. AMS and Sectoral Bodies can build upon these KPIs in each Sector in a trickle-down manner as envisioned by the Consolidated Strategy.

Undoubtedly ambitious yet realistic, implementation of the Consolidated Strategy toward a Digital ASEAN Community is true and consistent with the 4IR. It elevates competitiveness, pushes for creativity and innovation, and creates opportunities. These are principles that are well-aligned with the characteristics of the ASEAN Community. With the right technologies and mechanisms in place, such regional initiatives, starting with this Consolidated Strategy, should become simpler, more effective, and more frequent.

Annex 1: The 4IR – Global and regional trends

Various strategies have been crafted across the globe to drive adoption of the 4IR. For instance, the European Commission in 2010 launched the Digital Agenda for Europe, an initiative of the Europe 2020 strategy to boost its economy through realising the sustainable economic and social benefits of a digital single market. The European initiative focuses on improving cybersecurity, infrastructure, interoperability, and digital knowledge such as literacy, technical skills, and inclusivity. The European Commission has since strengthened its data protection legislation to protect consumers and has seen a boost to its economy by fostering an inclusive and digitally connected European Union. The European Commission has further set up a scoreboard to monitor the progress of digital transformation in each country, allowing EU Members and stakeholders such as governments, business, and societies to take action based on local conditions.

Outside Europe, Uganda, which has likewise acknowledged the importance of 4IR, launched its National 4IR Strategy in October 2020 to address opportunities to become a continental 4IR hub in Africa that enables a smart and connected Ugandan society. To achieve this vision, the strategy called for identifying key opportunities in human capital, productivity, economy, and governance; leveraging critical enablers such as connectivity, governance, knowledge, and resources; ensuring the strategy's successful delivery through coordinated implementation by the government; and facilitating an ecosystem for 4IR adoption and coordinating funding where necessary.

In ASEAN, all AMS have adopted national 4IR or related strategies, such as those listed identified in Table 1 below. These strategies highlight how ASEAN as a region has already recognised the importance of 4IR, hoping to create regional synergies that can be developed by a Consolidated Strategy.

Table Annex 1.1. Non-exhaustive 4IR or related strategies from ASEAN Member States

AMS	Relevant Documents
Brunei Darussalam	• Digital Economy Masterplan 2025 (2020). • Digital Payment Roadmap 2019-2025 (2018). • The Digital Government Strategy 2015-2020 (2015).
Cambodia	• Telecommunication ICT Development (TICT) Policy (2020). • Cambodia Industrial Development Policy 2015-2025 (2015). • Cambodia ICT Masterplan 2020 (2014). • Cambodia STI Roadmap 2030 (2021). • Cambodia STI Policy 2020-2030 (2019).

AMS	Relevant Documents
Indonesia	• Government Regulation No. 7/2021 on the Ease, Protection, and Empowerment of Cooperatives and Micro, Small, and Medium Enterprises (2021). • National AI Strategy 2020-2045 (2020). • Indonesian Digital Roadmap 2021-2024 (2020). • Job Creation Act (Law Number 11 of 2020). • Digital Financial Innovation Roadmap and Action Plan 2020-2024 (2020). • National Medium-Term Development Plan (RPJMN) 2020-2024 (2020). • Blueprint for the Indonesian Payments System 2025 (2019). • Government Regulation No 71/2019 on Electronic Systems and Transactions (2019). • Presidential Regulation No. 95/2018 on Electronic-Based Government Systems (SPBE) 2018-2025 (2018). • Making Indonesia 4.0 (2018). • President Regulation No. 74/2017 on the Indonesian e-Commerce Road Map 2017- 2019 (2017).
Lao PDR	• Signing of an MoU with Microsoft (as part of Microsoft's National Empowerment Plan) (2016). • e-Government Development Plan 2013-2020 (2013) . • National Strategies for Science and Technology Development 2013-2020 and Vision 2030 (2013).
Malaysia	• National e-Commerce Strategic Roadmap 2.0 (2021). • Public Sector Digitalisation Strategic Plan 2021-2025 (2021). • National Fourth Industrial Revolution (4IR) Policy (2021). • National Science, Technology and Innovation Policy (2021). • Malaysia Digital Economy Blueprint (2021). • Policy Document on Licensing Framework for Digital Banks (2020). • National Entrepreneurship Policy 2030 (2020). • Industry 4WRD: National Policy on Industry 4.0 (2018). • Malaysia Smart City Framework (2018). • Malaysia Green Technology Masterplan 2017-2030 (2017). • Launch of the Digital Free Trade Zone (DFTZ) Initiative and Pilot Project (2017). • The Malaysian Public Sector ICT Strategic Plan 2016-2020 (2016). • The National e-Commerce Strategic Roadmap (2016).
Myanmar	• Myanmar Digital Economy Roadmap (2018-2025). • Universal Service Strategy for Myanmar 2018-2022 (2018). • Myanmar e-Governance Master Plan (2016-2020). • 12-Point Economic Policy of Myanmar. • Myanmar Sustainable Development Plan (MSDP) 2018-2030. • COVID-19 Economic Relief Plan (CERP) 2020.

AMS	Relevant Documents
Philippines	• Philippine Development Plan (2017-2022). • Inclusive Innovation Industrial Strategy (i3S). • Inclusive Filipinnovation and Entrepreneurship Roadmap. • Science for Change Programme (S4CP). • RA 10929 or the Free Internet Access Programme of 2017. • Cloud First Policy (DICT DC 2017-002). • RA 11293 or the Philippine Innovation Act of 2019. • RA 11337 or the Innovative Startup Act of 2019. • National ICT Ecosystem Framework (2019). • The National Cybersecurity Plan 2022 (launched 2019). • E-Government Masterplan (EGMP) 2022 (launched 2019). • The Philippine Central Bank's (BSP) Digital Payments Transformation Roadmap 2020-2023 (2020). • eCommerce Philippines 2022 Roadmap. • National Artificial Intelligence Strategy for the Philippines (2021).
Singapore	• National AI Strategy (2019). • Digital Economy Framework for Action (2018). • Digital Government Blueprint (2018). • Digital Readiness Blueprint (2018). • Research Innovation and Enterprise Plan 2020 (2016). • Smart Mobility 2030 (2014). • Smart Nation Singapore (2014).
Thailand	• Digital Economy Promotion Master Plan 2018 - 2022. • National Cybersecurity Strategy 2017 - 2022. • Digital Government 2017-2021(2017). • National Digital Government Development Plan of Thailand (fiscal year 2020-2022). • Thailand 4.0 (2016). • National Digital Economy Master Plan 2016-2020 (2016).
Viet Nam	• Decision No. 12/QD-BKHDT Approving a Programme to Support Enterprise Digital Transformation, 2021-2025 (Ministry of Planning and Investment) (2021). • Resolution 50/NQ-CP Issuing the Government's Action Programme to Implement Politburo Resolution No. 52-NQ/TW (2020). • Directive 01/CT-TTG Promoting Development of Digital Technology Enterprises in Vietnam (2020). • Decision 2289/QD-TTG Promulgating the National Strategy on the Fourth Industrial Revolution to 2030 (2020). • Decision 127/QD- TTG Promulgating the National Strategy on Research, Development and Application of Artificial Intelligence to 2030 (2020). • Decision No. 749/QD- TTG Approving a Programme for National Digital Transformation by 2025, Oriented to 2030 (2020). • Resolution No. 52 of the Central Committee on Guidelines and Policies to Actively Participate in the Fourth Industrial Revolution (2019). • Decision No. 2813/QD-BKHCN Approving the National Key Science and Technology Programme to 2025 'Supporting Research, Develop And Technology Application Of Industry 4.0' (2018). • Ministry of Industry and Trade Decision 4246/QD-BCT (2017). • Directive No. 16 on Strengthening the Ability to Access the Fourth Industrial Revolution (2017).

In light of the COVID-19 pandemic, 4IR technologies have offered efficiency and precision, put forward opportunities, and enhanced people's overall quality of life through improved products and services. Economies and societies that have adopted 4IR technologies to monitor and manage COVID-19 cases have overcome the pandemic more successfully. While not many nations have established the advanced infrastructure needed to assure 4IR affordability and accessibility for all, the pandemic has highlighted a need to develop a comprehensive 4IR strategic framework for nations, including AMS, to ensure that underlying physical, economic, and health-related risks are mitigated as early as possible and to ensure that immediate needs for capability development and capacity improvements are addressed.

Beyond the pandemic response, 4IR technologies are expected to play a key role in economic and social development in the region. These technologies, which are defined and explained in Annex 3, include cloud-based applications, blockchain, Internet of Things (IoT), robotics, additive manufacturing, augmented reality, big data and advanced analytics, and artificial intelligence (AI).

Annex 2: List of ongoing 4IR-related initiatives in ASEAN

The following is a list of ongoing 4IR-related initiatives in ASEAN:

Initiatives on technological governance and cybersecurity:

(1) *ASEAN Cybersecurity Cooperation Strategy 2017-2020. Guidance for AMS in developing a coordinated approach to build national cybersecurity capacity.*

(2) *ASEAN Data Management Framework 2021. Set out six foundational components to help organisations leverage corporate governance structures to define, manage, and monitor data management processes.*

(3) ASEAN Declaration to Prevent and Combat Cybercrime 2017. Resolved to strengthen the commitment of AMS in preventing and combating cybercrime.

(4) ASEAN Framework on Digital Data Governance 2018. Set out on strategic priorities, principles, and initiatives to guide AMS in policy and regulatory approaches.

(5) ASEAN Framework on Personal Data Protection 2016. Established guidelines to implement measures to promote and strengthen personal data protection across ASEAN.

(6) ASEAN Information and Communications Technologies Master Plan 2016-2020. Enabled economic transformations across ASEAN through digital transformations to propel ASEAN toward a digitally enabled economy.

(7) ASEAN International Mobile Roaming Framework 2017. Aimed at promoting transparent and affordable international mobile data roaming services in ASEAN.

(8) ASEAN Leaders' Statement on Cybersecurity Cooperation 2018. Tasked relevant Ministers to recommend feasible options for better coordination among AMS on cybersecurity.

(9) ASEAN Model Contractual Clauses for Cross Border Data Flows 2021. Set out a template on contractual terms and conditions for potential inclusion in binding legal agreements between parties transferring personal data across borders.

(10) ASEAN Framework for Next Generation Universal Service Obligation 2019. Recommended approaches for policymakers to align policies and programmes with supply-side connectivity and demand-side solutions.

(11) ASEAN Statement on the Promotion of Good Governance and Acceleration of an Agile Civil Service in a Digital Economy 2019. Tasked the ASEAN Cooperation on Civil Service Matters (ACCSM) to undertake implementation of the Statement's commitments through follow-up initiatives in the ACCSM Work Plan 2021-2025 and ACCSM+3 Work Plan 2021-2025.

(12) Implementation Guide for the ASEAN Data Management Framework (DMF) and Cross-Border Data Flow (CBDF) Mechanism 2021. Provided guidelines on implementation in relation to timeline and capacity building.

(13) Protection of Children from All Forms of Online Exploitation and Abuse in ASEAN 2019. Committed to establishing a national unit and data collection mechanism, as well as to enhancing legal frameworks, law enforcement, social welfare programmes, education curriculums, and private sector engagement against online child exploitation and abuse.

Initiatives on the digital economy:

(1) Action Agenda on Digitalisation of ASEAN MSMEs through Capacity Building Initiatives 2019. Developed to increase technology adoption by MSMEs to enable their effective participation in the digital economy.

(2) ASEAN Agreement on e-Commerce 2018: Helped to develop the e-commerce industry by creating a conducive environment for growth and advancing trade rules while building digital connectivity.

(3) ASEAN Declaration on Digital Tourism 2020. Affirmed the need for digital technology to enhance tourism development and competitiveness, facilitate growth, and develop sustainably.

(4) ASEAN Declaration on Industrial Transformation to Industry 4.0 2019. Embraced innovation and digital technologies in the 4IR to accelerate economic growth and social advancement.

(5) ASEAN Digital Integration Framework 2018. Established priority areas for AMS to deliver on the full potential of digital integration.

(6) ASEAN Digital Integration Framework Action Plan (DIFAP) 2019-2025. Identified six priority areas for the immediate term to address barriers and accelerate existing platforms and plans to realise digital integration.

(7) ASEAN Digital Integration Index (ADII) 2021. A starting point for ASEAN to review implementation progress for the ASEAN Digital Integration Framework (DIF), as well as indicated the strengths and weaknesses of individual AMS in terms of digital integration.

(8) ASEAN Digital Masterplan 2025. Established actions for AMS governments and regulators to transform ASEAN into a leading digital community and economic bloc that is powered by secure and transformative digital services, technologies, and ecosystems.

(9) ASEAN Guidance Notes on Digital Financial Services. A reference to further develop digital financial services and advance financial inclusion in Southeast Asia.

(10) ASEAN Guidelines on Fostering a Vibrant Ecosystem for Startups across Southeast Asia 2020. Reference for AMS to build and sustain a vibrant ecosystem for scalable startups.

(11) ASEAN Online Business Code of Conduct 2020. Established 15 core commitments to consumers, particularly for emerging e-commerce transactions.

(12) ASEAN Online Sale Day 2020. Gave enterprises across AMS opportunities to promote their domestic products and services to customers across ASEAN.

(13) ASEAN Payments Policy Framework for Cross-Border Real Time Retail Payments within the ASEAN Region and Its Implementing Policy Guidelines. Set out the vision for ASEAN payments integration and provided components for implementing the Framework to facilitate cross-border real-time retail payments.

(14) ASEAN Public-Private Partnership Regional Framework for Technology Development in the Food, Agriculture, and Forestry (FAF) Sectors 2017. Set out guidance for AMS on creating predictable and efficient PPP environments to promote technology development and dissemination in FAF value chains.

(15) ASEAN Regional Guidelines on Promoting Climate Smart Agriculture 2015. Comprised of three pillars: sustainably increasing agricultural productivity and incomes, adapting and building resilience to climate change, and reducing greenhouse gas emissions from agricultural production and processing.

(16) ASEAN Regional Guidelines for Promoting Climate Smart Agriculture (CSA) Practices, Volume II (2017). Introduced best practices for agricultural insurance, integrated farming systems, and climate services for agro-advisories.

(17) ASEAN SME Academy. A one-stop, open-access gateway providing self-paced training resources for ASEAN MSMEs.

(18) ASEAN Access (formerly known as the ASEAN SME Service Centre web portal). A one-stop shop and information portal for internationally-oriented SMEs and businesses interested in working in the region and beyond.

(19) ASEAN Strategic Action Plan for SME Development 2016-2025. Established strategic goals to create globally competitive, resilient, and innovative MSMEs in ASEAN.

(20) ASEAN Trade Facilitation Framework 2016. Comprised four elements:

a. ASEAN Customs Transit System (ACTS) 2020. Established an enhanced flow of goods, services, labour, and capital in ASEAN.
b. ASEAN Single Window (ASW) 2018. Avenue for the digital exchange of trade-related documents between AMS.
c. ASEAN Solutions for Investments, Services, and Trade (ASSIST) 2016. Provided a consultative mechanism for issues encountered by enterprises related to cross-border goods or service transactions.
d. ASEAN Trade Repository (ATR). Provided information on the trade laws and procedures of each AMS.

(21) Bandar Seri Begawan Roadmap. Established the ASEAN Digital Transformation Agenda to Accelerate ASEAN's Economic Recovery and Digital Economy Integration.

(22) Digital Trade Standards and Conformance (DTSC) Work Programme (2021-2025).

(23) e-ASEAN Framework Agreement 2000. Provided measures to develop the ICT Sector through the public and private sectors by liberalising trade in ICT products and services, and by reducing digital divides.

(24) Guideline on Accountabilities and Responsibilities of E-Marketplace Providers 2019. Guidance on creating a conducive environment for the growth of e-commerce platforms, unlocking cross-border trade opportunities, and fostering development of consumer confidence in the region.

(25) Policy Guideline on Digitalisation of ASEAN Micro Enterprises 2019. Identified guidelines for AMS on enabling an environment for micro enterprise adoption of digital tools and digitalisation.

(26) Quick Response (QR) Codes Interoperability Initiative among AMS 2021. Facilitated linkages for cross-border QR payments and remittances between AMS.

(27) Report on the Roadmap and Action Plan to Promote Smart Manufacturing Development in ASEAN 2020. Evaluated the current status and needs of AMS on smart manufacturing and established an action plan to promote smart manufacturing for AMS.

(28) Kuala Lumpur Transport Strategic Plan 2016-2025, also recognised as the ASEAN Transport Strategic Plan 2016-2025. Outlined the goals, actions, and milestones for air transport, land transport, maritime transport, sustainable transport, and transport facilitation.

(29) Work Plan to Implement the ASEAN Agreement on Electronic Commerce 2021-2025.

(1) ASEAN Communication Masterplan (ACMP) II 2018-2025. Provided detailed communication strategies and approaches to engage key audiences, such as local communities, businesses, and Civil Society Organisations (CSOs).

(2) ASEAN Declaration and Roadmap on Human Resources Development (HRD) for the Changing World of Work 2020. Statement on developing a roadmap supporting technology skills adoption and enhancing ASEAN's human resources to contribute to ASEAN's sustainable development, competitiveness, and resilience. The roadmap outlined key areas to promote cultivation of lifelong learning cultures, inclusive education, and employment; develop demand-relevant competencies and qualifications; and improve employability, job quality, enterprise competitiveness, and sound HRD policies and financing.

(3) ASEAN Declaration on Strengthening Social Protection 2013. ASEAN's statement on reducing vulnerabilities and risks, with a focus on the poor, persons with disabilities, the elderly, out-of-school youth, children, migrant workers, and other vulnerable groups.

(4) ASEAN Early Childhood Care, Development, and Education (ECCDE) Quality Standards 2017. Baseline requirements, rating system, and implementation guidelines needed to enable quality early childhood care in ASEAN

(5) ASEAN Enabling Masterplan 2025. Mapped key action points to the rights of persons with disabilities.

(6) ASEAN Framework Action Plan on Rural Development and Poverty Eradication 2016-2020. Mapped the action plan's components to corresponding programmes, projects, activities, timelines, and coordinators.

(7) ASEAN Labour Ministers' Statement on the Future of Work: Embracing Technology for Inclusive and Sustainable Growth 2019. Statement on increasing community workforce capacity in line with technological advances, demographic transitions, and the green economy.

(8) ASEAN Strategic Plan on Culture and Arts 2016-2025. Six strategies with corresponding action points and implementation arrangements supporting cultural understanding among AMS.

(9) ASEAN Strategic Plan on Media and Information 2016-2025. Four strategies supporting information access, information dissemination programmecare development, communication technologies, and stakeholder engagement.

(10) ASEAN Work Plan on Sports 2021-2025. Mapped key elements and priority areas on the promotion of ASEAN through sports to foster development, peace, sports integrity, sports for all, sport science, sports tourism, and the sport s industry.

(11) ASEAN Work Plan on Education 2021-2025. Expected outputs include improved learning effectiveness and inclusiveness at the basic education and secondary levels through the promotion of digital transformation, improved TVET quality through quality assurance, personnel capacity building, innovations, and mobility for changing labour market demands.

(12) ASEAN Work Plan on Youth 2021-2025. Action plans focused on education, health and well-being, employment and opportunity, participation and engagement, as well as the promotion of ASEAN awareness, values, and identity.

(13) Bali Declaration on the Enhancement of the Role and Participation of the Persons with Disabilities in ASEAN Community and Mobilisation Framework of the ASEAN Decade of Persons with Disabilities 2011-2020. Statement on developing opportunities for persons with disabilities in areas such as employment, education, political participation, recreation, and independent living and recreation, among other things.

(14) Chairman's Press Statement on the Launch of the ASEAN Centre for Active Ageing and Innovation (ACAI) 2019. Highlighted establishment of a dedicated knowledge centre for the ageing and the elderly to support evidence-based policies and strategies, capacity development programmes, and innovation for active ageing.

(15) Concept Note of the ASEAN Smart Cities Network (2018). Outlined the ASEAN Smart Cities Network as a collaborative platform that works toward the common goals of smart and sustainable urban development.

(16) Declaration on Socially Responsible Media for a Peaceful and Prosperous Community 2014. Outlined social responsibilities for traditional, mainstream, and new media.

(17) Framework and Joint Declaration to Minimise the Harmful Effects of Fake News 2018. Outlined strategies to address fake news, including education and awareness, detection and response, and norms and guidelines.

(18) Framework for Developing Digital Readiness among ASEAN Citizens. Frame of reference for AMS to take stock, exchange best practices, and continually enhance approaches to digital readiness.

(19) Framework for Promoting Accessibility for All in ASEAN Digital Broadcasting. Guidelines for AMS to promote broadcasting access services, namely closed captions, audio description, and sign language for all groups, including the vulnerable.

(20) Future ASEAN Agenda on TVET 2020. Included policy reforms recommendations for the TVET labour market in ASEAN.

(21) Go Digital ASEAN. Designed to equip MSMEs and youth, particularly those in rural and isolated areas, with crucial digital skills and tools, expand economic opportunity across ASEAN countries, and minimise effects from the COVID-19 crisis.

(22) Joint Statement of ASEAN Youth Ministers on Enhancing Youth Cooperation for a Cohesive and Responsive ASEAN Community 2020. Promoted inter-AMS collaboration and relationships driven by ASEAN youth to overcome the challenges of COVID-19 and realise the digital transformation opportunities of the 4IR and other disruptions in the future.

(23) Regional In-Service Training Modules for Industry 4.0 in TVET and Its Implementation 2020. Included modules covering innovative teaching and learning, professional development training, and curriculum design.

(24) The ASEAN Human Rights Declaration. Articles referring to the right to privacy (21) and the right to information (23), among other things.

(25) The Five-Year Work Plan (FYWP) of the ASEAN Intergovernmental Commission on Human Rights (AICHR) 2021-2025. Called for the conduct of an AICHR consultation and dialogue on human rights and the impact of 4IR in the digital age.

(26) The Narrative of ASEAN Identity 2020. Guiding principles and values for The ASEAN Identity, accompanied by parameters that included ASEAN Awareness, ASEAN Relevance, and ASEAN Appreciation to measure the entity's success.

(27) TOR of ASEAN Technical and Vocational Education and Training (TVET) Council 2020. Stated the vision, mandate, objectives, functions, priority areas, governance mechanism, and stakeholder engagement mechanism of the ASEAN TVET Council. One of the Council's objectives is to support the advancement of access to TVET for all especially for 4IR-related technological and digital skills.

(1) ASEAN Comprehensive Recovery Framework. Broad strategies, initiatives, and target deliverables for the COVID-19 pandemic.

(2) ASEAN Declaration on Culture of Prevention for a Peaceful, Inclusive, Resilient, Healthy, and Harmonious Society. Provided a cross-Sectoral platform for collaboration to promote and embed preventive mind-sets to address human, social, and sustainable development.

(3) ASEAN Innovation Roadmap 2019-2025. Suggested focus areas, such as innovation policy, support for startups and enterprises, mobility, and intellectual property management to create a vibrant innovation ecosystem in ASEAN.

(4) Master Plan on ASEAN Connectivity 2025. Implementation strategy for sustainable infrastructure, digital innovation, seamless logistics, regulatory excellence, and people mobility.

Annex 3: Definitions of 4IR-related technologies

In the context of this document, 4IR technologies include the following:

Cloud-Based Applications

A cloud-based application is defined as a software or platform that processes its data in the cloud instead of a local server. Service models surrounding the cloud include Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). The use of cloud-based applications, such as Google Drive, Dropbox, and Amazon Web Services in ASEAN is on the rise. The cloud-based applications global market is projected to reach USD 362.3 billion by 2022. Within ASEAN alone, IaaS has been forecasted to grow at a compounded annual growth rate (CAGR) of 19.8% between 2020-2024 – a rate that is significantly higher than the region's forecasted GDP growth. This trend is driven by a shift in IT spending caused by the COVID-19 pandemic that has required corporations to establish conducive environments for remote work, relying on online file storage services and data centres instead of traditional office-based servers. These needs have been reinforced by rising demands for big data, Internet of Things, and other 4IR technologies that depend on cloud-based applications and storage for value creation and addition.

Flexibility and cost effectiveness are some of the positive implications that come with cloud adoption. This is supported by a report by global technology house Cisco, which stated that cloud data centres would process 94% of workloads by 2021. However, risks such as cybersecurity and data governance remain, requiring timely and careful consideration by stakeholders before adoption.

Blockchain

Blockchain is defined as a distributed (decentralised) database that acts as an open, shared, and trusted public ledger that is tamper-proof and can be inspected by everyone. The series of systems involved in a blockchain transaction ensures data is secure and validated without incurring high transaction costs. Examples of blockchain applications include cryptocurrencies and other similar online transactions.

Widespread adoption of blockchain technology is reflected in a survey conducted by Deloitte, which said that 55% of global organisations have positioned blockchain as a top-5 strategic priority. The market is projected to increase to USD 39.7 billion by 2025 worldwide and spending on related solutions is expected to reach USD 11.7 billion by 2022, with the highest adoption in the banking industry. Embracing blockchain technology has benefits such as reduced transaction costs, better efficiency due to quicker transactions, and transparency. In light of its rapid adoption, however, regulation of the technology will be necessary to ensure privacy is protected.

Internet of Things (IoT)

Gartner defines the Internet of Things (IoT) as 'the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment'. There are currently five common types of IoT applications: Consumer IoT, Commercial IoT, Industrial IoT (IIoT), Infrastructure IoT, and Military Things. IoT is seeing increasing use in society, as per the example of Smart Home applications that connect home appliances and devices so that they may be controllable from another device (e.g., a mobile phone).

With the evolving demand for connectivity and integration of networks, technology developments, and the need for cost optimisation driving the need for IoT, the IoT global market is expected to grow to USD 2.4 trillion annually by 2027. It is expected that IoT will continue to streamline business. As IoT is embraced, efficiency and productivity are likewise expected to rise.

For societies such as ASEAN to fully embrace IoT, however, threats such as data leaks and cyberattacks must be effectively managed and addressed by new regulations to ensure secure usage by governments, business, and citizens.

Robotics

Robotics allows users to configure computer software and hardware and use user interfaces to perform processes and tasks, thus allowing the execution of processes at a lower human capital cost.

Robotics can assist corporations to improve quality and productivity while reducing the cost of production. This has led to its common application in the automobile manufacturing industry as well as other manufacturing sectors to perform repetitive and mundane tasks such as bottling, coupling, labelling, and assembly, among other things. With cost and production efficiency as the main priority for most physically laborious and highly industrial sectors, it is no surprise that there has been an uptick in the adoption of robotics technology globally, where it is projected to achieve revenues of USD 1.89 billion by 2021.

While the economics of robotics are considered advantageous in the long run, this typically also results in the threat of irreversible replacement for human workers. This points to a need in ASEAN to continuously reskill and upskill its labour force, especially the marginalised, so as to ensure that the implementation of 4IR technologies will be inclusive and will not result in further marginalisation.

Additive Manufacturing

Utilising computer-aided-design and additive manufacturing (commonly known as 3D printing) allows for the production of precise objects that are potentially stronger, lighter, and more readily available instead of being constrained by production sites and supply chains.

Additive manufacturing is highly beneficial for spare parts, such as for aircraft or automobiles, or for medical devices, such as prosthetics and wearable devices. The global additive manufacturing market is projected to reach USD 13.75 billion by 2027, largely driven by decreases in product lifecycles due to the need to meet constant and increasingly challenging changes in consumer demands. In ASEAN, the penetration rate of additive manufacturing was only 6%, or USD 3.8 billion, as of 2019, despite its potential to generate USD 100 billion in economic value and create 4 million jobs in the region. Reduced costs due to a potential lower reliance on imports and the elimination of warehousing costs are a few illustrations of additive manufacturing's benefits.

While highly beneficial, high set-up costs and complications surrounding IP regulation continue to stunt additive manufacturing's growth, thereby requiring attention from governing bodies.

Augmented Reality

Augmented reality (AR) is the integration of real-time information in the form of text, graphics, audio, and other virtual enhancements into real-world objects or environments.

Among the first successful and widespread use of AR technology in ASEAN was the commercial launch of video-game manufacturer Nintendo's Pokemon Go app in 2016, where AR was combined with GPS and other social features to allow users to catch Pokemon in an augmented world. This resulted in a widespread acceleration in awareness regarding AR that quickly expanded the technology's possibilities to include a wider range of applications. Among such applications are those in the health careindustry, where AR is now used in medical laboratory education and to diagnose patients by providing more accurate illustrations of a disease and the consequences on a patient's body. With the COVID-19 pandemic driving the need for contactless and hyper-realistic innovations, the AR market is forecasted to reach USD 72.8 billion globally by 2024.

However, a general lack of regulation governing AR is resulting in cyberthreats that are impeding AR technology's widespread adoption. Economies such as ASEAN will require that these be addressed for Community members to continuously benefit.

Big Data and Advanced Analytics

Big data and advanced analytics are defined as the use of advanced techniques to analyse very large, diverse data sets that include structured, semi-structured and unstructured data from different sources that come in different sizes – from terabytes to zettabytes.

With the amount and complexity of data that the world is amassing every second of every day, the global market for big data and advanced analytics is expected to reach USD 105.1 billion by 2027. Applications of big data and advanced analytics include improved customer understanding, which allows for the customised formulation and delivery of goods and services such as for e-commerce or online education courses. Another instance would be to improve harvest yields within the agriculture industry through the identification of issues at more granular scale, allowing farmers to identify the best approaches from sowing to harvesting.

To obtain accurate analyses, however, this technology requires large volumes of data. With highly specific and usable data still lacking in many sectors, a critical first step is to gather and organise relevant big data prior to performing analytics. This can be achieved through sensing hardware – whether analogue or smart – or IoT rollouts, effectively causing hurdles for most stakeholders due to potentially high initial investment costs. Further, a lack of proper regulation on data usage and cybersecurity gives rise to increased risks for data breaches or misuse, compounding initial investment costs to account for needed cybersecurity measures.

Artificial Intelligence

Gartner defined artificial intelligence (AI) as the application of advanced analysis and logic-based techniques, including machine learning, to interpret events, support and automate decisions, and take action. AI's importance has been on the rise globally, with its USD 27.23 billion value in 2019 increasing to USD 266.92 billion by 2027, driven by an increase in digital data and the need to effectively provide predictive and data-supported analyses.

Within ASEAN, AI has the potential to contribute up to nearly USD 1 trillion to ASEAN's GDP. This potential refers to applications such as predictive algorithms to provide customised teaching approaches to students, effectively enhancing student learning experiences and streamlining education services. Other industries such as health carecan likewise adopt AI to assist in research and development, allowing limitless simulations and eventually allowing data-driven scenarios to gradually improve results. AI-powered chatbots similarly reduce the need for face-to-face visits with doctors, allowing patients with non-complex symptoms to rely on AI recommendations instead, freeing up medical professionals for more complex problems. Similar applications are often explored by manufacturers or service providers for first-line customer service, resulting in a streamlining of customer complaints and the better use of human resources.

Despite its numerous applications, AI presents risks similar to that of big data and analytics, especially concerning potential cybersecurity breaches and data misuse.

Annex 4: Digital Transformation and Education

Early education

Early childcare and development have been acknowledged by experts, policy makers, governments, and parents as a critical foundation for development. Notwithstanding the issues relating to the overexposure of children to digital technology, technologies introduced in early childhood and in moderation can generally enable children to learn and demonstrate creativity. Child-computer interactions can contribute to high-quality early education, which is characterised by its adaptiveness, accessibility, and use of evidence-based teaching approaches. This focus ensures progress for all children, especially when coupled with diagnostic tools. Digital literacy exposure at this stage of development allows children to increase their cognitive skills for accessing, using, creating digital content, thereby ensuring that no child is left behind in the technological revolution, which will enhance their chances for success in adulthood.

Moving forward, policies related to digital literacy education at an early age should keep pace with international standards. Societies should allow for early education providers to exercise creativity and discover new teaching methods to continuously engage and enhance children's grasp of technology. Education policies that push for the strengthening and free flow of methods should be promoted, such as digitally enabled curricula; digitalised and cloud-based records; and IoT-enhanced examinations, books, and classrooms to provide a more customised learning approach for students. These will be especially helpful for children with learning disabilities, as utilising tools such as adaptive computing and augmentative communication systems that can assist students with challenges such as speech barriers. There are foreseeable challenges, including gaps in human resources and infrastructure, so these must be anticipated and addressed in a timely manner to ensure sustained progress overall.

Secondary education

Secondary education forms the baseline requirement for employment across ASEAN. This culminates what is considered as basic education, which leads to greater productivity contributions to the economy. There are approximately 100 million secondary school-aged children in ASEAN. Close to 20% of these children are not enrolled. With the COVID-19 pandemic, children have been dropping out of school at an alarming rate, projected to be at 24 million globally, due to the challenges brought about by distance learning and infrastructure limitations.

Anticipating the gap in skilled workers within the employment pool, secondary schools must prepare and adjust to meet future demands. Education 4.0 can respond to this with the alignment of human and machine, capitalising on the potential of digital technology, open resources, and a globally connected education. Digital training in schools must be able to instill the societal value of using tools and technologies, and ensure that education is inclusive, adaptive, and accessible for all young adults. With this type of training, young adults will possess the ability to evaluate, innovate, and develop technology and be able to identify how, why, when, and where to use any types of digital tools. This will also help students develop four key skills: critical thinking, communication, collaboration, and creativity, along with the incorporation of science, technology, engineering, arts, and mathematics into curriculums.

Higher education

With the COVID-19 pandemic accelerating the need for more advanced skill sets that can only be attained from higher education programmes, government leaders are starting to see first-hand how learners with high quality instruction, technology, connectivity, and access to new and better resources will have an impact on the speed at which nations recover economically and socially in the years to follow.

In ASEAN, where there are up to 12 million students studying at over 7,000 higher education institutions, the challenge that must be resolved by universities is improving the quality of education management through the 4IR. Despite holding the Top-1 position through the National University of Singapore, ASEAN holds only 17 slots in Asia's Top 100 according to QS Top Universities in 2021, suggesting a need for continued improvement throughout the region to increase overall competitiveness by converging their curriculums with the latest innovations and industry developments. For this to fully materialise; hardware, software, and internet infrastructure must be properly improved to ensure unobstructed access. There must, in particular, be effective collaboration between Technical and Vocational Education and Training (TVET) and higher education mobility, as the disruption caused by the COVID-19 pandemic has been adverse. Apart from causing major disruptions to teaching, learning, and research; the pandemic has adversely affected the many internationalisation of activities by universities, most notably regarding the mobility of students and staff.

One critical response to the COVID-19 is a major increase in interest and activities relating to virtual student mobility (VSM), or the use of information and communications technology (ICT) to create cross-border collaborations that enhance intercultural understanding and knowledge exchange. These activities can take place in a fully supported ICT environment as a complement to physical mobility. Since the 4IR has forged an irreversible and seamless connection of the physical and digital worlds, ASEAN must consider VSM adoption as a permanent option for the Education Sector. VSM brings advantages at a time when borders and campuses are closed, and when over 60% of higher education institutions around the world have increased virtual mobility provisions during the pandemic. VSM has the potential to lower the costs associated with international travel, to expand access, and to be a more environmentally sustainable option.
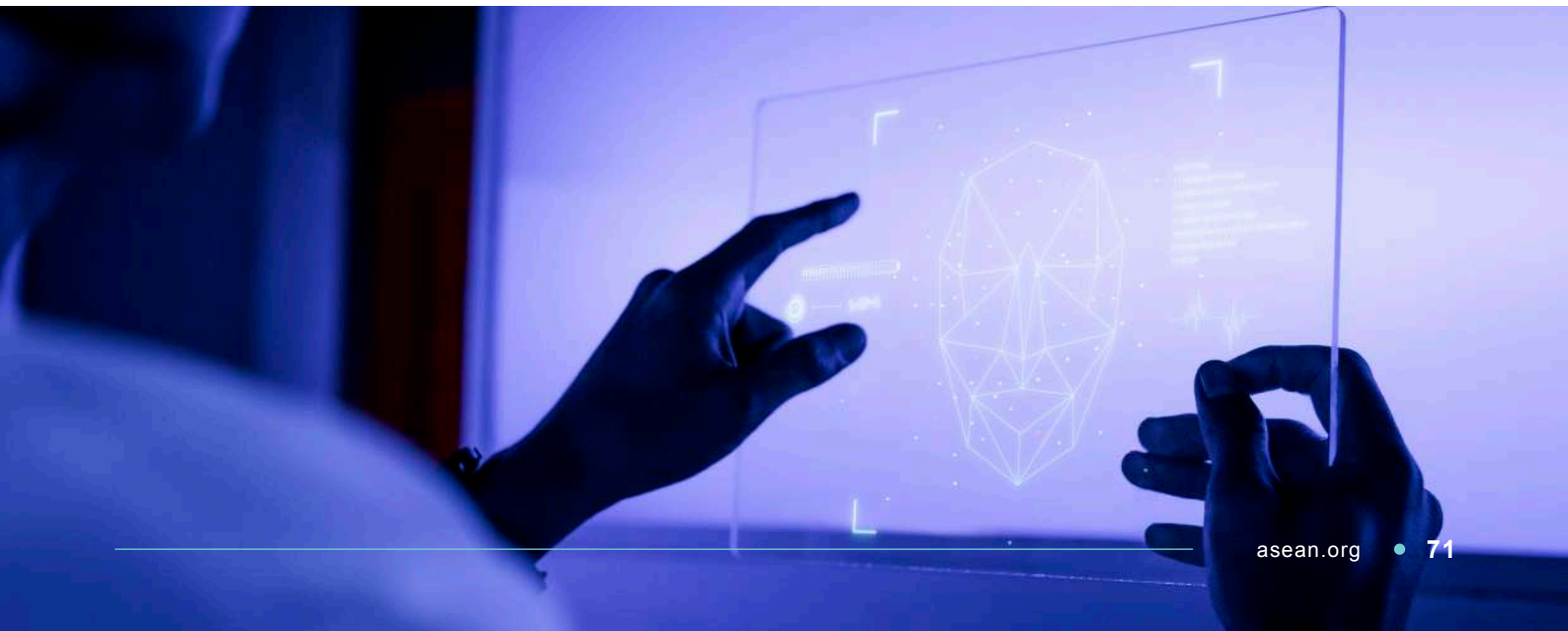
Vocational education

With most of the 4IR occurring in recent years, a large share of ASEAN's population is facing this shift beyond their formative years, leaving many to turn to vocational education programmes to catch up with changing times. Vocational educational programmes must continuously transform and adopt new technologies to remain relevant and effective in their delivery of information of the same topics. This has led to TVET ranking high on the agenda of ASEAN, where five technologies drive most digital transformation: ubiquitous computing, collaboration technologies, extended reality, artificial intelligence, and blockchain.

Besides inclusion within curriculums, structured technical apprenticeship programmes with good cooperation and linkages between vocational schools and industries will enable students to receive the right digital skills training and on-the-job experience, thereby ensuring programme alignment with business and industry needs. 4IR technology can also support TVET operations and delivery, addressing challenges such as low participation rates, access in rural areas, sustained public spending, and quality. ASEAN's Future Agenda on TVET and Declaration on Industrial Transformation to Industry 4.0 can serve as the foundation for future initiatives in this space.

Collaboration between TVET institutions and universities is likely to address the inequitable nature of TVET, by improving its social status and acceptance, as well as allowing higher income opportunities and greater mobility for TVET graduates, especially for those from disadvantaged socio-economic backgrounds. Transition pathways from TVET to higher education generally refer to arrangements that enable students to progress from one qualification to another, through admission or credit transfer, or both, on a defined qualification pathway. A framework to accept credit transfers between institutions in ASEAN – within and between AMS – should be considered.

Continuing education programmes

Countries face two moving targets in the coming decade: meeting the Sustainable Development Goals and raising national skill levels to survive and thrive in the 4IR. To meet these targets, continuing education students should be equipped with 4IR skills, namely communication, creativity, collaboration, and critical thinking, which have been adopted globally by business and society. Students of all ages should be encouraged to take ownership of their education and discover new ideas even when they are not in the classroom, as education need no longer be linear in light of the 4IR. As working-class adults may not be able keep pace with the rapid changes in digital transformation, it is imperative for continuing education programmes to be digital to empower this segment of the population for further learning. To facilitate this, knowledge management within institutions is needed to support the introduction of digital learning formats in public and community-based continuing education organisations. An acknowledgement of the critical role that continuing education plays in creating a digital-ready workforce is also critical, as this sets up societies to promote public-private partnerships that encourage corporations to invest in upgrading and re-skilling their current employees, in particular through method that embrace the 4IR. Finally, ASEAN must also allow for the promotion of capacity development by government agencies in designing and evaluating skill development programmes for all, with more focus on self-employed and informal and gig workers.

Other forms of education or learning intervention

In other forms of education and learning intervention, the reduction of digital literacy gaps, including those driven by the language of technology, must always be a concern alongside innovation. Innovation in this case potentially creates blended learning experiences that combine both traditional classroom-based methods and 4IR-enabled methods, in particular for 4IR topics that freely cross between the physical and digital worlds.

In light of the shifting processes of teaching and learning, individualised learning, learning on demand, cloud-based learning, and innovative learning environments like mixed-reality simulations, augmented reality, and remote laboratories must be considered to ensure that all citizens have equitable access to learning intervention opportunities at different stages of their lives.

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