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Resilient nations.*

Development 4.0

Opportunities and Challenges
for Accelerating Progress
towards the Sustainable
Development Goals in Asia
and the Pacific

Written by:

**The
Economist**

**INTELLIGENCE
UNIT**

Development 4.0

**Opportunities and Challenges
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and the Pacific**

About this report

This document builds on a research programme undertaken by The Economist Intelligence Unit between January and May 2018 and supported financially by the United Nations Development Programme (UNDP). The views and opinions expressed in this publication are those of The Economist Intelligence Unit and do not necessarily reflect the official position of the UNDP. The foreword and policy recommendations sections were written by the UNDP.

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The Economist Intelligence Unit

Stefano Scuratti, Project Director: stefanoscuratti@economist.com

Jennifer Wells, Senior Marketing Executive: jenniferwells@eiu.com

The United Nations Development Programme (UNDP)

Jaco Cilliers, Chief – Regional Policy and Programme for Asia and the Pacific: jaco.cilliers@undp.org

Scott Stanley, Regional Economics Specialist, Asia and the Pacific: scott.stanley@undp.org

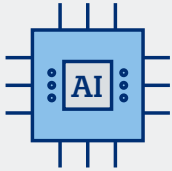
Taimur Khilji, Regional Economics Specialist, Asia and the Pacific: taimur.khilji@undp.org

Mahtab Haider, Communications Specialist, Asia and the Pacific: mahtab.haider@undp.org

Cedric Monteiro, Regional Communications Advisor for Asia and the Pacific: cedric.monteiro@undp.org

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Foreword by the United Nations Development Programme

Rapid advances in technology will profoundly affect societies in Asia-Pacific. The Fourth Industrial Revolution—characterised by innovations such as artificial intelligence, automation, and bio-technology—is likely to transform existing systems of production, management, and governance. How countries embrace and adapt to the coming technological changes will determine whether they meet the promise of the *2030 Agenda for Sustainable Development* and achieve the Sustainable Development Goals (SDGs).

UNDP partnered with the Economist Intelligence Unit (EIU) to review the likely implications of this technological revolution on progress towards the SDGs in the Asia-Pacific region. The resulting analysis identifies the region's risk flashpoints, the channels through which risks might constrain SDG progress, and, critically, the ways that new technologies might be harnessed to advance rather than hinder sustainable development.

The Fourth Industrial Revolution is also converging with other mega-trends, including rapid demographic transition and growing consequences of climate change. This convergence is pushing countries to fundamentally reconsider and adapt existing arrangements between governments and citizens. This includes assessing the suitability of current approaches to, among other things, democratic governance, the definition of work, privacy, basic citizen rights, and the obligations of the state to its people.

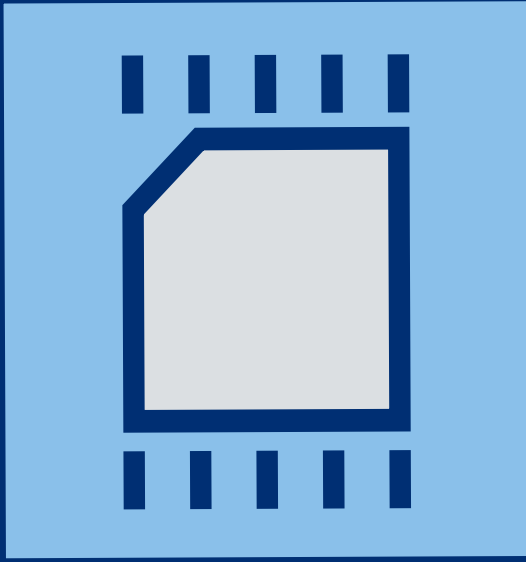
Governments have an opportunity to pro-actively embrace this moment and the call for transformative change. Reactive policies and institutions will be increasingly ill-suited to manage the impact of technological innovation or to capture its potential to help strengthen approaches to sustainable development. In the coming era, those governments more likely to accelerate progress towards the SDGs will be those that actively design policies and institutions that are more predictive, adaptable, and responsive to citizen needs.

Designing new social and economic approaches is daunting and will not happen overnight. This report points to several key policy areas where governments can begin assessing and adapting their current approaches, institutions, and policies for the coming era. Building on the report's analysis, UNDP has specifically identified five critical themes that can help form the basis for transformation: 1) Embrace predictive and adaptive decision-making; 2) Capture emerging sources of growth and employment; 3) Reimagine citizen engagement and personalised service delivery; 4) Enhance protection to leave no one behind; and 5) Mobilise and allocate finance for a better future.

These represent critical domains where governments—together with civil society, the private sector, and development partners—can evaluate current approaches, consider future scenarios, and create and test new systems and models. This does not represent a comprehensive set of recommendations covering all the ways technology is likely to affect societies. A regional overview also cannot develop a policy roadmap for any specific country. The Asia-Pacific region is diverse and the Fourth Industrial Revolution will affect countries in different ways. But this report and the accompanying UNDP policy recommendations highlight critical areas where action now can boost a country's ability to capitalise on opportunities arising from the inevitable technological change underway. It is up to each government to develop solutions appropriate to their own economic and social context. This report and recommendations aim to support this process, principally by identifying themes for further analysis and by guiding policy and institutional design that can help societies embrace the opportunities afforded by technological change and manage the possible negative consequences of it.



Executive summary



The Asia-Pacific region is in the throes of a digital transformation, accelerated by technological change, including intelligent robots, autonomous drones, sensors, and 3-D printing. Countries must adapt or be left behind if they are to achieve the Sustainable Development Goals.



Over 60% of salaried workers in Indonesia, the Philippines, Thailand and Vietnam occupy positions at high risk of automation.

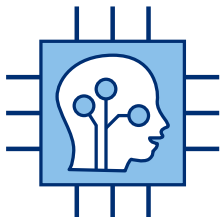


Progress on at least nine Sustainable Development Goals could be directly affected by the Fourth Industrial Revolution, and millions in Asia's emergent middle class could slide back into poverty.



Possible responses include strengthening social protection policies, leveraging AI and automation to optimise public services, promoting the use of technology to solve ecological challenges, and supporting new growth sectors.

Automation, artificial intelligence (AI) and the innovations of the “Fourth Industrial Revolution” are penetrating everything from automotive, garment and electronics manufacturing to business processes, logistics and healthcare. The benefits, in terms of efficiency, productivity, speed and agility, are undoubted.



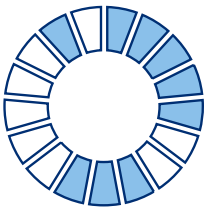
UNEMPLOYMENT IS THE MOST COMMONLY DISCUSSED THREAT. LABOUR ORGANISATIONS, GOVERNMENTS AND ECONOMISTS ARE CONCERNED THAT HUMAN WORKERS ARE VULNERABLE TO REPLACEMENT AT AN UNPRECEDENTED SCALE AND SPEED.

These innovations could make products safer, increase industrial productivity, shorten global supply chains and make public services more personalised, predictive, and participatory, as citizens both provide and benefit from increasing data flows around public services. However, as with all technological change, their impact will be shaped by choices and the ends to which they are put. Just like nuclear fission could create civilian energy or military weapons, these innovations could have a wide range of applications and impacts – both positive and negative.

Unemployment is the most commonly discussed threat. Labour organisations, governments and economists are concerned that human workers are vulnerable to replacement at an unprecedented scale and speed, which could worsen inequality, undermine social cohesion, and increase poverty. Machine learning (ML) and automation, through which physical and digital robots acquire abilities once considered uniquely human – like

strategic thought, self-corrective learning and context-responsiveness – could replace many lower- and middle-class jobs that have been engines of social mobility in times past. This is not just a threat to jobs but also to the tax base in nations where formal employment in at-risk sectors like manufacturing and business service outsourcing is threatened.

WHAT CONTRIBUTION CAN THESE TOOLS MAKE TO THE ACHIEVEMENT OF THE SDGs, AND IN WHAT WAYS DO THEY THREATEN PROGRESS? HOW, WHEN AND BY WHOM WILL THESE IMPACTS BE FELT?



To date, the debate about the impacts of automation and AI on society has largely focused on the developed world and China, where most of said innovations are clustered. But the development community is taking an increased interest in the opportunities and threats posed by innovation. What contribution can these tools make to the achievement of the Sustainable Development Goals (SDGs), and in what ways do they threaten progress? How, when and by whom will these impacts be felt? What can be done to avert negative outcomes and ensure that automation, AI and the new digital economy make a net positive contribution to the SDGs?

This report presents a structured, developing Asia-focused assessment of these questions. It outlines the positive and negative channels through which AI and automation will impact the achievement of the SDGs and then lays out the policy instruments available to governments to steer outcomes in developmentally constructive directions. This assessment evaluates policy instruments across three domains – economic, social and environmental – to ensure these technologies help, rather than hinder, progress to the 2030 goals.

Negative scenarios – and impacts on progress towards the Sustainable Development Goals

The report first presents the current literature on potential socio-economic downsides of automation and AI, examines current and near-term risks in Asia, and assesses what these mean across the manufacturing and services sectors.

It then identifies the impacts these risks would have on progress towards securing the SDGs. While pan-Asian, the report also identifies country-specific risk factors and flashpoints, and differentiates between countries facing threats to existing industries and those whose vulnerability is their potential *future* loss of entry into sectors they might otherwise have hoped to access.

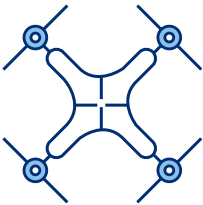
The report finds that at least nine SDGs could be negatively impacted in clear ways, primarily through the direct and indirect consequence of increased unemployment, but also through other channels such as dangers and threats in emergent sectors like the "gig" and "on-demand" economies. Throughout, the report pays particular attention to the impact of technological change on gender, particularly in terms of the economic empowerment of women. How these new technologies are developed could make a positive contribution to gender equity, or deepen inequality.

Positive scenarios – and impacts on sustainable development

Negative forecasts and predictions are informed by already existing, or conceivable, trends. But such an analysis alone would be one-sided. Human choices, policies, and institutional evolution will also shape the societal outcomes of technological change. Previous periods of rapid technological change led to the rise of new sectors and employment opportunities and contributions to the increased efficiency of public services. Automation and AI can also support the SDGs where stakeholders collaborate to find socially advantageous applications. For instance, drones and satellites are delivering health and humanitarian supplies in rural areas, and data analytics have guided disaster relief efforts. Precision agriculture is increasing agricultural yields and

reducing the use of harmful inputs, while AI is helping scientists track and predict the impact of climate change. In short, similar tools can be used in vastly different ways. Algorithms can help predict disease outbreaks, or help disseminate hate speech. Automation can mark student essays so teachers can focus on lesson planning and instruction, or replace customer service

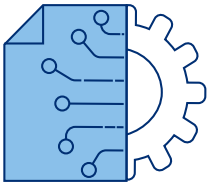
operatives. Acknowledging the dual uses of all these innovations, the second dimension of the report articulates the ways in which automation and AI could support progress toward the SDGs and the channels through which those relationships could evolve.



DRONES AND SATELLITES ARE DELIVERING HEALTH AND HUMANITARIAN SUPPLIES IN RURAL AREAS, AND DATA ANALYTICS HAVE GUIDED DISASTER RELIEF EFFORTS.

Policy responses

This report shows that technology does not have pre-determined outcomes for society. What matters will be the degree to which governments, development actors, labour organisations and other stakeholders, including technology companies themselves, participate in, shape, nurture, and guide the innovation process towards socially and environmentally advantageous ends.



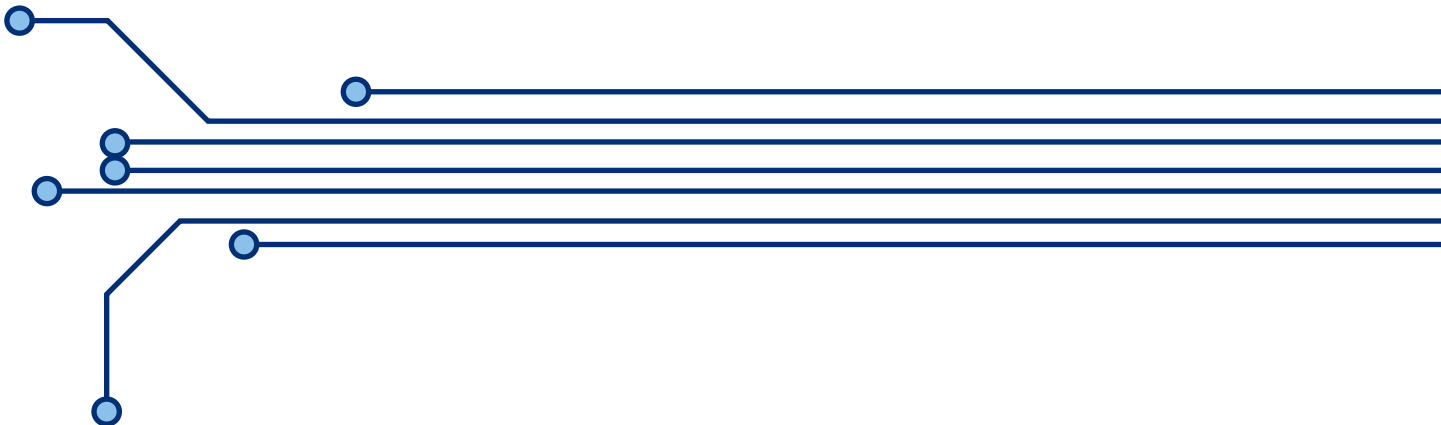
RESPONSES INCLUDE STRENGTHENING SOCIAL PROTECTION POLICIES, DRIVING GREATER USE OF AI AND AUTOMATION TO OPTIMISE PUBLIC SERVICES, PROMOTING THE USE OF TECHNOLOGY TO SOLVE NATURAL RESOURCE AND ECOLOGICAL CHALLENGES, AND MAXIMISING THE BENEFITS OF TECHNOLOGY TO SUPPORT NEW GROWTH SECTORS

Having thus mapped the positive and negative ways in which automation and AI could impact the SDGs, the concluding section of the report identifies interventions which, if pursued successfully, could ensure a positive impact across the three

broad domains: **economy, society and**

environment. This includes strengthening social protection policies, and the greater use of AI and automation to optimise public services, promoting the use of technology to solve natural resource and ecological challenges, and maximising the benefits of technology to support new growth sectors like the green and circular economy, digital technology and "network platforms", like ride-hailing and sharing economy apps, which are showing rapid growth both in Asia and globally.

This multidimensional perspective, alive to both positive and negative technological pathways and how they could impact achievement of the SDGs, can help the development community and governments to be mindful of the risks and, critically, to proactively embrace the opportunities, of accelerating technological change. This, in turn, can encourage development actors to focus on the institutional and governance reforms needed to ensure the net impact of new technology in the economic, social and environmental domains is positive.



Introduction, definitions and policy context

Over the last five years, AI and automation have seen unprecedented advances in speed, performance and scope. Situated within the broader “new digital economy”, covering emergent trends including the Internet of Things (IoT), ubiquitous smartphones, advanced data analytics and cloud computing, we are living in a “second machine age” set to unleash dramatic changes in human productivity, work and welfare, in a turbulent process of “wrenching change”¹.

“Techno-anxiety”, however, is on the rise, with a range of commentators, policymakers, think-tanks and economists worrying whether today’s innovations could replace humans in a growing number of physical and cognitive tasks, and if powerful AI could be put to malicious use. While much literature examines such issues in the West and China, where automation, AI and digital innovation is clustered, the implications for developing economies – and Asia in particular – are paramount. How worried should the development community be about technological acceleration? What are the risk factors, versus the upsides?

This report provides a structured analysis to help governments and development actors ensure that today’s technologies make a constructive contribution to the social, economic and environmental challenges facing the region. Examined through the prism of the SDGs, it identifies Asia’s risks, the possible negative impacts of new innovations, and the ways in which the policy community can respond to manage the downsides, and leverage the many benefits that new technologies can bring to support the ambitions of the 2030 Agenda for Sustainable Development.

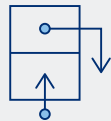
Definitions

Internet of Things



IoT refers to the fusion of Internet connectivity with everyday objects, enabling bidirectional data flows and "smart" products. Its subfield, the Industrial Internet of Things (IIoT), refers to machine-to-machine communication in industrial production, which includes "digital twins" that design units, and test and simulate production, helping to bring products to market faster, with more iterations and experimentation.²

Big Data



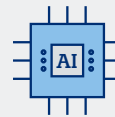
Big data refers to the generation and computation of very large datasets, both structured and unstructured. While there is no simple marker of "big" as opposed to conventional data, a popular definition refers to "three Vs" – volume, velocity and variety – while other commentators have added "variability" and "complexity".

Robotics and Automation




While robots have a long precedent in electronics and manufacturing, their roles are now expanding due to greater 3D situational awareness, flexibility and movement range, which enables them to carry out more diverse tasks such as stacking goods, and providing care services for the elderly.

Artificial Intelligence



Computer-based applications that carry out functions typically associated with humans, such as visual perception, decision-making, and speech recognition. AI's most recent advances include machine learning (ML), in which algorithm-driven tools can self-correct and learn over time. Robotic process automation (RPA) is the application of robotics to the processes of an increasing range of white collar jobs. In the words of AI visionary Andrew Ng, "if a task takes less than a second of thought, a machine can probably do it."³



Automation and the future of work: Contested narratives

Technology has historically brought disruptive change and created new employment that has often been safer and more productive. The latest wave of technological change is yet to deliver development gains on a par with previous periods



Researchers have identified a large range of tasks – and jobs – vulnerable to automation from current or future technologies.



Critics have warned of “premature deindustrialisation”, defined as the early withering of industry as a share of economic output in developing countries.



AI and automation have significant public sector implications, from reducing government bureaucracy to optimising service design and delivery.

The First Industrial Revolution (1760–1840) used water and steam power to mechanise production, beginning in Britain’s textiles industry.⁴ The Second Industrial Revolution, in the late 19th and early 20th centuries, harnessed electric power to enable mass production, and unleashed the tools of the modern age, including the internal combustion engine and modern communications.⁵ The Third Industrial Revolution of the 1970s brought electronics and information technology (IT) to production, and the Fourth Industrial Revolution of today is fusing physical, digital and biological spheres, evidenced by robotics, IoT, AI, additive (3D) printing and robotic software automation.⁶

These “four waves” impose a somewhat simplified linear order to what has in reality been a hesitant and uneven process, with some innovations existing for decades before widescale deployment, and long lags between new technologies and corresponding increases in productivity growth or, more importantly, human well-being. The Fourth Industrial Revolution is the most contestable of all as it has yet to deliver development gains on a par with previous periods.^{7 8}



THE PROSPECT OF SELF-LEARNING AND “THINKING” MACHINES IS SPARKING FEARS THAT THIS INNOVATION REVOLUTION MAY LOOK VERY DIFFERENT TO WHAT CAME BEFORE

What could distinguish today's era as a meaningful break from the past is the growing ability of machines – physical and informational – to self-learn and self-correct through “machine learning”. ML, which in some cases mimics the human brain through “neural networks”, vastly expands the types of activities that can be automated to include legal research, health diagnostics, policing decisions and customer services. Technology has always brought disruptive change, and often eliminated livelihoods, but it has also created new employment that has often been safer and more productive compared with the so-called “dirty, dangerous and demanding” jobs it replaced in areas like manufacturing. But today, the prospect

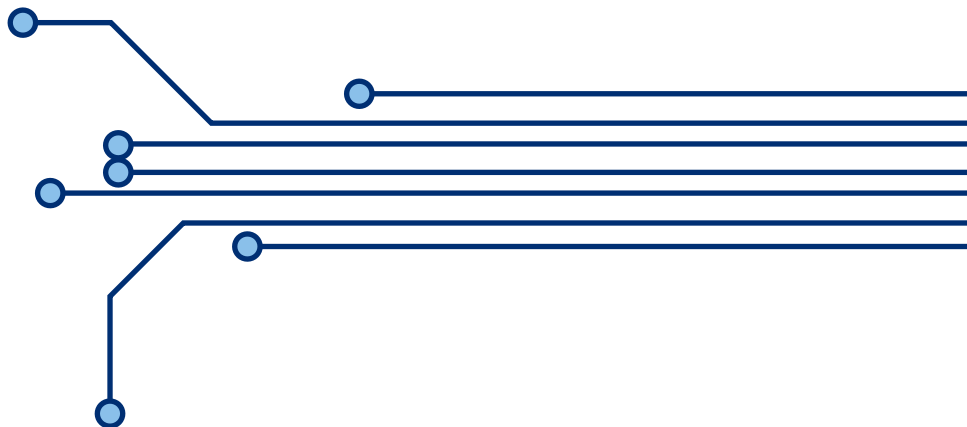
of self-learning and “thinking” machines is sparking fears that this innovation revolution may look very different to what came before.^{9 10 11}

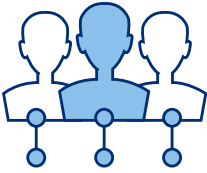


To date, the literature on automation and AI focuses mostly on its potential impact on employment, but there are broader concerns such as the prospect of “premature deindustrialisation” in developing economies, the loss of a common economic growth model (in the form of labour-intensive, export-focused manufacturing), and even the abuse of new powerful technologies like AI, be it through spying and surveillance or the use of algorithm-driven social media platforms to spread misinformation and foment tension. Fears about the power of new technology have even been voiced by the entrepreneurs at the heart of it, including Tesla founder Elon Musk and Facebook founders Mark Zuckerberg and Chris Hughes.¹²

The current discourse and literature falls into three areas: employment, premature deindustrialisation and public services.

THERE ARE BROADER CONCERNS SUCH AS THE PROSPECT OF “PREMATURE DEINDUSTRIALISATION” IN DEVELOPING ECONOMIES, THE LOSS OF A COMMON ECONOMIC GROWTH MODEL (IN THE FORM OF LABOUR-INTENSIVE, EXPORT-FOCUSED MANUFACTURING), AND EVEN THE ABUSE OF NEW POWERFUL TECHNOLOGIES LIKE AI BY NEFARIOUS STAKEHOLDERS





JOB LOSSES FROM AUTOMATION WILL NOT ALWAYS BE EVENLY DISTRIBUTED – EVIDENCE SUGGESTS THAT MEN TEND TO GAIN ONE JOB FOR EVERY THREE JOBS LOST TO TECHNOLOGICAL ADVANCES, WHILE WOMEN GAIN ONE JOB FOR EVERY FIVE JOBS LOST

1. Employment

Researchers have identified a large range of tasks – and jobs – vulnerable to automation from current or future technologies. One study put 47% of American jobs at risk, with a UK-based analysis identifying 36%, and other figures ranging from 55% in Uzbekistan to 86% in Ethiopia.^{13 14 15} Job losses from automation will not always be evenly distributed – evidence suggests that men tend to gain one job for every three jobs lost to technological advances, while women gain one job for every five jobs lost.¹⁶ This impact is worrying in its own right but also highlights a gender dimension, since some at-risk sectors such as garment manufacturing and business process outsourcing (BPO) are dominated by women, while increasing financial returns to STEM (science, technology, engineering and mathematics) education overwhelmingly flow to men. Women are also less able to take advantage of new opportunities in today's digital era, since they generally have less access to the Internet than men in most developing economies.¹⁷

The employment literature is not unanimous in its predictions. One OECD study critiques jobs-at-risk analyses for over-estimating unemployment by failing to distinguish between task and job automation, because some jobs described as at "high risk" of automation in reality include a range of tasks, only some of which are easy to automate.¹⁸ Employment forecasts are also complicated by the fact that technology brings "system effects" or beneficial "social overheads" that can offset the employment effects. Robert Gordon's history of American growth during the "special century" (1870–1970) notes how innovation and mechanisation helped eliminate child labour, free women from the home, lengthen lifespans and improve health and safety, such as through electric lighting (for more information, see the section on mitigating factors below).¹⁹

2. Premature deindustrialisation

Critics of neoliberalism, including Chang²⁰ and Rodrik,²¹ have warned of "premature deindustrialisation", defined as the early withering of industry as a share of economic output in developing countries, far sooner than was experienced by developed economies. This, they argue, is due to free trade frameworks that deny governments industry-boosting policy

tools like local content rules, subsidies and border protections to develop domestic industries. Rodrik believes this to have broader political implications for democracy itself because the labour movement has been a critical social actor, able to negotiate with elites the compromises and bargains (including social insurance and worker protections) that enabled the morphing of the working class into a middle class. Their critiques gain weight in the context of deepening automation. As the workforce fragments into gig workers, small enterprises and “petty services”, workers lose cohesion as well as the ability to organise and pursue their interests at a societal level.

3. Public services


AI and automation have significant public sector implications, from reducing government bureaucracy to optimising service design and delivery, which will be explored in the social domain section of this report. But there are also risks, including the embedding of racial, ethnic and gender biases in algorithm-based public services decisions such as those of policing and justice. Research shows that biased policing is aggravated due to data feedback loops which predict more crime in certain neighbourhoods, typically populated by a larger number of racial minorities.²² Artificial Intelligence and ML can “bake in” prevalent biases from the past into the future, whether it be image databases associating women with performing domestic chores and men with watching sports, or racial biases which increase police patrolling in ethnic minority areas.²³ Gender, race



ARTIFICIAL INTELLIGENCE AND ML CAN “BAKE IN” PREVALENT BIASES FROM THE PAST INTO THE FUTURE, WHETHER IT BE IMAGE DATABASES ASSOCIATING WOMEN WITH DOMESTIC CHORES AND MEN WITH SPORTS, OR RACIAL BIASES WHICH INCREASE POLICE PATROLLING IN ETHNIC MINORITY AREAS

and other stereotypes can also be encoded into algorithms by associating certain professions with particular genders: receptionists and nannies as female, with architects and philosophers as male.²⁴ The attainment of SDG 5 – gender equality and empowerment of all women and girls – will be undermined if AI tools are developed without oversight of such flaws. A second AI risk in the public services domain relates to privacy protection. A UK National Health Service (NHS)-based app developed by DeepMind, the AI firm acquired by Google,

reportedly breached patient privacy rules,²⁵ and concerns have emerged over whether the use of predictive analytics and big data in monitoring health could breach privacy and lead to, for instance, unfair insurance policy practices.²⁶ In China, groups have expressed concern about the rise of facial recognition and AI-embedded street cameras.²⁷



Impacts of automation and AI in Asia

Technology is hard to forecast, and dystopian predictions have accompanied the rise of each new technological and economic era. Yet, the data shows that, over three turbulent centuries, human welfare – whether measured in terms of income, life expectancy or health – has improved.



East Asia's development "miracle", from Japan to the "East Asian tigers" (Hong Kong, Singapore, South Korea and Taiwan) and China, through to the likes of Malaysia, Vietnam, Bangladesh and Thailand today, was built on manufacturing sectors now at risk of automation.



In the services sector, Asian economies with successful BPO sectors could see comparative advantages, like widespread English language skills and lower labour costs, dissipate in the face of automation.



AI and the new digital economy could bring both threats and opportunities to the attainment of a selection of SDGs. Progress towards at least nine SDGs could be undermined in the most negative automation and AI scenarios.

To date, most discussions about the impact of automation and AI on society have, with the exception of China (a leader in both sectors), focused mostly on advanced economies. But automation and AI will affect developing economies too. The most worrying implication is that some automation-vulnerable sectors are the very ones that “catch-up” countries rely on to drive their economic transformation.



ARE THESE PREDICTIONS UNNECESSARILY ALARMIST? OR WOULD DISREGARD FOR WARNING SIGNALS BE COMPLACENCY OF THE WORST KIND?

East Asia's development “miracle”, from “East Asian tigers” (Hong Kong, Singapore, South Korea and Taiwan) and China, through to the likes of Malaysia, Vietnam, and Thailand today, was built on manufacturing sectors now at risk of automation, including electronics, automotives and garments, while robotic process automation (RPA) threatens service industries which have driven GDP and jobs growth in India and the Philippines.

In a negative scenario, automation could hollow out these industries and rob today's emerging economies of the sectors exploited so successfully by their older siblings in the region.

Given that East Asia was the largest contributor to falling global poverty rates over the last half-century, this could in turn compromise the attainment of the SDGs. Technology is hard to forecast, and dystopian predictions have accompanied the rise of each new technological and economic era. Yet, the data shows that, over three turbulent centuries, human welfare – whether measured in terms of income, life expectancy or health – has improved. Are these predictions unnecessarily alarmist? Or would disregard for warning signals be complacency of the worst kind?

While precise forecasts of automation and AI penetration are challenging, it is possible to look, at an aggregate level, at the ways in which it is currently evolving – or could technically evolve. This section discusses the potential impacts on manufacturing and services in a negative scenario, and how this could influence Asia's progress towards the SDGs.

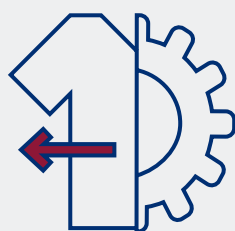
Automation and AI: An Asia risk map



India

Textiles account for **45m** jobs
13% of export earnings and **10%** of manufacturing production

Automation threatens **69%** of jobs



Bangladesh

Garments equal **80%** of exports, **45%** of industrial workforce.

Export-sensitive to EU (54.5%) and US (19.3%)

Malaysia

MVA at **22%** of GDP, among the highest in emerging Asia



Manufacturing sector still between mass production and automation

Thailand

Manufacturing comprises of **74.6%** of merchandise exports



Moderately exposed to automation leaders the US (11.2%), EU (10.3%), and China (11.4%)

China

Factories projected to have over **400,000** industrial robots installed by 2018



WORLD'S TOP ROBOTIC PRODUCER, EQUAL TO US AND EU COMBINED

Philippines



BPO employs over **1m** people; **59%** are women

Women account for over **70%** of the textiles employment

Vietnam



Manufactured goods equal **81%** of merchandise exports

ASEAN's largest textiles, clothing and footwear (TCF) exporter

Indonesia

56%

of jobs "at risk" of automation according to ILO

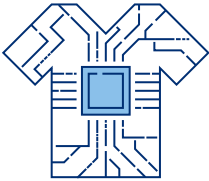


Manufacturing goods equal **44%** of merchandise exports

Source: Various, The Economist Intelligence Unit analysis.

Impact on manufacturing

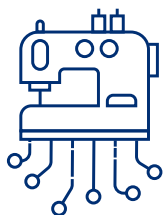
Asian manufacturing largely fueled the region's remarkable half-century of GDP growth, notably in East Asia, but spreading, more recently, to Southeast Asia, in goods including automotives, electronics, and garments. The share of manufacturing value added (MVA) as a percentage of GDP is highest in East Asia and increasingly Southeast Asia, where parts of the supply chain have migrated.



**OVER
60%
OF SALARIED WORKERS IN
INDONESIA, THE PHILIPPINES,
THAILAND AND VIETNAM OCCUPY
POSITIONS AT HIGH RISK OF
AUTOMATION**

The most recent MVA data highlights Thailand (27%), Myanmar (22%), Malaysia (22%), Indonesia (21.2%) and the Philippines (19.6%) as higher risk, with Cambodia (17%) and Vietnam (15.8%) following. Over 60% of salaried workers in Indonesia, the Philippines, Thailand and Vietnam occupy positions at high risk of automation.²⁸ South Asia's MVA is at 16% of its GDP, with Bangladesh at 17.9% and India at 16%. The least exposed country in the region is Laos at 8%.²⁹

The share of MVA alone does not determine automation risk: the technical nature of production is a crucial consideration. Vietnam, for instance, is a higher-risk economy because it has a heavy exposure in electronics. This is an automation-sensitive sector because robots excel at structured, hard materials of pre-determined sizes.³⁰ Electronics are also automation-sensitive because of higher commercial margins, and intense global competitive pressure which forces firms to keep up with Western rivals; Asian manufacturers Samsung, Foxconn and Huawei are all progressing automation plans. Automation is thus already relatively advanced in export-led electronics manufacturing, and automation risk increases as countries move to more advanced production sectors. This dynamic has implications not just for the countries already present in the sector, but for those lower-income economies that would otherwise hope to enter such global product market categories.



ONE MARKET LEADER, SOFTWARE AUTOMATION, HAS INTRODUCED A SEWING ROBOT THAT CAN REPORTEDLY REPLACE TEN WORKERS AND PRODUCE 1,142 T-SHIRTS IN EIGHT HOURS, COMPARED WITH 669 FROM A HUMAN SEWING LINE

Garments and footwear are more heterogeneous in terms of automation risk. This sector is a vital jobs engine; it accounts for 80% of Bangladesh's exports, and employs around 45% of the industrial workforce, while India's garment-producing sector is 45m strong. Textiles are also female-dominated, with the share of women in the sector's workforce exceeding 70% in Cambodia, Laos, the Philippines, Thailand and Vietnam, adding a critical gender dimension to any labour displacement. However, garments are at lower automation risk for technical reasons: soft materials are harder for robots to handle. One market leader, SoftWear Automation, has introduced a sewing robot that can

reportedly replace ten workers and produce 1,142 t-shirts in eight hours, compared with 669 from a human sewing line,³¹ but thus far there is limited evidence of large-scale textiles automation and data suggests that garments are not a dominant area of robotics production. Of the 1.6m industrial robots in 2015, the latest year of available data, only 1,580 were in textiles.³² A leap forward to robotic instruments could change this. Harvard researchers recently

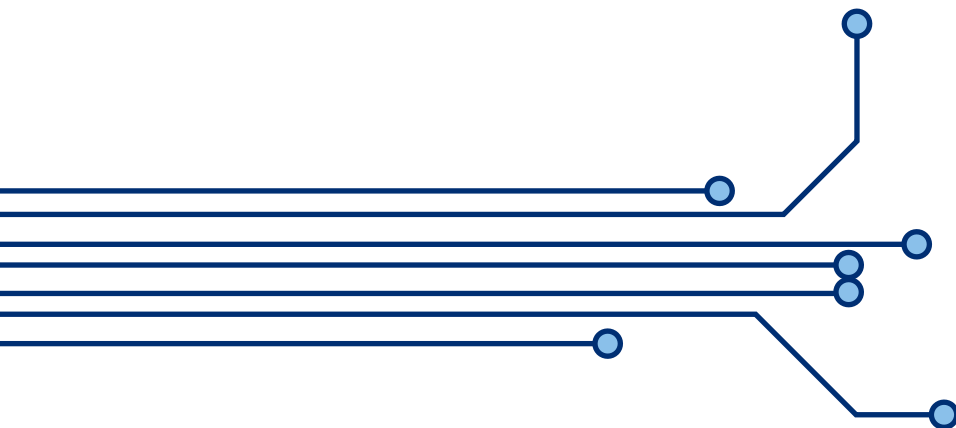
successfully developed "soft robots" that can sense touch, pressure, movement and temperature, and improved tactile sensitivity will doubtless be quickened by research into "care-bots" which can play a more active role in healthcare.³³

Shoes and trainers, a subfield of the clothing sector, is showing more immediate evidence of automation. Global giant Nike is working with Flex, the manufacturer behind Fitbit, to automate shoe-making; its Asia production sites in Vietnam, Indonesia and China could all be affected. Nike's rival Adidas has also reshored to Germany and the US, using computerised knitting, robotic cutting and additive manufacturing. Reshoring in sectors like footwear and fashion is, for Western firms, not just about lowering labour cost but also other benefits in terms of speed to market, and greater product development flexibility, including product customisation, which may be a growing trend at the high end of the Western consumer market and could be enabled by additive manufacturing.

Automation and reshoring matter, since trainers and sports shoes alone are an US\$80bn/year global industry.³⁴ If firms in high-income countries advance their automation agenda faster than those in low- and middle-income countries in Asia, Asian exporters face the risk of losing market share. Countries with large domestic populations that include a significant "consumer class" (such as Indonesia and India) may offset this through growth in domestic demand, but this would be a challenging pathway, with no guarantee of success.

Beyond countries' industrial structure, other factors play an important role. The EIU's Automation Readiness Index identifies factors such as the innovation environment, education policies, and labour market policies as key determinants of countries' ability to effectively respond to this type of technological innovation.³⁵

RESHORING IN SECTORS LIKE FOOTWEAR AND FASHION IS, FOR WESTERN FIRMS, NOT JUST ABOUT LOWERING LABOUR COST BUT ALSO OTHER BENEFITS IN TERMS OF SPEED TO MARKET, AND GREATER PRODUCT DEVELOPMENT FLEXIBILITY, INCLUDING PRODUCT CUSTOMISATION, WHICH MAY BE A GROWING TREND



Impact on services

Through ML, algorithm-driven decision frameworks and rapidly improving voice- and face-recognition accuracy, services sectors are already, or could soon be, impacted by automation. RPA is replacing human workers in areas like paralegal services, compliance, administration, IT support and customer services.



TWO ASIAN ECONOMIES ARE HIGHLY EXPOSED - INDIA AND THE PHILIPPINES. THEIR COMPARATIVE ADVANTAGES, LIKE WIDESPREAD ENGLISH LANGUAGE SKILLS AND LOWER LABOUR COSTS, COULD BOTH PROVE IRRELEVANT

Two Asian economies are highly exposed - India and the Philippines. Their comparative advantages, like widespread English language skills and lower labour costs, could both prove irrelevant. The Philippines' Trade Department believes AI could replace up to 50% of the 1.2m Filipinos working in the BPO industry.³⁶ The shrinkage of the sector could also hit the

Philippines' tax base, as the sector's revenues are approximately US\$25bn, amounting to 7.3% of GDP.³⁷ India is also exposed to BPO automation, with major Indian IT firms announcing automation plans, including Cognizant, Infosys and Wipro, although they have shown a desire to reallocate workers to higher-skilled jobs rather than pursue layoffs.³⁸ Large brands such as these are sensitive to public opinion and government perception and, as such, layoffs are less likely from national brands than

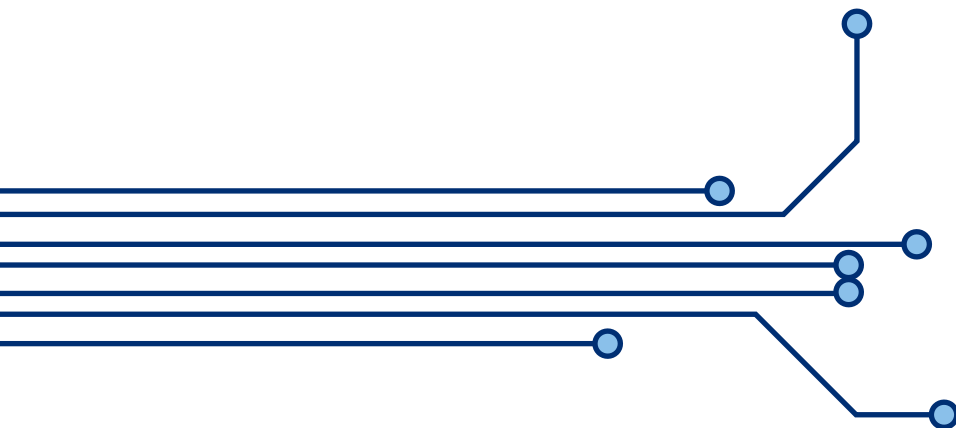
foreign investors (see the section below on mitigating factors).

AI could substantially diminish the competitive advantage of English language-speaking in the services sector, hitherto enjoyed by India and the Philippines, although this could also allow economies with other strengths, but lacking a widely spoken global language, to enter the sector.

A second services sub-sector where employment could be negatively impacted by automation and AI is logistics and fulfilment. Commentators have described e-commerce as helping to offset job losses in manufacturing by creating new, better jobs in areas like logistics, delivery and warehousing.³⁹ Yet, in Asia, Alibaba, the e-commerce king, is exploring automated fulfilment (the use of robots to manage warehousing and parts of the package-deployment work process).⁴⁰ As with the Indian IT giants, such brands are unlikely to disregard public and government opinion, given worries about social unrest stemming from unemployment.

Positively, as will be explored in part two of this report, certain service sub-sectors which employ hundreds of millions of workers across the continent – retail and tourism – are less automation-sensitive.

COMMENTATORS HAVE DESCRIBED E-COMMERCE AS HELPING TO OFFSET JOB LOSSES IN MANUFACTURING BY CREATING NEW, BETTER JOBS IN AREAS LIKE LOGISTICS, DELIVERY AND WAREHOUSING.



Impact on individuals: An SDG perspective

In the 2000s, the focus of development policy shifted from the generic, broad-based emphasis on economic liberalisation that came before, to a focus on human development outcomes.



THE RELEGATION OF MEDIUM-SKILLED, WAGED WORKERS INTO UNEMPLOYMENT AND/OR INFORMAL EMPLOYMENT WOULD PUSH A LARGE COHORT OF ASIA'S POPULATION BACK INTO POVERTY

The 2030 Agenda moves even further, emphasising the need for approaches that take account of the integrated nature of the dimensions of sustainable development – economic, social and environment – where decisions in one domain affect outcomes across the others. As such, this report takes the 2030 Agenda and the SDGs as the central organising framework. The graphic on the following page outlines the dual ways in which automation, AI and the new digital economy could bring both threats and opportunities to the attainment of a selection of SDGs. The follow-on text explains in more detail the threat effects, while the following section elucidates the opportunities.

If they materially reduce employment within services and industries, automation and AI could have negative effects on progress towards the SDGs. The relegation of medium-skilled, waged workers into unemployment and/or informal employment would push a large cohort of Asia's population back into poverty, while the lowest-skilled workers – and the poorest countries, yet to enter the manufacturing and services value chain – would lose access to a development model that had hitherto substantially driven poverty reduction in Asia. SDGs that depend on pro-poor fiscal interventions, such as investing in clean water and sanitation, would also be undermined by a reduction in government tax revenues, should foreign investors reshore from their Asian bases.

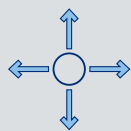
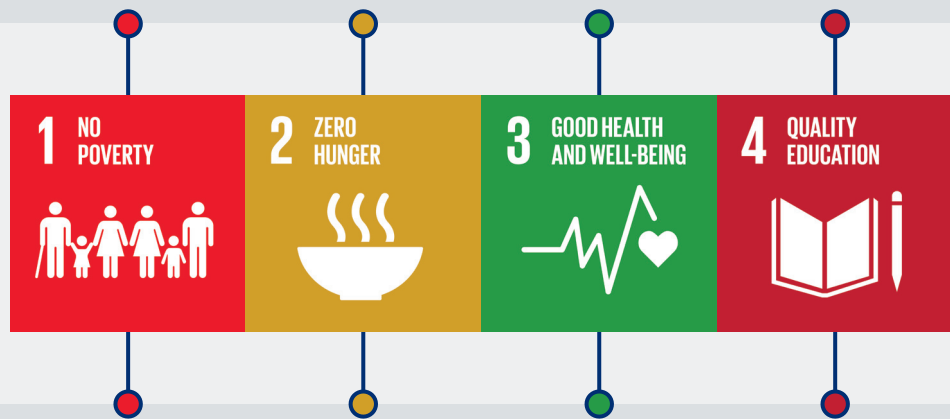
Automation and AI's threats and opportunities to SDGs in emerging Asia



Threats

- Increased unemployment.
- End of export-led manufacturing model.
- Reduced tax base.
- Lower disposable income for food purchases.
- Reverse migration to food-insecure rural areas.
- Micronutrient-deficient diets.
- Health spending constraints.
- Lack of safeguards in gig-economy.
- Job insecurity.
- Obsolete educational curricula.
- Reduced public spending on education.
- Widening gap between high and low-skilled.

SDGs

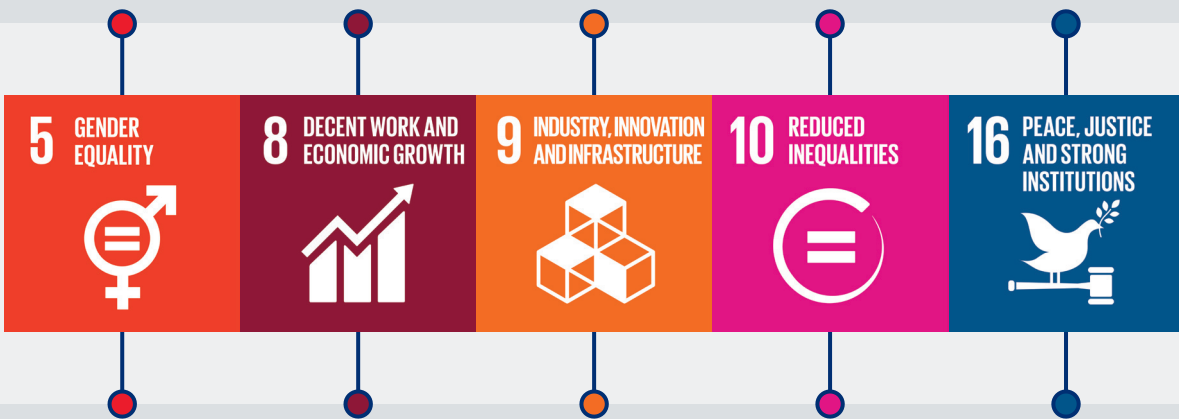


Opportunities

- More efficient welfare through digital ID.
- AI and big data-enabled fin-tech.
- New livelihoods in the gig economy.
- AI and big data-driven food supply chains optimisation.
- Improved manufactured food quality through sensors.
- Yield improvement through precision agriculture.
- Advanced health diagnostics through AI and big data.
- Improved access to care through telemedicine.
- Blockchain and AI-optimised patient data.
- Low cost e-learning tools.
- Speech recognition for learning.
- AI-based marking optimises teacher time allocation.



- Greater gender pay imbalance in STEM.
- Reduced women employment in BPO and retail.
- Algorithm-driven decisions bias against women.
- Resurgence of informal sector.
- Loss of export-led manufacturing model.
- Regionalisation of supply chains.
- Decline of the BPO sector.
- Decline of developing economy technological innovation.
- Polarised industrialisation.
- Racial and ethnic bias from badly-designed AI.
- Wealth polarisation away from labour.
- Higher wages for STEM-trained middle classes.
- Social media bots generate misinformation.
- Increased cyberterrorism vulnerability.
- AI-based surveillance targets minorities.



- Women opportunity in automation-proof sectors (e.g care economy an tourism).
- Reduced decision-maker bias in recruitment or finance through AI-powered selection software.
- Creation of new, improved livelihoods.
- Reinvigoration of rural areas through internet-enabled entrepreneurship.
- Benefits of IoT encourage ICT infrastructure investment (e.g 4G/5G).
- Emergence of new innovation champions in middle income Asia.
- Women excel in rising sectors of creative industries and e-commerce.
- Internet inclusion gives discriminated groups more independent means of income.
- Blockchain-powered citizen data management.
- Human rights enforcement through social media listening.

Source: The Economist Intelligence Unit.

That comes on top of longstanding challenges facing revenue departments in developing countries, such as the use of transfer pricing measures by some multinational firms, through which profits in higher-tax jurisdictions are drained through internal financial engineering and channelled to low-tax jurisdictions. International transparency efforts, and the work of non-governmental organisations (NGOs) like tax justice groups, have helped expose tax-avoidance practices by multinationals, but the problem remains significant. Furthermore, falling taxes due to the re-orchestration of manufacturing supply chains undermines the policy progress made.

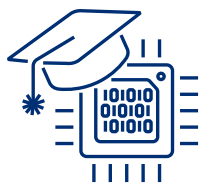
Overall, and as shown in the graphic on the previous pages, this analysis finds that progress towards at least nine SDGs could be undermined in the most negative automation and AI scenarios.⁴¹ Most effects stem from the loss of employment in automation-vulnerable sectors like electronics, automotives, BPO and, to a lesser extent, garments, pushing once upwardly mobile workers back into poverty. Loss of predictable waged employment in turn impacts household budget decisions and would cause some families to under-invest in their children's education. This channel – waged employment converting into higher investment in children's education – was crucial to East Asia achieving its generational transformation.



AUTOMATION-DRIVEN UNEMPLOYMENT COULD HAVE A GENDER DIMENSION SINCE WOMEN DOMINATE EMPLOYMENT IN VULNERABLE SECTORS LIKE BPO AND GARMENTS.

Automation-driven unemployment could have a gender dimension since women dominate employment in vulnerable sectors like BPO and garments. Women have made significant economic advancements through BPO in the Philippines, delivering services like back-office support, software development and data transcription. Women account for 59% of the more than 1m people employed in the Philippines' BPO sector, and 89% of salaried call centre staff.⁴²

Men and women will respond differently to the new opportunities that attend technological development. Rising economic returns to STEM skills in higher-technology contexts could benefit males who are generally over-represented in these sectors. One UNESCO report found that only three Asian countries out of 18 had an equal or above proportion of female STEM researchers.⁴³ Even new jobs created by digital technology, like logistics, deliveries and ride-hailing, could benefit male employment, given concerns around women's safety in such contexts, or their constrained ability, for cultural reasons, to work independently.⁴⁴



SECTORS LIKE EDUCATION, SOCIAL WORK, HEALTHCARE, AND THE CARE ECONOMY MORE GENERALLY, HAVE A STRONG FEMALE PRESENCE, AND A LOWER RISK OF JOB AUTOMATION

Not all automation and technology will hit women harder than men – some manufacturing assembly sectors are male-dominated, while women are more advantaged by the rise of new economic opportunities such as hosting. Airbnb data shows that, globally, women have earned US\$10bn through the platform and are often using income for vital spending such as rent, and as a

source of capital to invest in their own ventures.⁴⁵

Sectors like education, social work, healthcare, and the care economy more generally, have a strong female presence, a lower risk of job automation, and provide jobs at multiple levels which can help address labour market challenges.^{46 47} Tourism, which is currently

relatively immune to automation, also provides

better opportunities for women's participation in the workforce, women's entrepreneurship, and women's leadership than other sectors of the economy; global evidence shows that women are also more likely to hold managerial positions in tourism.⁴⁸ In Indonesia, Malaysia, the Philippines, and Thailand, more than half of tourism businesses are run by women.⁴⁹

Some e-commerce and gig economy activities can also have positive gender impacts by offering more flexible working arrangements for women than conventional full-time employment often does. Digital entrepreneurship could have pro-female effects because start-up costs are low thanks to low-cost software and widening Internet access, which could tackle a structural factor limiting women's entrepreneurship: their more limited ability to access capital.

SDG progress could also be undermined by risks that attend new job sources enabled by digital innovation. Good health and well-being (SDG 3) could be compromised as workers move into the gig economy, where conditions are often unregulated and can be dangerous, without union or trade association protection. Stress, over-work, and isolation have all affected gig workers around the world and workers' rights groups claim that so-called gig economy platforms put pressure on workers to meet minimum hours, even though the platform itself offers no work guarantees or protections.⁵⁰ While union participation has often been absent in Asian manufacturing, the *ability* to unionise or form labour interest groups, even with NGOs and human rights groups, is challenged by the fragmentation and atomisation of the workforce in the low-end gig economy. Greater exposure to traffic pollution is another SDG 3-related risk in growing sectors like transport and deliveries, especially in Asia's large

urban zones. Of course, working conditions in manufacturing industries have not been without their health impacts – witness the collapse of Bangladesh’s Rana Plaza,⁵¹ and the suicides in Foxconn electronics factories. The point is that new sectors may bring threats of their own.

Beyond employment dynamics, there are other threats posed by AI and associated digital sectors, including big data and predictive analytics, that could undermine progress towards the SDGs, and especially SDG 16: peace, justice and strong institutions. Social media bots and algorithm-based platforms have contributed to social divisions through enabling and disseminating hate speech and misinformation. This is now well-documented in the US context, but Asia is also feeling its effects. Online hate speech has been prominent during the Rohingya crisis, both in Myanmar and abroad, with social media platforms enabling the spread of misinformation and the propagation of racial and ethnic hatred.⁵² In India, the rapid spread of information via platforms like WhatsApp has given rise to violence, evidenced by the recent murders by gang members of seven men wrongly believed to have been involved in child abductions.⁵³ Even if misinformation is not the product of bots, it relies on social media platforms to be spread, through their algorithm-based dissemination mechanisms. A second impact of AI on the SDGs relates to inequality: both gender inequality (SDG 5) and overall inequality (SDG 10). There is evidence of bias in algorithm-based decisions in justice and policing, which can result in overt police presences in areas populated by minority groups, for instance.⁵⁴

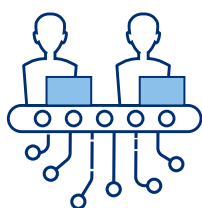
Finally, SDG 16, and especially its “strong institutions” component, could be undermined by the use of AI and big data by authoritarian governments which can use powerful surveillance tools to monitor, spy on and track populations. Governments can also engage in state-on-state cyberattacks. Related concerns include the development of lethal autonomous

weapons without proper UN-driven ethical oversight, the unethical use of drones for military purposes or by rogue actors like terrorists, the use of cryptocurrencies to facilitate illegal commerce and criminal gang activity, and social and environmental conflict between companies and communities in areas harbouring raw materials needed for today’s technologies, including lithium and rare-earth metals.⁵⁵

FINALLY, SDG 16, AND ESPECIALLY ITS “STRONG INSTITUTIONS” COMPONENT, COULD BE UNDERMINED BY THE USE OF AI AND BIG DATA BY AUTHORITARIAN GOVERNMENTS WHICH CAN USE POWERFUL SURVEILLANCE TOOLS TO MONITOR, SPY ON AND TRACK POPULATIONS.

Mitigating factors

These SDG impacts are not forecasts, but rather possible future pathways which, without proactive approaches, could undermine progress towards the SDGs.⁵⁶ But this alone is not a holistic way of thinking about technological change.



THE EVIDENCE CLEARLY SHOWS THAT AI AND AUTOMATION ARE MULTIPLE-USE TECHNOLOGIES THAT COULD HAVE BENEFITS, NOT JUST FOR THOSE WHO DESIGN THEM

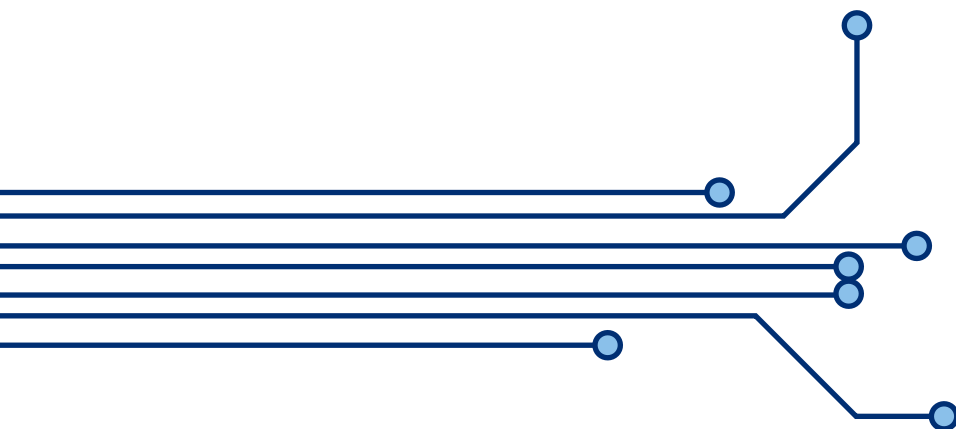
The evidence clearly shows that AI and automation are multiple-use technologies that could have benefits, not just for those who design them. Welfare payments and public services can be more efficient in the digital era, with rote bureaucracy carried out by AI, allowing civil servants to focus on other, more complex policy areas, as well as allowing some countries facing fiscal constraints to limit the size of the public sector without reducing services. AI, data analytics and apps are already contributing to reducing hunger, both through precision agriculture at the farm level and through innovations which connect excess food sources, like restaurants and hotels, with NGOs that can distribute to the food-poor. Open, low-cost e-learning tools, automated marking to free up teachers' time for lesson planning and interpersonal work with students, and the creation of new sources of growth, like ride-hailing and courier services, are just some of the opportunities built on the same underlying suite of innovations.

As well as acknowledging the opportunities brought by technology – which will be explored in more depth in the following section – it is also important to note the caveats to techno-anxiety. The interplay between automation, AI and the SDGs is shaped by a large number of intervening variables. While policy-related factors will be discussed in more depth in the next section (including a more in-depth discussion of AI), the points on the next pages are other key economic variables that will shape the extent and depth of the impact of automation.

Automation risk varies by sub-sector.

While the risk framework examined aggregates risk in manufacturing and services, automation risk varies across sub-sectors rather than overall GDP categories. Electronics and automotives are more automation-sensitive because they involve linear workflows and structured, defined physical materials, and because their product markets are globally competitive and dominated by the world's most sophisticated technology companies. Garments are harder to automate completely because robots are still less competent at managing unpredictable, creasing and soft materials – an important part of the garments workflow.⁵⁷ Of course, further innovation could increase risk if these obstacles are overcome, but technical nuances matter. Similarly, BPO is a high-risk service sector, but tourism and retail are lower-risk, as will be explained in more depth in the following section.

OPEN, LOW-COST E-LEARNING TOOLS, AUTOMATED MARKING TO FREE UP TEACHERS' TIME FOR LESSON PLANNING AND INTERPERSONAL WORK WITH STUDENTS, AND THE CREATION OF NEW SOURCES OF GROWTH, LIKE RIDE-HAILING AND COURIER SERVICES, ARE JUST SOME OF THE OPPORTUNITIES BUILT ON THE SAME UNDERLYING SUITE OF INNOVATIONS



GDP and trade structure.

GDP, employment distribution and trade structure all shape the real impact of automation. Philippines BPO is “high-risk”, but employs around 2–3% of the labour force.^{58 59} India has 45m textiles workers, but the informal sector dominates output and informal firms typically have less incentive and means to automate in ways directly threatening to employment. While these dynamics should not justify ignoring automation threats, they provide context for assessing overall impact.

Other structural factors include export versus domestic demand. Small economies heavily exposed to high-tech markets will be more at risk than those with a large domestic market, if automation technology is not likely to be adopted by firms within a lower-income country context.

Risk levels also depend on the distribution of the workforce across automation-sensitive

and non-sensitive sectors; retail jobs are less automation-vulnerable given the often unpredictable, customer-facing nature of interactions, and retail employs over 40m people in ASEAN (Association of Southeast Asian Nations) countries alone, compared with 800,000 in automotives and 2.5m in electronics.⁶⁰ Similarly, tourism does not appear automation-vulnerable and is a major employer with strong growth trends across the continent, which has abundant cultural, ecological and geographical assets that attract millions of travellers around the world.

SMALL ECONOMIES HEAVILY EXPOSED TO HIGH-TECH MARKETS WILL BE MORE AT RISK THAN THOSE WITH A LARGE DOMESTIC MARKET



INDIA'S INFOSYS MOVED 9,000 WORKERS FROM LOWER-SKILLED JOBS TO MORE ADVANCED PROJECTS, LIKE ML AND AI, AND WIPRO REDEPLOYED 3,200 PEOPLE IN 2016, AND PREDICTED TO MOVE ANOTHER 4,500 IN 2017.

Political economy factors.

It should not be assumed that just because firms can automate, they will retrench as much as possible. There is evidence of firms reallocating workers. India's Infosys moved 9,000 workers from

lower-skilled jobs to more advanced projects, like ML and AI, and Wipro redeployed 3,200 people in 2016, and predicted to move another 4,500 in 2017. Political considerations and pressure to maintain employment levels will play an important role and firms – either from the country, or with a desire to remain present in the country – can be expected to respond in some circumstances to political and societal pressures.

Social overhead capital, and “system effects”.

Pinpointing job losses resulting from innovation may underestimate the public benefits these same technologies have, often for the same communities. As cited elsewhere in this study, improvements in living standards in the US from 1870 to 1970 were largely driven by innovation, including automation, which freed up workers to pursue more profitable opportunities, spared children farm and household labour to pursue schooling, liberated women from domestic drudgery, lowered the cost of consumer conveniences, and contributed to lengthening lifespans. System effects are a useful tool for thinking through such dynamics. These occur when a) “a set of units or elements is interconnected so that changes in some elements or their relations produce changes in other parts of the system and b) the entire system exhibits properties or behaviours that are

different from those of the parts.”⁶¹ Technology risk forecasts must account for system effects and the ways in which new technologies can shape social and economic outcomes even as they displace institutions and livelihoods. Examples of AI and automation-related system effects could include the emergence of cash-rich digital platform companies reinvesting profits in segments once considered public sector responsibilities, from urban design to disease surveillance. Other examples include efficiency

gains in critical services that tackle bottlenecks that keep poorer entrepreneurs from accessing capital: the use of non-traditional data, such as social media networks and activities, is being explored to widen access to finance and credit. Similarly, the application of blockchain to property registries could give millions of people access to titles on which they could secure financing, both for business activities and for household loans and credit. Bringing more people into the innovation ecosystem in this way can have far-reaching and unpredictable effects. The creation of more open, meritocratic economies could generate a rise in self-employment and firm formation, lessening the central employment functions of government and large firms. Finally, AI-driven healthcare research could lead to cures for common and rare diseases that are often ruinous for poor families and responsible for the “poverty cycles” that prevent breadwinners from accessing opportunities. These are not listed as panaceas or predictions, but as examples of possible pathways that could set off system effects.

**THE APPLICATION OF
BLOCKCHAIN TO PROPERTY
REGISTRIES COULD GIVE MILLIONS
OF PEOPLE ACCESS TO TITLES
ON WHICH THEY COULD SECURE
FINANCING, BOTH FOR BUSINESS
ACTIVITIES AND FOR HOUSEHOLD
LOANS AND CREDIT.**

Case study

Impact of Automation and AI on Vietnam

Vietnam, with a population of more than 90m, has maintained the world's second-highest growth rate per person since 1990, behind only China.⁶²

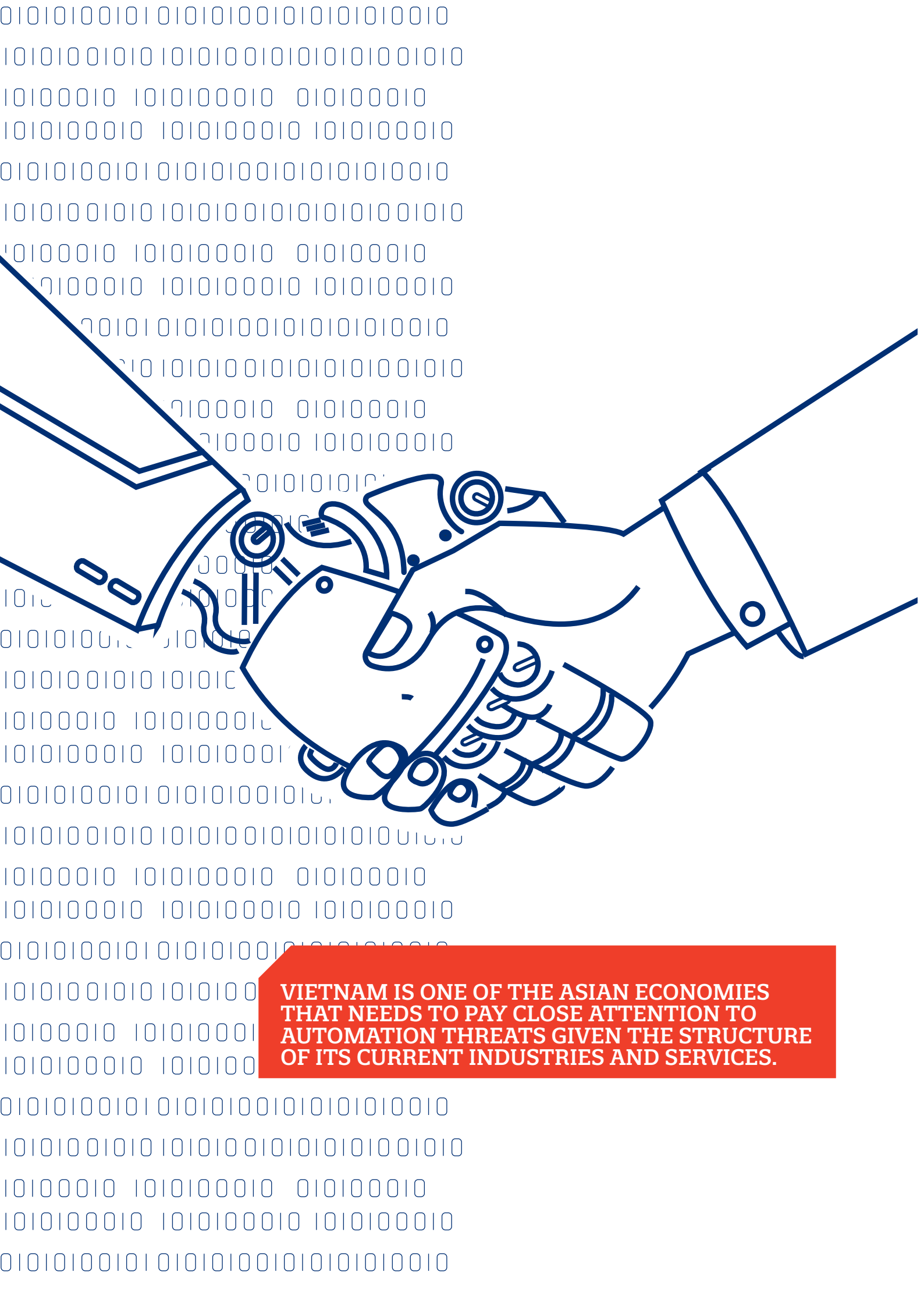


THE ILO HAS ESTIMATED THAT 70% OF JOBS IN VIETNAM HAVE A HIGH PROBABILITY OF BEING REPLACED BY MACHINERY.

Economic development has been strong, driven by a young population, cheap labour, a stable government, foreign direct investment, and increased trade liberalisation, as well as natural resource exploitation. However, the country still needs to embark on sustained structural transformation, which entails lifting productivity and avoiding the middle-income trap by shifting its growth model. The tools of Industry 4.0 could provide support but equally, through automation, erode existing sectors before they have advanced to higher-value addition plateaus.

The country's service, industry (which includes construction) and agriculture sectors account for 44%, 39% and 17% of GDP, respectively, and the largest sectors of the country include manufacturing, mining, construction, real estate and finance.⁶³ By comparison, the agriculture sector employs the largest share of workers at nearly 50%, and is characterised by small-scale production, inadequate infrastructure, low productivity and a low mechanisation ratio. Services and industry employ the remaining 31% and 21% of workers, respectively.⁶⁴

The informal sector remains sizeable, and researchers estimate that it could account for 25–30% of GDP and nearly 60% of the workforce, or approximately 18m people.⁶⁵ The Asian Development Bank has estimated that approximately 1m agricultural workers need to upgrade their skills each year as they transition into industry and services.⁶⁶



VIETNAM IS ONE OF THE ASIAN ECONOMIES THAT NEEDS TO PAY CLOSE ATTENTION TO AUTOMATION THREATS GIVEN THE STRUCTURE OF ITS CURRENT INDUSTRIES AND SERVICES.

Industry-level vulnerability to automation and AI

The ILO has estimated that 70% of jobs in Vietnam have a high probability of being replaced by machinery. This compares with an average of 56% of jobs at risk in the region, although some of these jobs, such as in agriculture, are also affected by structural challenges beyond mechanisation. Occupations with the highest risk of disappearing in the future include shop sales assistants (2.1m), garden labourers (1m) and sewing-machine operators in garment manufacturing (770,000).⁶⁷ Separately, the Ministry of Labour, Invalids and Social Affairs has determined that Vietnam needs to create about 650,000 jobs per year to keep pace with growth in the labour force and the expected structural changes in the market.⁶⁸

Education is one of the fundamental pillars of Vietnam's socio-economic planning. Reforms include the establishment of new accreditation and quality-assurance mechanisms, a new national qualifications framework, and an increase in higher education enrolments by 125%, from 200 students per 10,000 people in 2010 to 450 students per 10,000 by 2020.⁶⁹ The national curriculum reform reinforces the development of 21st-century skills, such as intellectual curiosity, civic capacity, foreign languages and information and communications technology (ICT) skills.⁷⁰ The government is committed to modernising education and currently spends around 15% of total expenditures on education.⁷¹

Promoting ICT and high-tech industries is another government priority. For example, the national broadband plan calls for 3G and 4G networks to cover 95% of residential areas by 2020.⁷² Increased connectivity will provide access to the digital economy and can facilitate trade, information-sharing and education. Vietnam is also developing regional high-tech clusters that receive support from both the central and local governments, as well as from other relevant state agencies. Three high-tech parks located in Hanoi, Ho Chi Minh City and Danang continue to attract international investors. For example, Samsung has invested cumulatively approximately US\$17bn in the country and the local subsidiary was the largest company in Vietnam in 2017, superseding PetroVietnam, the state oil company.⁷³

WITH APPROXIMATELY 70% OF THE POPULATION AT INCOME LEVELS CLOSE TO THE POVERTY LINE, THE COUNTRY NEEDS TO CREATE DECENT WORK EVEN AS THE ECONOMY STANDS TODAY

Impact of automation on individuals: An SDG lens

Despite Vietnam's positive economic trajectory, attainment of the SDGs is far from assured. With approximately 70% of the population at income levels close to the poverty line, the country needs to create decent work even as the economy stands today, let alone if substantial job losses are incurred due to automation. Given the size of automation-vulnerable sectors in the country, SDG 1 (no poverty) is jeopardised, which by extension threatens many other SDGs.

Gender (SDG 5) is one important SDG in the Vietnamese case. Labour force participation rates for women are among the highest in the world at around 72%. However, there is a 10 percentage point gap in labour force participation between women and men, although this has improved from previous years. Women form a large majority of the working poor, earning 10.5% less than men in the paid employment sector according to the most recent labour force survey data, and are most affected by underemployment, unemployment and precarious working conditions.⁷⁴ It is not yet clear what impact the Fourth Industrial Revolution will have on the most vulnerable workers, but policymakers must continue to monitor them and provide adequate support when necessary. Gender inequality can also be tackled by addressing unequal participation in scientific and technological careers. Women account for around 40% of scientific researchers, but only 19% of key national science and technology programmes have female leaders or a high percentage of women researchers. Government initiatives that encourage women in science may help to tip the scales towards greater gender equality in technical fields.

A further important SDG for Vietnam is the promotion of innovation, industry and infrastructure (SDG 9), as this is the means by which the country can avoid a middle-income trap and find new growth engines as wages rise. In 2016, the government launched a scheme to provide national support and funding for innovation and entrepreneurship through to 2025. The programme aims to develop over 2,000 innovation projects and start-ups that will have a total value of investment capital of around VND 2trn (approximately US\$89.3m). Financing will also be available from private partners.⁷⁵ A strategic industrial policy, which provides the underlying infrastructures needed to foster innovation, would be one proactive move that could help Vietnam not just withstand the threats of technological change, but be an active participant in them.

Policy considerations

Vietnam is one of the Asian economies that needs to pay close attention to automation threats given the structure of its current industries and services. This will require both macro and micro policies, including those which improve supply-side competitiveness, and which link competitiveness and productivity to the country's overall national development strategy.

Generally, the information base for innovative government policies is low and the system tends to produce multiple, overlapping and sometimes competing initiatives. A 2016 report by the World Bank and the Ministry of Planning and Investment found that government research and development (R&D) funding is spread thinly across more than 600 small government research institutes that produce little valuable output. The allocations are small, fragmented and abstractly linked to high-level socio-economic goals in long-term government planning documents.⁷⁶ Centralised coordination of R&D policies could facilitate better governance and measurement towards achieving the high-level goals. High-level statements do indicate political will – notably, in May 2017, the prime minister ordered both central agencies and local administrations to make optimal use of Fourth Industrial Revolution tools as part of an effort to promote progress in digital infrastructure development and human resources.

LONGER-TERM INVESTMENTS WILL NEED TO FOCUS ON EDUCATION REFORM, A KEY COMPONENT OF THE STRATEGY FOR THE FOURTH INDUSTRIAL REVOLUTION, AND COULD BE MORE CLEARLY DEFINED WITH CLEAR MEASURABLE GOALS IN ORDER TO ASSESS PROGRESS.

Longer-term investments will need to focus on education reform, a key component of the strategy for the Fourth Industrial Revolution, and could be more clearly defined with clear measurable goals in order to assess progress. The education system should be a point of focus, from as early as the pre-primary level. A second long-term demographic factor for policymakers to consider is the country's ageing population – a growing risk affecting economic growth, welfare, poverty and income distribution, which may call for more active labour market policies to ensure a sufficiently skilled labour force to carry the weight of a larger share of older citizens.



Responding to the opportunities and challenges of automation and AI

How can automation, AI and the new digital economy accelerate progress towards the SDGs and what can governments do to maximise the upsides, and manage the risks?



Economic policy, and growth policy in particular, must work with the technological, geopolitical and policy tools available at the time, rather than try to copy outdated models.



Data privacy protocols, fines for companies with inadequate data protection protocols, and even bans on companies failing to show good faith and proper engagement with operational risks are examples of how harder regulatory enforcement in the digital sphere is playing out.



Unlike manufacturing, in which Asian firms took decades to catch up with the West and compete, in the digital economy the timelines are compressed, with home-grown firms quickly dominating their own markets.

Technologies do not always have pre-determined outcomes for societies. Policy choices, social dialogue and public opinion all shape the ends to which technology is deployed. In the 19th and 20th centuries, advances in transport, electricity and power led to unprecedented improvements in standards of living in Western countries, across a broad spectrum of their populations. Today, nations with high innovation rates and deep technological adoption include many peaceful, egalitarian and flourishing societies like South Korea, Japan, Finland, Switzerland, Sweden and the Netherlands,⁷⁷ while the world's lowest-scoring nations in the Human Development Index and Gini inequality rankings, such as the Democratic Republic of Congo, the Central African Republic, Brazil and South Africa, suffer far more from poor governance, conflict and corruption than from a surfeit of technology.

In the US, the world technology leader, inequality has many social and political causes including the costs of higher education, weak social safety nets in healthcare, and structural inequalities, including the mass incarceration of minority groups. Observers also argue that policies that favour elites are more deserving of scrutiny as a cause of inequality than automation.^{78 79 80} As such, any analysis seeking to make sense of technological change must recognise both the opportunities that innovation brings and the ways that key stakeholders, especially public institutions, shape its outcomes. Against such a backdrop, this section examines how automation, AI and the new digital economy could accelerate progress towards the SDGs and what governments can do to maximise the upsides, and manage the risks, across the three domains of sustainable development: economic, social and environmental. From such a perspective, technological innovation can contribute to the ends that matter – to people, prosperity, the planet, peace and partnerships.

Economic

Economic policy, and growth policy in particular, must work with the technological, geopolitical and policy tools available at the time, rather than try to copy outdated models.

The Asian manufacturing boom delivered profound benefits but was the product of an era, many of whose conditions, political and economic, no longer hold. Wage differentials with the West were far higher in the 1970s than in the early 2000s. Geopolitical dynamics, such as US aid to South Korea during the Cold War, provided massive financial assistance for public investment. Today, in contrast, reshoring is a policy priority in advanced economies as blue-collar workers have seen their standards of living decline in relative terms as Asia's have grown. Automation is therefore one among many forces threatening the labour-intensive manufacturing model.

Changing circumstances call for new growth strategies which can withstand emergent threats, and take the opportunity to recognise limits of older models, such as environmental harm, and leverage the new opportunities that exist today and which did not previously. These growth strategies can indeed improve on the many flaws of the prior era. Factory work conditions have been gruesome, and workers have enjoyed few labour protections and paid a heavy price for Asia's development boom in previous decades. Recent events, from collapsed garment factories in Bangladesh to the spate of suicides and suicide attempts at the Foxconn factories,⁸¹ bring into question whether such elements can be described as consonant with the values of the 2030 Agenda. Asian policymakers are increasingly looking at emergent growth sectors, mostly building out the digital economy using the same underlying innovations this report has. Digital platforms – spanning "search", "social" and "e-commerce" – are especially powerful innovations that are already growing quickly in many Asian economies.

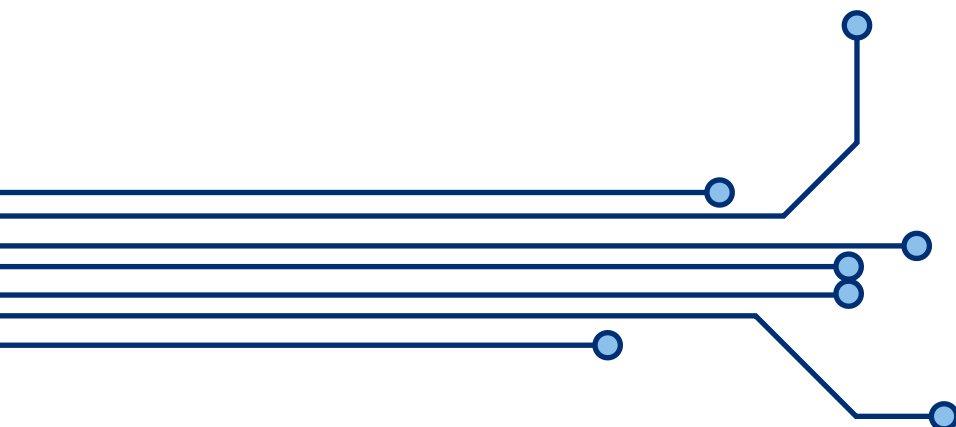
**ASIA'S E-COMMERCE
TRANSACTIONS
ACCOUNTED FOR
25% OF THE BUSINESS-
TO-CONSUMER MARKET
GLOBALLY IN 2016**

A digital platform is a business based on enabling value-creating interactions between external producers and consumers, providing an "open participative infrastructure for these interactions and setting governance conditions for them."⁸² Economists believe digital platforms are writing a new chapter in commerce.⁸³ Unlike industries of old, which leveraged supply economies of scale to achieve low-cost production, digital platforms leverage "demand economies" of scale through which every participant joining the network – whether drivers and passengers in ride-hailing, or sellers and buyers in e-commerce – makes the platform more valuable for all participants⁸⁴ and the data that platforms acquire through that activity is in turn commercially valuable.

Unlike manufacturing, in which Asian firms took decades to catch up with the West and compete, in digital economy the timelines are compressed, with home-grown firms

quickly dominating their own markets. Asia's e-commerce transactions accounted for 25% of the business-to-consumer market globally in 2016,⁸⁵ led by China and India. Digital commerce is a smaller segment in ASEAN countries but still generated US\$150bn in revenues in 2016, while Southeast Asia as a group is forecast to become one of the world's top-five digital economies by 2025, with the Internet user base forecast

to pass 480m by 2020.⁸⁶ Top firms include Alibaba, Tencent (China) and Flipkart (India) in e-commerce, and Didi Chuxing (China), Ola (India) and Grab (Southeast Asia) in transport.



IF POLICYMAKERS ARE LOOKING FOR A NEW GROWTH PARADIGM, THE DIGITAL ECONOMY, INCLUDING PLATFORMS BUT GOING BEYOND THEM, SHOWS PROMISE.



If policymakers are looking for a new growth paradigm, the digital economy, including platforms but going beyond them, shows promise. In nurturing these sectors and providing the appropriate regulatory frameworks, policymakers can support the “knowledge-intensity” of economies, which has been a core ingredient of endogenous growth theory. Endogenous growth theory argues that the development of new ideas and the number of people working in the knowledge sectors make economies

more productive in ways that physical capital investment on its own cannot. This model, developed over the course of the 1990s, influenced the emergence of human capital as a core development domain, in contrast to previous decades, which emphasised a narrower package of reforms involving economic liberalisation. This provides the economic logic supporting greater focus on areas like education, healthcare and other metrics of human wellness, rather than cruder, market-wide economic liberalisation reforms.

Data regulation will be critical

A knowledge-driven economy requires digital infrastructure to allow firms to transact efficiently, and appropriate restraints to deal with challenges, such as data privacy or online fraud. However, digital is not always at the heart of national and regional growth initiatives. For example, a stocktaking analysis of the ASEAN Economic Community (AEC) blueprint of 2015 found that more progress was needed in areas like encouraging the flow of digital data in the region, a critical enabler of knowledge-based economic development. The analysis also observed that only 30% of ASEAN countries had enacted privacy legislation in the e-commerce domain, and only 60% had consumer protection regulations, which are crucial to build trust in online commerce.⁸⁷

Investment in connectivity and innovation will be needed

Investment is needed to ensure ubiquitous, high-speed Internet access, especially 4G and 5G networks. The EIU's 2018 Internet Inclusion Index identified rapidly improving year-on-year 4G coverage in the likes of Indonesia (658.8%), Thailand (366.7%) and China (244.0%), for instance. But it also revealed highly constrained Internet access in other parts of the region, including limited public efforts to promote WiFi availability and a pronounced gender gap in Internet access, with Pakistan, Sri Lanka, India, the Maldives and Nepal at the bottom of the global rankings.⁸⁸ Bridging this gap will be critical to enable the scaling-up of digital platforms and networks.

The power of these innovations lies in their ability to overcome physical and locational constraints: rural interventions can help ensure such benefits are realised. Google's Saathi project trained ambassadors to educate women in 300,000 villages on the benefits of the Internet in day-to-day life, and the ambassadors work as local agents providing services including the distribution of products (e.g. phones and SIM cards), and working as para-technicians helping people access government benefits via the Internet.⁸⁹ Such livelihood models did not exist in previous decades, and could provide new, better and more efficient means to access good and services.

Innovation-promoting policies also show great promise. These include removing business obstacles like high licensing costs, aggressive bankruptcy rules, or burdensome tax systems, and roll out incentives to encourage catalytic underlying sectors, like e-commerce and e-payments, as part of the creation of more dynamic, small and medium-sized enterprise (SME)-friendly growth pathways.⁹⁰

Any discussion of digital growth models would be incomplete without observing the risks these sectors can bring, as has been apparent in the many regulatory problems – such as

anti-trust and privacy breaches – facing the likes of Google in the EU and Facebook after the post-Cambridge Analytica era. Hate speech, social polarisation and debates over misinformation have all been prominent across a number of Asian countries. Regulators are also eyeing monopoly formations.⁹¹ For instance,

the aggressive expansion of some gig economy platforms has left workers vulnerable by changing ride-hailing pricing after drivers invest significant sums in vehicles.⁹² To counteract such



ANY DISCUSSION OF DIGITAL GROWTH MODELS WOULD BE INCOMPLETE WITHOUT OBSERVING THE RISKS THESE SECTORS CAN BRING

problems, and ensure innovative new sectors contribute to the SDGs, governments can explore forming consultative groups and public–private consortia with leading firms to develop codes of conduct and best practices, and pursue educational campaigns for people entering sectors like the gig economy. They will also need to consider firmer regulatory interventions which explicitly forbid certain types of activities or conduct in the digital economy. Data privacy protocols like those enshrined in the EU's new General Data Protection Regulation (GDPR), fines for companies with inadequate data protection protocols, and even bans on companies failing to show good faith and proper engagement with operational risks, as has occurred with Transport for London against ride-hailing company Uber, are just a few examples of how harder regulatory enforcement in the digital sphere is playing out in other regions.

Gender should be part of the design and implementation of economic growth policy

Economic policies can have a positive impact on gender divergence; conversely, failure to develop growth policy with a gender lens can aggravate and entrench inequalities.

One study of male and female workers across 31 developed and developing countries found that STEM skills were positively related to labour market returns,^{93,94} especially for workers in digital-intensive sectors, and the persistent gender wage gap could be explained in part by males' greater access to STEM education. Another study suggests that the increase in female earnings following an increase in ICT skill acquisition ranges from 4% in Denmark to 19% in South Korea.⁹⁵

A digital growth policy without a gender lens could exacerbate inequality, even if it creates positive economic outcomes overall. Narrowing the gap will require policies to equip female workers with sufficient STEM and ICT skills, including encouraging girls

and women to pursue STEM-related studies in the first place.⁹⁶ Basic skills are critical. In a World Wide Web Foundation study, almost all women in the survey of nine poor urban communities including in India, Indonesia and the Philippines,

owned or had access to a mobile phone but, on average, only 21% of the connected women had searched for critical information on topics like health, legal rights and transport information.⁹⁷ (The majority of women who lack access to digital technologies are in developing countries – the gender gap in

A DIGITAL GROWTH POLICY WITHOUT A GENDER LENS COULD EXACERBATE INEQUALITY

mobile broadband access is 45% in Sub-Saharan Africa, and up to 50% in some parts of rural Asia.⁹⁸)

Other gender-framed growth policies include those that close the gap in digital finance and measures to protect women entering vulnerable sectors like the gig economy; a study of such opportunities for Syrian women refugees in Jordan, for instance, called for interventions to encourage protection and ensure safety.⁹⁹ For more equitable outcomes in the new digital economy, companies should "design-in" such good practices, and governments should identify protective measures, as well as skill-supporting initiatives, to ensure that digital growth has pro-gender or gender-neutral effects.



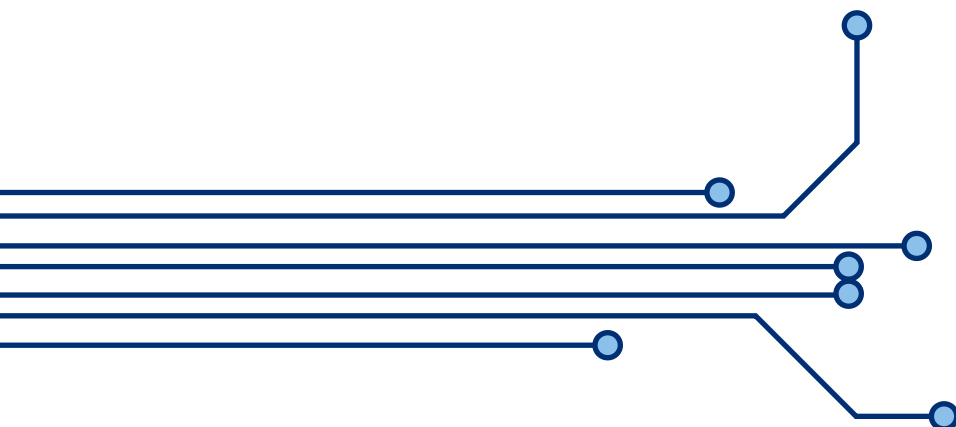
Education policy will need to focus on 21st-century skills

Education is one of the few time-proven development strategies and has been rightly prioritised in the human capital literature.

FUTURE-PROOFING ECONOMIES BEGINS WITH EARLY CHILDHOOD EDUCATION AND BASIC EDUCATION, STRETCHES THROUGH TO THE PROMOTION OF LIFELONG LEARNING, AND INVOLVES THE CULTIVATION OF SOCIAL AND CREATIVE SKILLS ALONG WITH THE TECHNICAL KIND.

Future-proofing economies begins with early childhood education and basic education, stretches through to the promotion of lifelong learning, and involves the cultivation of social and creative skills along with the technical kind. The most important policy levers are listed below, but in each case, quality is a critical aspect. Many educational reforms in Asia's lower-income economies have been stymied by funding shortages, poor teacher training, or uneven implementation. In these cases, education

systems can serve to reinforce inequalities, rather than remove them, as better funded schools in more affluent areas produce increasingly better educated children, who go on to occupy the most lucrative and powerful jobs in private and public sectors.



Countries fighting the Digital Gender Divide¹⁰⁰

SOUTH KOREA



South Korea is supporting a research fund for female student research teams in architecture, materials, machinery, and computers, as well as promoting female talent in science and engineering fields by providing field experience programmes.

ARGENTINA



Argentina's *Ellas Hacen* (They Do) programme, in conjunction with the National Plan for Digital Inclusion and the Digital Educators Network of Argentina, aims to increase digital literacy among unemployed women and provide the most vulnerable sectors of the population with the necessary skills, motivation and confidence to use new technologies for their own benefit, through courses for the creation of basic Internet use capabilities.

AUSTRALIA



The Australian government is investing AU\$13m over five years from 2016/17 in initiatives focused on women's participation in STEM. The National Innovation and Science Agenda is contributing to ongoing efforts by the government to encourage more girls and women to study STEM and pursue STEM-based and entrepreneurial careers.

BRAZIL



Meninas Digitais in Brazil aims to promote technology and STEM subjects by motivating female high school students and by developing their skills with short computing courses.

JAPAN



The Japanese government is carrying out the *Riko Challenge* to inspire women to choose careers in STEM and increase the number of female science and engineering professionals.

MEXICO



The OECD Mexico initiative, *NiñaSTEM PUEDEN*, launched in early 2017, invites Mexican women who have prominent careers in science and mathematics to act as mentors and encourage girls to choose STEM subjects. *Codigo X* in Mexico is a programme to orientate women towards disciplines related to STEM and to promote the inclusion of girls and women in ICT sectors.

GERMANY



In 2008 Germany launched the National Pact for Women in MINT (STEM) Careers to increase women's interest in scientific and technical studies. The initiative brings together politics, business, science and the media to improve the image of STEM-related professions in society.

Basic education.

Millions of children remain out of school across Asia, despite a target set at the turn of the century to guarantee universal basic education by 2015. Many countries fail to teach even basic cognitive skills, let alone prepare students for the future. It is crucial that all youths access a full course of basic education, and that governments allocate adequate funds, and skills, to train teachers. Syllabuses, teaching methodologies, and assessment modes should be regularly refreshed to reflect 21st-century skills and expertise. This need not only come from the public sector. Issues such as teacher absenteeism show that state schooling may fail to address students' needs: a Transparency International study put the figure of absenteeism at over 15% in India, Indonesia, Cambodia, Pakistan and Bangladesh,¹⁰¹ while India in particular has been singled out for poor levels of quality education in its school system.¹⁰² In some contexts, low-cost private schools have been shown to achieve greater levels of service quality provision, although this is largely a reflection of the poor state of public schooling than any inherent traits; UNESCO has noted that governments can use "strategically low-cost private schools as an interim solution while plans are implemented to raise the number and the teaching quality of public schools."¹⁰³

Secondary education.

Education quality needs to improve at the secondary level too, with greater curricular focus on ICT and STEM subjects in preparation for an evolving job market. More can be done to instill higher-order soft skills including creative problem formulation, social intelligence, cultural sensitivity, adaptability and leadership. The lack of these attributes remains a bottleneck to Industry 4.0 uptake and they will become increasingly important. To nurture them, liberal arts and social sciences should be prioritised alongside STEM subjects – rote learning will not equip workers with the skills to navigate technical problems and complex technologies.¹⁰⁴

Some countries are focusing on secondary-level reforms to connect the future workforce to the technological realities of tomorrow. Singapore regularly updates its curricula, assessment models and teaching methods with changes including the integration of more IT and cognitive-thinking skills and the introduction of more practical forms of learning.¹⁰⁵ Indonesia has reoriented its curriculum to focus on "new literacies" of data and technology, and extra-curricular activities that

develop leadership and teamwork skills. It also issues grants and technical guidance to universities seeking to reorient their curricula, and is promoting hybrid and online qualifications to improve educational access.¹⁰⁶

Technical and vocational learning.

Many countries already promote Technical and Vocational Education and Training (TVET) but quality is often poor. To improve outcomes, governments should identify skills which are in deficit at a regional, as well as national level, and prioritise practical work-integrated learning, which combines classroom study with hands-on experience. TVET courses should offer flexibility, so that cash-poor students can work while they study. Competency-based assessment systems to grant poorly-educated but skilled workers qualifications based on their experience could be an area to consider.¹⁰⁷

For example, Malaysia's "Redesigning Higher Education" strategy aims to prepare students for the Fourth Industrial Revolution with programmes including 2u2i – a technical training pathway including two years of university and two of industry apprenticeship – and a CEO Faculty, where industry leaders provide lectures, curriculum development and mentoring at universities. In Thailand, the Institute of Field Robotics at King Mongkut's University of

Technology, Thonburi, has been offering courses on industrial robotics and automation systems to nurture relevant skills and capacities to support a wide-scale adoption of robotics and automation technologies across the nation.¹⁰⁸ The government is aiming for an investment of 12bn Baht (US\$362m) in the first year, increasing to 200bn Baht (US\$6bn) over the next five years,¹⁰⁹ and has pledged to support all target groups that can use automation or robotics systems, covering the agricultural, industrial and service sectors, to enhance their manufacturing efficiency and help them compete more effectively at the global level.

TO IMPROVE OUTCOMES, GOVERNMENTS SHOULD IDENTIFY SKILLS WHICH ARE IN DEFICIT AT A REGIONAL AS WELL AS A NATIONAL LEVEL, AND PRIORITISE PRACTICAL WORK-INTEGRATED LEARNING, WHICH COMBINES CLASSROOM STUDY WITH HANDS-ON EXPERIENCE

Lifelong learning.

Countries should support on-the-job learning and invest in lifelong education and entrepreneurship programmes that allow adults to re-skill in cases of redundancy. Incentives are numerous, including grants, subsidies, scholarships, or education credit. So too are free tuition and the guarantee of paid leave from work. Lifetime learning funds – taking contributions from employers, employees and government, which are invested tax-free and withdrawn as required – may prove a viable model for the future. In addition, the development of national guidelines can help workers navigate career pathways and provide advice on relevant education and training programmes. Governments may also support businesses with sector-specific training based on national competency standards. Policymakers can work with businesses and the third sector to identify missing skills and



TO ENSURE THAT GRADUATES EMERGE WITH JOB-READY SKILLS, APPRENTICESHIP SCHEMES MUST FORM A BIGGER COMPONENT OF SECONDARY AND TERTIARY EDUCATION.

and pique students' interest in alternative careers. The Philippines, for instance, has partnered with industries to promote alternative job opportunities for high school graduates. In the Panglao municipality, the association of hotels and resorts has trained high school teachers to engage students about the prospect of a career in tourism and services.¹¹⁰ Previously, 80% of public high school graduates would not have

gone on to a college where tourism courses were offered, but due to the industry collaboration, almost all grade 10 graduates enrolled in grade 11 looked towards potential employment in the tourism industry, according to analysis by the Asia Foundation.

Companies may contribute materials or facilities to schools, or train teachers to talk about certain jobs, in order to boost the uptake of prerequisite subjects. To ensure that graduates emerge with job-ready skills, apprenticeship schemes must form a bigger component of secondary and tertiary education. Some industry associations run vocational training courses or digital literacy centres. They should work with universities and skills development institutes to build appropriate qualifications, train instructors, and improve the quality of technological education where standards are in question.

Social

Automation, AI and the new digital economy can have a positive impact on social outcomes through their deployment in public services, and social protection policy is the primary mechanism through which the negative impacts of automation, including but not limited to unemployment, can be mitigated or offset. This second domain explains the ways the AI and innovation technology portfolio can be successfully used to promote the SDGs, and the social protection policies that could counter its downsides.

AI can improve the efficiency of public administration and service delivery

Governments are adopting AI, ML, big data and blockchain to optimise public services. By improving the efficiency of public administration, and lowering costs, AI can support the SDGs by freeing up government resources to focus on critical areas, lowering the fiscal cost of public administration and improving governments' ability to reach those most in need.^{111 112} Within the civil service, AI and ML can reduce bureaucracy and paperwork and improve data-driven services, as automation cuts the time taken to produce paperwork. Evidence shows that AI can be

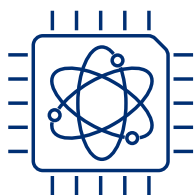
EVIDENCE SHOWS THAT AI CAN BE USED IN PUBLIC ADMINISTRATION WHERE HUMAN RESOURCES ARE LIMITED.

used in public administration where human resources are limited. For example, a study estimates that documenting and recording information consumes half a billion staff hours annually, at a cost of US\$16bn in wages, in the US federal government, with procuring and processing information consuming another 280m person hours at a cost of \$15bn in wages.¹¹³ Automated workflows and innovations such as blockchain are powerful forces that could dramatically cut such workloads. In the UK NHS, simple digital innovations have already cut costs and improved efficiency. Examples include a website, built by a doctor, which standardised documentation procedures for discharge summaries, which

are completed when patients leave hospital and return to their general practitioner. These had previously been prone to inconsistency and often contained missing or confusing information entered by often harried and over-worked medical staff.¹¹⁴ Such examples show how even simple digital innovations can make a substantial difference to public service delivery.

Some Asian governments continue to suffer from very slow public administration processes – India's court system is a case in point – which can stymie economic growth and social welfare. Given that automation excels in structured, rule-based work, there is a huge opportunity to deploy such software for government administration.

Data-driven public services can be a boon in healthcare provision



AI CAN ALSO SURPASS MEDICAL EXPERTS IN THE DIAGNOSIS OF DISEASES

Public services benefit from improved data, and evidence shows that AI and automation are making a contribution to more effective service delivery. Healthcare is a particular beneficiary. ML can improve infectious disease monitoring, crucial in a region with high population density and large cities, and this includes identifying less-known risks. One team used ML to determine bat species most likely to host filovirus, which causes severe haemorrhagic fevers like Ebola; their model, which achieved 87% accuracy, signalled significant bat reservoirs in parts of Southeast Asia, even though most focus to date has been on Sub-Saharan Africa.¹¹⁵

Collaborating with ML research communities could improve countries' readiness to such outbreaks. AI can also surpass medical experts in the diagnosis of diseases: Alphabet-owned firm DeepMind has predictive analytics models and data-sharing tools which have brought benefits including identifying patients at risk of deterioration, and have been utilised by public health services in the UK and US.

Developing Asia can leverage smartphones to help populations access AI-based diagnosis, or human expertise where there are no local specialists. There are an estimated 8bn smartphones equipped with cameras able to diagnose heart, eye and blood disorders. Along with pattern recognition and ML diagnostic tools like IBM's *Watson*, this could improve services in areas like oncology (as is already happening in China),¹¹⁶ and help deliver expert services in countries that may lack medical specialists.¹¹⁷ 3D printing is a further boon to health systems, with existing use cases including Nepal, where aid workers have used additive

manufacturing to replace water pipes and components for hospital incubators for newborns.¹¹⁸ Governments can harness AI, satellites and big data to respond to disasters, particularly in humanitarian relief efforts, including food supply and distribution of relief workers and resources.¹¹⁹ AI can also help victims of domestic abuse, providing assistance during the filing of relevant paperwork that is both time-consuming and, for victims, distressing.^{120 121} AI is among the technology portfolios that are now driving personalised medicine, in which treatments are increasingly capable of responding to each person's unique genomic and biological profile. While still in relative infancy, and mostly clustered in high-income economies with the most advanced medical systems, the promise of personalised medicine for more tailored and effective interventions could in time benefit Asia's health systems and will be substantially aided by AI, ML and related Fourth Industrial Revolution innovations.

AI-powered education can improve outcomes and coverage

Education is the second social service category that can benefit from automation and AI to deliver more personalised pedagogy. "Smart schools" can leverage AI to reduce teacher bureaucracy and improve tailoring. Chinese start-up Master Learner uses AI to mark students' homework, which can free teachers – who number approximately 14m in China – to spend more time directly teaching and interacting with students. (China's government has reportedly made AI-enabled

education a national strategy.)¹²² Other SDG-related innovations include speech recognition, which helps disabled students leverage digital technology, and adaptive learning algorithms, which deliver individualised education: IBM's Watson has been shown to produce insights

about students based on their demographics, strengths, and challenges, enabling teachers to create more targeted instruction. AI can also develop predictive capabilities for the prevention of cyberbullying: families submit complaints which are investigated by government agencies and actions are taken. Data is used to train AI systems (with privacy protection measures in place) to provide early warnings to families.¹²³

“SMART SCHOOLS” CAN LEVERAGE AI TO REDUCE TEACHER BUREAUCRACY AND IMPROVE TAILORING.

Other sectors, such as urban liveability, can benefit

Beyond core social sectors like health and education, there are also examples of AI, automation and new digital economy tools in areas like urban planning and logistics. Alibaba has partnered with the Malaysia Digital Economy Corporation and Kuala Lumpur city council to develop technology capable of live traffic predictions and recommendations to increase traffic efficiency in Kuala Lumpur. The system analyses data from video footage, traffic bureaus, public transportation systems and mapping apps, integrated with 500 inner-city cameras by 2018.¹²⁴

Social protection responses will be needed

The above examples illustrate how technologies can improve social services and make a positive contribution to the SDGs, but social policy can also counter the downsides of new technologies, as touched upon in the first part of this report. The function of social protection should be to provide every citizen with a basic, dignified standard of living regardless of employment status, disability or disadvantage. The social

protection floor is defined by the ILO as the “nationally defined set of basic social security guarantees to ensure, over the life cycle, that those in need have access to essential healthcare and basic income security”.¹²⁵

This is both a moral imperative and the necessary foundation of a resilient labour market because, without such a social protection floor, unemployment can push people into

chronic poverty. Deteriorating mental and physical health, and inadequate financial means to access information about new work opportunities, re-train or migrate to new job opportunities, can lock individuals into permanent poverty. Well-designed and sustainable safety nets can thus ensure a smoother transition, and an elastic, responsive labour market that adapts to change.

Social protection interventions can be split into four categories: protective (providing relief from deprivation, such as disability benefits or non-contributory pensions); preventive (averting deprivation such as through savings clubs, insurance or risk diversification); promotive (enhancing incomes and capabilities); and transformative (which address social equity and exclusion such as through anti-discrimination laws, affirmative action, and

THE FUNCTION OF SOCIAL PROTECTION SHOULD BE TO PROVIDE EVERY CITIZEN WITH A BASIC, DIGNIFIED STANDARD OF LIVING REGARDLESS OF EMPLOYMENT STATUS, DISABILITY OR DISADVANTAGE

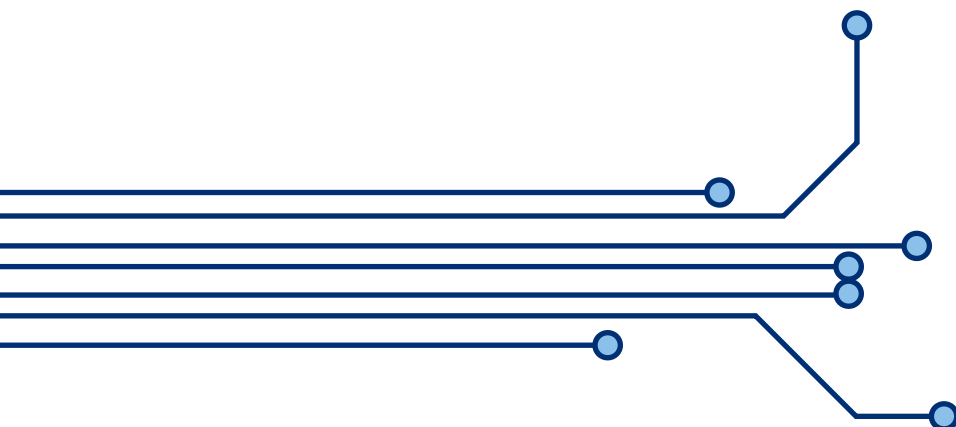
sensitisation campaigns).¹²⁶ Social protection policies target eight broad areas: child and family support, maternity support, sickness, unemployment, employment injury, disability/invalidity, survivors, and old age.¹²⁷ Here we focus on measures to help those displaced by technological change.

In Asia, there is considerable variation in the scale and scope of social protection measures. According to the *ILO World Social Protection Report 2017*, China, Hong Kong, Japan, Thailand and Vietnam have at least one statutory programme in place covering all eight domains, while Myanmar, Timor Leste, Bhutan, Nepal and Malaysia cover only four areas, indicating large variation in regional social protection levels¹²⁸. Unemployment support is the most critical when it comes to automation's threats, and comes in many forms. China, Hong Kong, Japan, and South Korea have contributory and non-contributory schemes to support the unemployed, and Japan and South Korea provide partial income replacement for unemployment and measures to facilitate return to employment.¹²⁹ Other countries have weaker measures like severance pay (e.g. Malaysia and the Philippines).¹³⁰ Thailand and Vietnam have a track record in

delivering employment support measures, and India has unemployment programmes, but less than 3% of the unemployed reportedly access them. The following nations have no unemployment benefits programme or no information pertaining to such a programme:

Bangladesh, Bhutan, Brunei, Indonesia, Malaysia, Nepal, the Philippines, and Vietnam.¹³¹ Beyond conventional statutory instruments, two other policy levers have been explored: cash transfers, and public works programmes/employment guarantees.

IN ASIA, THERE IS CONSIDERABLE VARIATION IN THE SCALE AND SCOPE OF SOCIAL PROTECTION MEASURES.



Cash transfers.



CASH TRANSFERS MADE WITHOUT ANY EXPLICIT EMPLOYMENT FOCUS RESULTED IN LITTLE OR NO CHANGE TO ADULT LABOUR MARKETS

Cash transfers provide direct cash benefits to individuals, without regard to their past contributions through tax (e.g. national insurance). Means-tested transfers provide benefits to people or households whose income falls below a pre-determined threshold, and are primarily financed by government revenues.¹³² Conditional cash transfers tie the continued receipt of money to specific development-related behaviours like child schooling or vaccinations.¹³³

Cash transfers have steadily expanded globally in both developed and developing economies, and governments have re-purposed them to deal with new challenges; for example, US safety net programmes were scaled up to support post-disaster recovery after Hurricane Katrina, and Ethiopia's Productive Safety Net Programme (PSNP), to aid for the chronically deprived added top-ups linked to weather-related shocks.¹³⁴

Evaluation literature presents a mixed picture of the effectiveness of cash transfers. Contrary to assumptions that such measures dis-incentivise work, studies show that their receipt does not cause people to work less, except in certain cases such as the elderly. However, one literature assessment observed that cash transfers made without any explicit employment focus resulted in little or no change to adult labour markets, while those tied to job search assistance or for business start-up activity increased adult labour supply and earnings through channels including the alleviation of financial constraints to either job searching or new business formation.¹³⁵

A more novel mode of cash transfer is universal basic income (UBI), an unconditional, population-wide basic financial transfer intended to provide a minimum income baseline. It has received growing attention as a tool to both simplify complex welfare systems and help those falling into unemployment and poverty. Even leading voices in the technology sector itself have put their weight behind the idea – Elon Musk predicted that job losses from automation could necessitate government help for some, and Facebook founder Mark Zuckerberg has publicly lent support to the idea, while entrepreneur Andrew Yang, who is running for US President in the 2020 elections, has put UBI at the heart of his campaign agenda.

THERE ARE ALSO MANY IDEOLOGICAL FACTORS WHICH HAVE INFLUENCED THE DEBATE OVER UBI FOR DECADES.

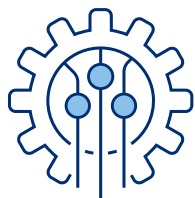
It is too early to establish whether UBI is effective, since no country has tried it at scale with monitoring and evaluation measures in place. There are also many ideological factors which have influenced the debate over UBI for decades. One is whether it is additional to current welfare systems or replaces them – if the latter, then by dint of being universal, it could be regressive by spreading welfare payments to many on middle and high incomes. Andrew Yang, in contrast, envisages an opt-in system for those who *de facto* receive more support through existing welfare transfers, which might include those with disabilities. Other obvious debates include how such interventions would be financed – for example, through “robotax” levied on companies driving the automation transition. This is a complex problem for Asia, however, which is not the home of such firms – beyond China and its high-income economies – and therefore not a recipient of such tax spending.

Finland was an early mover in a small trial in which 2,000 people received €560 per month, commencing in January 2017. This has now expired with no data on efficacy – and while often discussed in the context of UBI, it was only for the unemployed and thus not universal in any sense.¹³⁶ Two economists dismissed the Finnish experiment as a publicity stunt with a sample too small to produce scientifically reliable results.¹³⁷

Other pilots are under way in Ontario and Scotland, as well as Silicon Valley start-up accelerator Y-Combinator and a non-profit in Kenya exploring UBI through randomised controlled trials, although no results are yet available.¹³⁸ Within Asia, Indian officials have shown interest in UBI. The Ministry of Finance’s 2016–2017 Economic Survey argued that Indian welfare systems are poorly targeted, and claimed that an annual transfer of US\$120 would help lift all but India’s very poorest above the poverty line, at a cost of 4.9% of GDP – a net-neutral cost only if it replaced other welfare systems.¹³⁹ Only large-scale trials and rigorous evaluations will show whether UBI could be a viable response to automation-related unemployment.



FINLAND WAS AN EARLY MOVER IN A SMALL TRIAL IN WHICH 2,000 PEOPLE RECEIVED €560 PER MONTH



HISTORICALLY, PUBLIC WORKS PROGRAMMES HAVE FREQUENTLY BEEN USED TO RESCUE ECONOMIES DURING TROUBLED PERIODS

Employment guarantees and public works programmes.

Employment guarantees offer a set number of workdays to vulnerable households or individuals. Historically, public works programmes have frequently been used to rescue economies during troubled periods. While no simple evaluations can be made of such interventions, economists have argued that public works programmes can be effective but have tended to focus on infrastructure and less on education and social services, which can have a greater payback; they have also criticised the tendency for infrastructure programmes to end in white elephant projects.¹⁴⁰

In developing Asia, the most notable and discussed public works programme is India's National Rural Employment Guarantee Act 2005 (NREGA), the largest public employment project in the world, which at its peak in 2009–10 granted 2.8bn days of employment to 54m rural households.¹⁴¹ NREGA offers 100 days of waged employment per financial year for rural households where adults are willing to participate in manual work. Unlike usual public works efforts, NREGA was a statutory right, rather than being at the discretion of government. Evidence on the programme is mixed. One 20-district review in 2006–7, soon after it was launched, found that female-headed household participation ranged from 12% to 52%, but many operational problems were reported, such as long time lags between requests and work allocation. Data at the time also showed limited uplift, with only 2% of household heads opening a bank account, although over half had purchased livestock.¹⁴² However, as befits a country of India's size and diversity, some states reported positive results. Dungarpur district in Rajasthan saw a high level of NREGA awareness and half the population utilising it, while corruption, a problem for NREGA elsewhere, was minimised due to tight oversight and transparency, which one think-tank attributed to Rajasthan's extensive experience in labour-intensive work programmes.¹⁴³

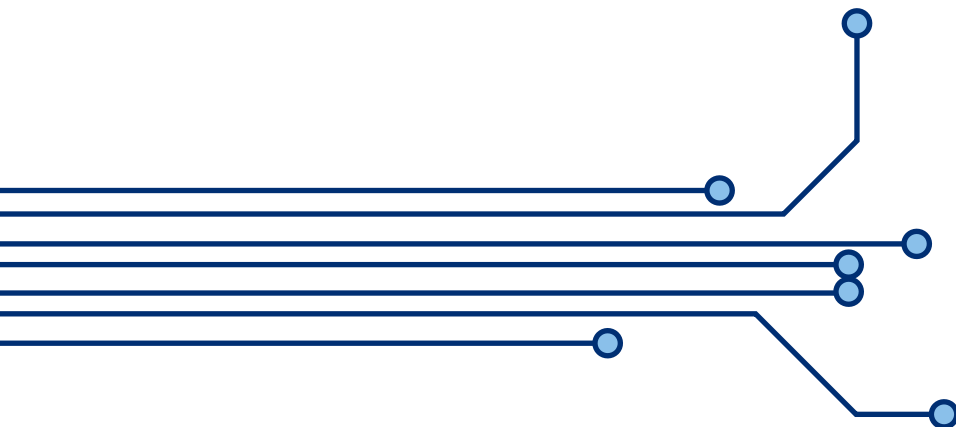
Public works programmes have also been assessed outside of Asia. One review of Ethiopia's PSNP, launched in 2005, identified some positive gender components, but noted that it failed to address gender inequality in food security and agricultural productivity. It also observed that the ends to which public works are aimed are not gender-neutral: roads, terraces and water harvest facilities may meet male needs more than female, with women potentially benefitting more from health clinics closer

to the community; gender is therefore an important factor in project selection.¹⁴⁴

While a comprehensive review of public works and employment guarantees is beyond the scope of this report, lessons learned so far indicate that these have been a common government intervention for dealing with economic transition in both rich and developing countries, but they alone do not amount to a strategy for economic transformation outside of high-income economies. The Obama administration in the US, for instance, sought to use the financial crisis stimulus as an opportunity to push the country towards green energy. Conversely, the resources of nations like India and Ethiopia have focused more on local works – an approach that is palliative and does not amount to a transitional strategy.

A potentially more promising avenue is to build out apprenticeship programmes, through integrating education systems with industry, to better align the two and provide apprenticeships with real on-the-job experience. The model has been popular in several European economies with industrial prowess, including Switzerland and Germany.

**IN DEVELOPING ASIA, THE MOST NOTABLE
AND DISCUSSED PUBLIC WORKS PROGRAMME
IS INDIA'S NATIONAL RURAL EMPLOYMENT
GUARANTEE ACT 2005**



Environmental

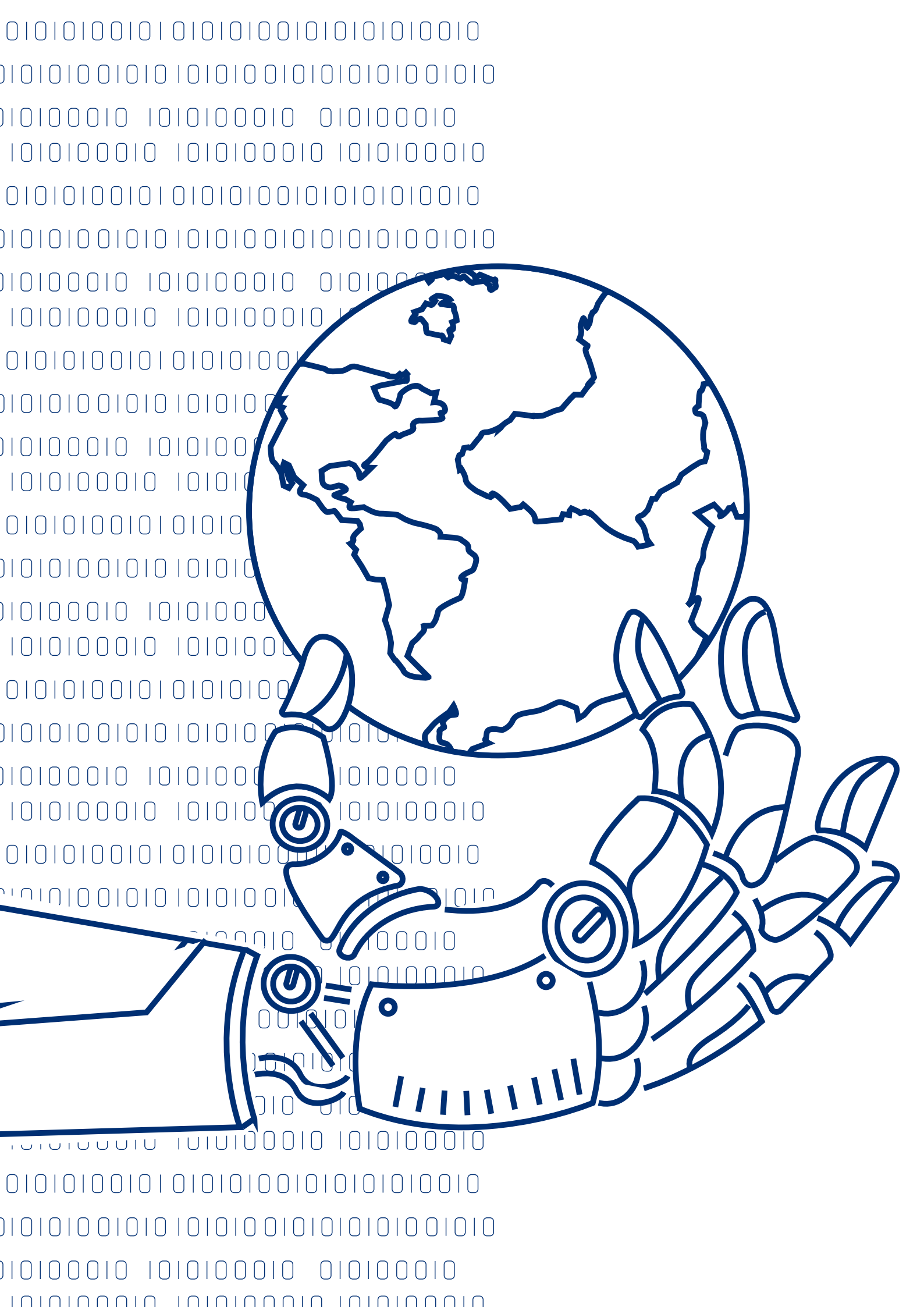
Current and emergent technologies can have environmental and ecological benefits, such as reducing waste and energy usage, and optimising our ability to harness nature's power. As a public good, environmental protection and conservation are responsibilities held by governments, which can develop appropriate regulations and acquire technologies that could help environmental bodies operate more effectively. As such, the third policy domain explores how AI, automation and the new digital economy can positively contribute to the environment and natural resource-related SDGs and areas of potential trade-offs.

Emergent technologies can drive energy efficiency in industry



FOURTH INDUSTRIAL REVOLUTION TECHNOLOGIES IMPROVE ENERGY EFFICIENCY AND REDUCE WASTE ACROSS CHANNELS, INCLUDING REAL-TIME ANALYTICS TO IDENTIFY ENERGY USAGE TRENDS AND SPOT INEFFICIENCIES AND WASTE.

The industrial sector accounts for approximately one-third of global final energy use, and the International Energy Agency has claimed that, even a decade ago, energy use could be reduced by between 13% and 29% in five energy-intensive sectors through implementing "emergent technologies", amounting to a 4% reduction in global CO₂ emissions.¹⁴⁵ Fourth Industrial Revolution technologies improve energy efficiency and reduce waste across channels, including real-time analytics to identify energy usage trends and spot inefficiencies and waste. Innovations like Virtual Power Plants, which pool distributed energy resources, are orchestrated by a cloud-based centralised or distributed control centre, using IoT devices and digital technologies. 3D printing and rapid prototyping, meanwhile, allow firms to experiment with new products and designs using a fraction of the industrial energy needed in conventional, large-scale manufacturing processes. 3D printing also enables machinery to be simplified, reducing its weight and improving combustion efficiency.



For example, the General Electric LEAP engine, the first with 3D-printed fuel nozzles made from advanced materials, posted a 15% increase in fuel efficiency.¹⁴⁶ Other efficiency gains from General Electric's use of software and additive printing include 10% higher energy production from wind, and 62% efficiency gains in gas turbines.

Asian governments should consider attracting firms that are successfully utilising such technologies, and provide support mechanisms for local competitors to ensure they benefit from the same technologies. Fiscal incentives including custom exemptions or trade facilitation measures could be explored. Governments should also consider partnerships with digital logistics platforms that can be agents of change. Regulations to phase out internal combustion engines, for instance, force fast-growing businesses to invest heavily in future-proofing their business: there are already 200,000 electric cars in Didi's fleet, potentially rising to 1m within a decade.¹⁴⁷

Agriculture stands to benefit from precision agriculture

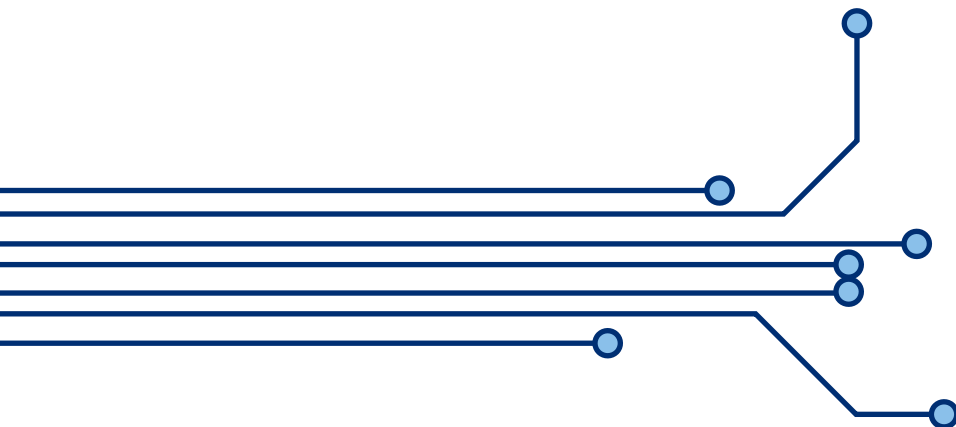
Asian agriculture faces a number of sustainability challenges including stagnant productivity, poorly regulated water usage and environmentally damaging practices. There is hope that precision agriculture, an emerging portfolio of technologies which applies robots, sensors, IoT, mobile telephony and geographical information systems, can improve farmers' visibility of their crops, helping them spot problems, respond to threats and more finely tailor their use of inputs, with powerful benefits in terms of, sustainability and reduced food waste. Innovations like vertical and hydroponic farming are also of note. The former grows food in vertically stacked layers, allowing greater output without using arable land, making it well suited to more densely populated areas. Asia is a lead market, with Spread and Fujitsu pursuing soilless and vertical agriculture.

Technology inventions have been shown in studies to make a meaningful contribution to food security, which underpins most of the SDGs. One study argued that a portfolio of innovations including integrated soil fertility management, precision agriculture and water harvesting, applied to wheat, rice and maize, could reduce the number of people at risk of hunger by 35%, and all climate change-related increases in child malnutrition in the Pacific Islands could be eliminated by a package of policies that includes increasing R&D to 2% of agricultural GDP.¹⁴⁸

PRECISION AGRICULTURE IS BEING LED BY DEVELOPED ECONOMIES.



However, precision agriculture is being led by developed economies. To increase its relevance and take-up in Asia, governments will need to work actively with the science and technology community and extension agencies, to support technology transfer, adapt innovations to local circumstances, and ensure that farmers – especially the smallholders who make up most of the agricultural production in lower-income Asia – understand how to use, and can access, these technologies. This can include helping them access higher-quality climate data – pest and disease forecasting services – and weather-based crop insurance programmes.¹⁴⁹ For example, NITI Aayog is collaborating with IBM to develop a crop yield prediction model, using AI to provide real-time analytics to farmers.¹⁵⁰ The partnership aims to enable use of technology to provide insights to farmers to improve crop productivity and soil yield, and control agricultural inputs, with the overarching goal of improving farmers' incomes. The scope of this project includes an introduction to, and making available, climate-aware cognitive farming techniques and identifying systems of crop monitoring and early warning on pest/disease outbreak based on advanced AI innovations. Governments can also work closely with data firms whose products can help them in their wider ecological services. Programmes such as Microsoft's "AI for Earth", for instance, fund projects to monitor, model and manage natural systems, and its Asia portfolio includes wildlife monitoring and plant pest prediction in India, and a disaster management cloud platform in Japan.¹⁵¹



Autonomous systems will support mining and resource extraction

Autonomous systems are being deployed in the mining sector, using systems that could be deployed in the Asia region. The head of mining multinational Anglo American, which is active in China and India, recently predicted that robots, virtual modelling and sensors will be managing mines "within a decade". BHP Billiton is also developing autonomous train systems in Australia's Pilbara iron ore region and robots have been used to improve safety in South African mines.¹⁵² As well as potentially carrying out more dangerous mining activities, such as developing the underground infrastructure, more sophisticated modelling tools could reduce harmful "tailings" – the run-off, often toxic, by-products of mining. This is critical because while many new technologies bring efficiency gains, they also increasingly depend on new types of raw materials: the advanced technologies of today rely on a number of resources that are problematic to extract. One study tracked the technology portfolios necessary to achieve the SDGs, and forecast large expected increases in demand for lithium, dysprosium/terbium, rhenium, and neodymium.¹⁵³ Accessing these and other heavy rare-earth metals brings risks, as they often occur alongside hazardous and radioactive elements like uranium and thorium, which can be released during the mining, smelting and refining process.¹⁵⁴ The study found that, as well as putting in place proper environmental protection policies, measures like recycling, especially of commodities such as copper, could also help, since products at the end of their lifetime can provide raw materials for new technologies. Evidence already shows problems in the Asia region. Bayan Obo, a major rare-earth mining site in Mongolia, has seen radioactive waste and sulfuric acid passing into dams and the Yellow River, which provides local drinking water. Cancer is a leading cause of death in the region and health problems associated with poisonous elements are reportedly common.¹⁵⁵



Conclusion: Technological change and the openness of the future

Asia's half-century of growth has made the largest contribution to global poverty reduction of any region, and was built on labour-intensive manufacturing and outsourced business services; precisely those sectors that are now threatened.



If automation evolves at the pace some predict, it could slow, or even reverse, the region's progress towards the SDGs.

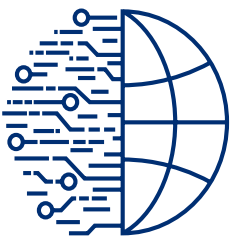


The same innovations threatening to replace workers are being credited with progressive impacts, from improving social service delivery and simplifying public sector bureaucracy to providing new revenues and forms of income in the digital economy, a sector in which Asia is flourishing



Choices made by governments, public institutions, the private sector and civil society shape the ends to which technologies are put and the extent to which their risks are managed.

The Fourth Industrial Revolution has generated much hype and excitement, with innovative companies promising a world of efficiency, productivity and progress. As these tools have advanced in range, speed and flexibility, they have amplified fears about technology-driven unemployment and inequality. This debate has been largely Western-centric to date as these economies deal with long-term stagnation in productivity and rising inequality. But development institutions and governments in emerging economies are rightly scrutinising this technology portfolio for threats – as well as opportunities – they might bring.



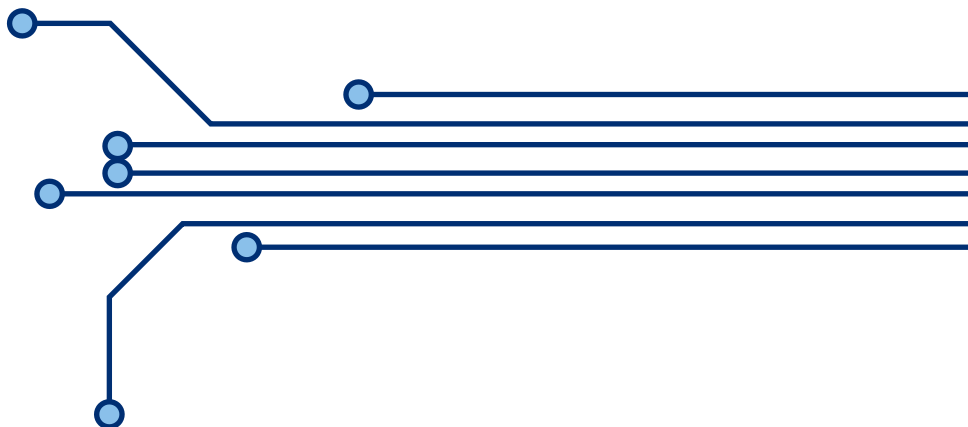
ASIA'S HALF-CENTURY OF GROWTH HAS MADE THE LARGEST CONTRIBUTION TO GLOBAL POVERTY REDUCTION OF ANY REGION, AND WAS BUILT ON LABOUR-INTENSIVE MANUFACTURING AND OUTSOURCED BUSINESS SERVICES, PRECISELY THOSE SECTORS THAT ARE NOW THREATENED.

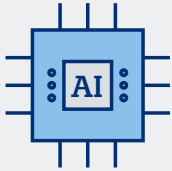
Asia's half-century of growth has made the largest contribution to global poverty reduction of any region, and was built on labour-intensive manufacturing and outsourced business services – precisely those sectors that are now threatened. If automation evolves at the pace some predict, it could slow, or even reverse, the region's progress towards the SDGs. Since

this region – predominantly driven by China's economic performance – has driven global poverty reduction figures over the last three decades, this would set back global progress too. However, the same innovations threatening to replace workers are being credited with progressive impacts, from improving social service delivery and simplifying public sector bureaucracy to providing new revenues and forms of income in the digital economy, a sector in which Asia is flourishing.

To inform public debate and policy development, this report has provided a structured, Asia-focused analysis, anchored to the SDGs, identifying the risks and opportunities posed by AI, automation and the new digital economy. It has identified the interventions through which opportunities could be harnessed, and risks mitigated. The most desirable policy mix will depend on a country's context, resources, current and future trade relationships, and the overall position of its government as regards the role of the state in guiding development.

Whichever route countries take, they should take heart in the fact that dystopian technological predictions have accompanied every new phase of innovation and rarely has economic history played out in either an overtly positive or negative direction. Choices made by governments, public institutions, the private sector and civil society shape the ends to which technologies are put and the extent to which their risks are managed. There are multiple drivers of inequality and economic marginalisation beyond the technological, which can be more directly influenced by governments. Innovation has always been an endeavour, shaped, constrained and directed by the choices we make about the role we want technology to play in the building of prosperous, inclusive and productive societies.





Policy directives by the United Nations Development Programme

Rapid advances in technology are already profoundly affecting societies in Asia-Pacific. But while the possible effects of these changes on jobs, growth, or the environment can be estimated, even the best predictions are unlikely to hold in the face of rapid innovation. The impact of the Fourth Industrial Revolution is not pre-determined. How countries embrace and adapt to the coming changes will influence whether they meet the promise of the *2030 Agenda for Sustainable Development and achieve the Sustainable Development Goals (SDGs)*.

Building on the findings of the report, the six policy themes below are intended to be a practical guide to help promote progress across dimensions of sustainable development (economy, society and environment) and across segments of society. These are critical domains where governments—together with civil society, the private sector, and development partners—can evaluate current approaches, consider future scenarios, and create and test new systems and models.

It is up to each country to develop solutions appropriate to their own economic and social context—both in the present and in the future. These recommendations support this effort. They identify themes for further analysis and guide policy and institutional design to help societies capture the opportunities afforded by technological change and manage the possible negative consequences of it.

Embrace predictive and adaptive decision-making.

The Fourth Industrial Revolution coincides with other mega-trends such as rapid urbanisation, rising inequality, and climate change. Reactive policies and institutions will be increasingly ill-suited to manage these new challenges or to capture the potential of technological innovations to help strengthen approaches to sustainable development. Governments more likely to accelerate progress towards the SDGs will be those that actively design policies and institutions that are more predictive, adaptive, and responsive to citizen needs.

- Use cognitive and analytical tools such as "strategic foresight", "horizon-scanning", "systems analysis", as well as big-data techniques and predictive analysis for policy and planning.
- Introduce a culture of innovation and experimentation to test new solutions and technology.
- Establish "cross-functional teams" from across ministries and between tiers of government.

Capture emerging sources of growth and employment.

Development models reliant on labour-intensive manufacturing are likely less suitable for the new era. One estimate, for example, is that 85% of the jobs that today's students will hold in 2030 do not currently exist. Governments cannot necessarily rely on existing sectors to drive future growth and employment but can instead be opportunistic and ready to capture new sources when they emerge. For example, the shift to environmental sustainability can generate jobs in the "green economy", such as in renewable energy, energy efficiency, recycling, and repair. Technical, creative and digital skills that aid problem-solving will also be increasingly relevant. Seizing new opportunities will require lifelong learning and agile, flexible training systems.

- Develop training systems that continually adapt and re-train workers, with targeted initiatives and incentives for women and girls, and introduce a culture where workers expect re-skilling several times over a lifetime, shifting into new sectors and new jobs or tasks within sectors.
- Forecast future labour needs and actively develop skills to match anticipated demand, including for new jobs (e.g., problem-solving and innovation) and for new skills needed to adapt existing jobs (e.g., environmentally sustainable practices).

- Incentivise the development and adoption of new technologies, especially those that reduce emissions, generate value, and promote natural systems upgrading.
- Explore how new technologies and enhanced business practices support increased efficiency and productivity of private enterprises, and opportunities for new business development along value chains.
- Support entrepreneurship through access to finance, business training, and networking opportunities to create an ecosystem of start-ups.

Reimagine citizen engagement and personalised service delivery.

Governments need to go beyond traditional forms of citizen engagement and rethink existing models of governance. New technologies make it possible for large numbers of citizens, including marginalised groups, to systematically engage and participate in shaping policy decisions and the services that affect them. New technologies can also provide better means for understanding citizen needs and pave the way for recipient-driven public service delivery.

- Use technology to create platforms for continuously assessing citizen demand, tracking usage, and gauging customer satisfaction.
- Broaden the development dialogue to include the views and perspectives of marginalised groups.
- Integrate technology as a fundamental layer of the public service architecture, including training staff across tiers of government in its use and applications.
- Leverage technology to boost efficiency, widen coverage, and personalise services.
- Adopt transparent and regulated processes related to the use of technologies that affect civic engagement and citizen interaction.
- Invest in expansion of the Internet to reach underserved communities to support wider access to information and direct connections with government platforms.

Enhance protection to help leave no one behind.

Adapting to coming changes will be difficult for many. Some workers will lose their jobs and others will discover their skills outdated. The impact of automation and technological change will also not be evenly distributed, including different consequences for men and women such as gaps in opportunity for developing skills relevant to the new economy. Some countries also confront a “youth bulge”, increasing the prospects of an unemployed generation in the absence of preventive measures, while others face a demographic shift toward older populations that will put pressure on pension systems. Governments need to consider—even in the best-case scenario—how to support citizens, including re-examining ideas of social protection and the basic obligations of the government to its citizens.

- Experiment with and evaluate forms of universal basic income (UBI). An ambitious package of UBI, depending on country income level, is estimated to cost between 5 and 18% of GDP.
- Leverage technology to improve social assistance and protection that is better targeted and tailored to specific demographic groups, including through improved understanding of needs through data and information collection.
- Prototype tech-driven solutions to boost efficiency and effectiveness of social programmes, such as through more efficient delivery systems.
- Consider innovative employment support, such as allowing flexibility for breaks in careers, facilitating transitions between wage and self-employment, and integration of care responsibilities into social protection.
- Support research to better understand and respond to the gender implications of AI and technology, including for perpetuating inequalities.

Mobilise and allocate finance for a better future.

Governments will need to reframe how they plan resource allocation and mobilise new sources of domestic revenue. This includes through both public and private sources to finance: (i) strengthened social protection; (ii) interventions aimed at quality investments in health and education; and (iii) the provision of opportunities to increase productivity among youth. Advances in technology can also support systems for allocating, transferring, and tracking spending, and can create opportunities to support new and necessary measures in collecting and enforcing tax collection.

- Determine options for phasing in tax reforms aligned with financing projections, such as excise tax, carbon tax, tax on large "super star" multi-national companies, and VAT.
- Leverage financing and direct investments toward key areas to accelerate education and skilling efforts.
- Explore how innovative finance mechanisms, including impact investment, crowdfunding, pooled funds, and blended financing can contribute to financing strategies for inclusive growth.
- Use foresight and costing methods to determine available resources and future gaps as a first step toward financing strategies that are responsive to future challenges.
- Experiment with increasing corporate and wealth taxes to help counteract possible inequality effects and source needed revenue.

List of abbreviations

| | |
|----------------|--|
| AEC | ASEAN Economic Community |
| AI | Artificial Intelligence |
| ASEAN | Association of Southeast Asian Nations |
| BPO | Business Process Outsourcing |
| GDPR | General Data Protection Regulation |
| ICT | Information and Communications Technology |
| IIoT | Industrial Internet of Things |
| ILO | International Labour Organization |
| IoT | Internet of Things |
| IT | Information Technology |
| ML | Machine Learning |
| MVA | Manufacturing Value Added |
| NGO | Non-governmental organisation |
| NHS | National Health Service (UK) |
| NREGA | National Rural Employment Guarantee Act (India) |
| PSNP | Productive Safety Net Programme (Ethiopia) |
| R&D | Research and Development |
| RPA | Robotic Process Automation |
| SDG | Sustainable Development Goal |
| SME | Small and Medium-sized Enterprises |
| STEM | Science, Technology, Engineering and Mathematics |
| TVET | Technical and Vocational Education and Training |
| UBI | Universal Basic Income |

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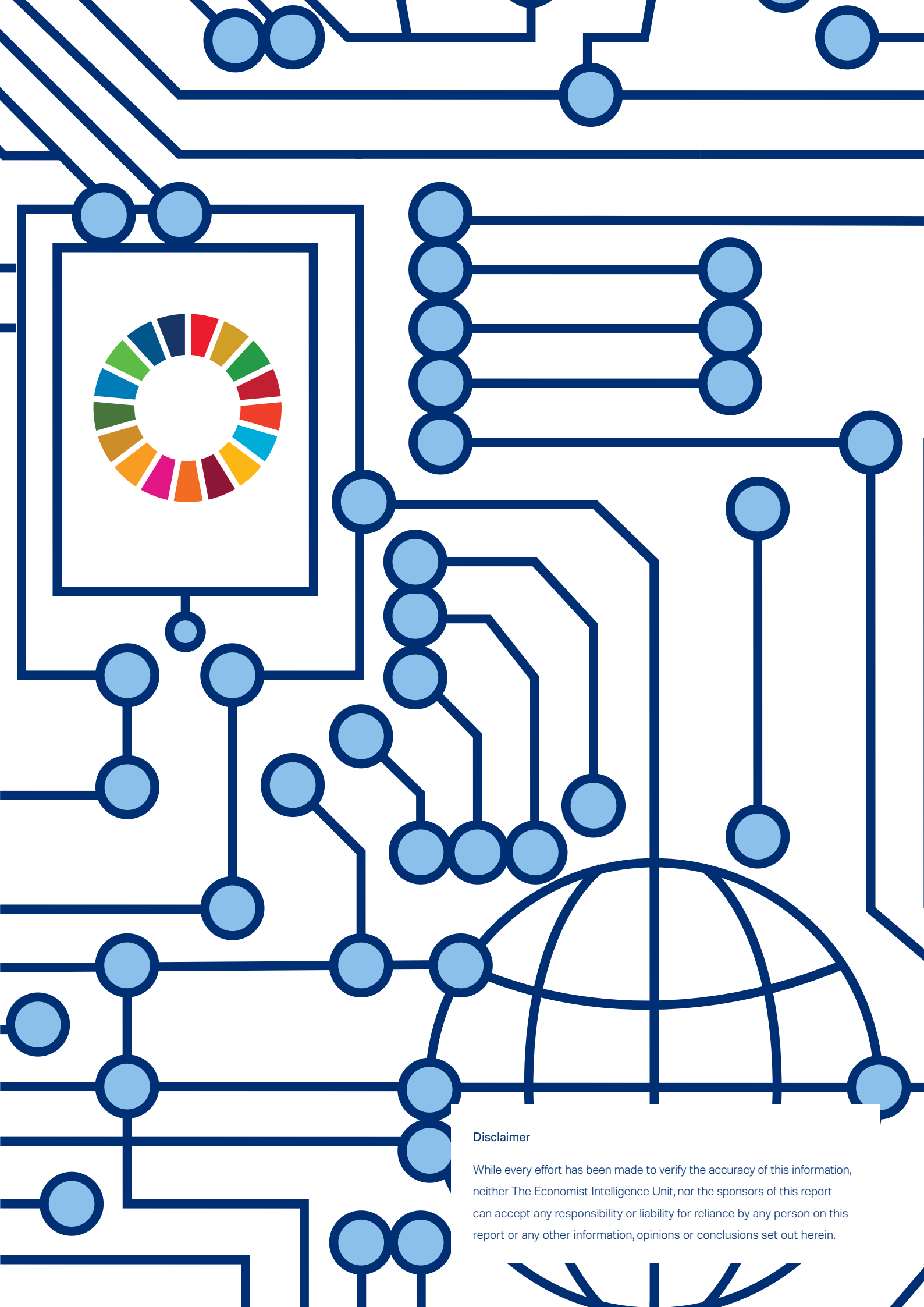
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