SRI LANKA STATE OF THE ECONOMY 2019

Transforming Sri Lanka's Economy in the Fourth Industrial Revolution (4IR)



INSTITUTE OF POLICY STUDIES OF SRI LANKA

SRI LANKA
STATE OF THE
ECONOMY
2019

INSTITUTE OF POLICY STUDIES OF SRI LANKA
100/20, Independence Avenue, Colombo 7, Sri Lanka

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Institute of Policy Studies of Sri Lanka

ISBN 978-955-7397-18-4

National Library of Sri Lanka-Cataloguing-In-Publication Data

Sri Lanka state of the economy 2019. - Colombo : Institute of Policy Studies of Sri Lanka, 2019
310 p. ; 25 cm.

ISBN 978-955-7397-18-4

i . 330.95493 DDC23

1. Sri Lanka - Economic conditions - 21st century
2. Sri Lanka - Economic conditions
3. Sri Lanka - Economic development

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The contributions of Gayendri Karunaratne in providing editorial support and Suresh Fernando in preparing infographics, under the overall guidance of Charmaine Wijesinghe and Shihara Maduwage are gratefully acknowledged.

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Acronyms

4IR	Fourth Industrial Revolution
ADB	Asian Development Bank
AI	Artificial Intelligence
A-Level	G.C.E. Advanced Level
BDA	Big Data Analytics
BOP	Balance of Payment
BPM	Business Process Management
BRI	Belt and Road Initiative
CBOs	Community-based Organisations
CEM	Cabinet Committee on Economic Management
CID	Criminal Investigation Department
CRISPR	Clustered Regularly Interspaced Short Palindromic Repeats
CSE	Colombo Stock Exchange
CSR	Corporate Social Responsibility
DCS	Department of Census and Statistics
DIE	Department of Immigration and Emigration
DLEC	Digital Learning Experience Centre
DLT	Distributed Ledger Technology
DOA	Department of Agriculture
DOM	Department of Meteorology
EDI	Electronic Data Interchange
EFF	Extended Fund Facility
EPO	European Patent Office
ESW	Electronic Single Window
EU	European Union
FAO	Food and Agriculture Organisation; Financial Accounting Outsource (Chapter 5)
FBR	Family Background Report
FDI	Foreign Direct Investment
FIPPs	Fair Information Practice Principles
FIRC	Fourth Industrial Revolution Council
FTA	Free Trade Agreement
FTC	Federation Trade Commission
GAPs	Good Agricultural Practices
GCM	Global Circulation Models
GDPR	General Data Protection Regulation
GIS	Geographic Information System
GNSS	Global Navigation Satellite System

GOSL	Government of Sri Lanka
GPS	Global Positioning System
GSP	Generalised Scheme of Preference
HIES	Household Income and Expenditure Survey
HIMS	Hospital Information Management System
HRIS	Healthcare Recipient Identification System
IAS	Invasive Alien Species
ICAO	International Civil Aviation Organisation
ICMIF	International Cooperative and Mutual Insurance Federation
ICT	Information and Communication Technology
ICTA	Information and Communication Technology Agency
ICTSD	International Centre for Trade and Sustainable Development
IEMS	Integrated Enquiry Management System
IFAD	International Fund for Agricultural Development
IFPRI	The International Food Policy Research Institute
ILO	International Labour Organisation
IMF	International Monetary Fund
IoT	Internet of Things
IPRs	Intellectual Property Rights
IPS	Institute of Policy Studies of Sri Lanka
ISB	International Sovereign Bond
IT	Information Technology
ITU	International Telecommunication Union
KA	Khan-Academy
KNOMAD	The Global Knowledge Partnership on Migration and Development
KPM	Knowledge Process Management
KYC	Know-your Customer
LFS	Labour Force Survey
LMS	Learning Management System
MCC	Millennium Challenge Corporation
MNE	Multinational Enterprise
MOE	Ministry of Education
TBT	Technical Barriers to Trade
MOOCs	Massive Open Online Courses
MSMEs	Micro, Small and Medium Enterprises
MTDI	Ministry of Telecommunication and Digital Infrastructure
NAITA	National Apprentice and Industrial Training Authority
NARESA	Natural Resources, Energy and Science Authority

NBSAP	National Biodiversity Strategic Action Plan 2016-2022
NEC	National Economic Council
NGO	Non-governmental Organisation
NSW	National Single Window
NTM	Non-tariff Measure
OECD	Organisation for Economic Cooperation and Development
O-Level	G.C.E. Ordinary Level
OPD	Outpatient
OPEC	Organisation of Petroleum Exporting Countries
OTAs	Online Travel Agents
PC	Personal Computer
PCC	Port City Colombo
PGIM	Postgraduate Institute of Medicine
PHN	Personal Health Number
PINs	Personal Identification Numbers
PKI	Public Key Infrastructure
PPAs	Past Pupils' Associations
QLFS	Quarterly Labour Force Survey
R&D	Research and Development
RBI	Reserve Bank of India
RPL	Recognition of Prior Learning
SCs	Smart Classrooms
SLAC	Sri Lanka Cargo
SLASSCOM	Sri Lanka Association of Software and Service Companies
SLBFE	Sri Lanka Bureau of Foreign Employment
SLC	Sri Lanka Customs
SLCERT	Sri Lanka Computer Emergency Readiness Team
SLINTEC	Sri Lanka Institute of Nanotechnology
SLPA	Sri Lanka Ports Authority
SMEs	Small and Medium Enterprises
SOEs	State Owned Enterprises
SOLAW	State of the World's Land and Water Resources for Food and Agriculture
SPS	Sanitary and Phytosanitary
SRR	Statutory Reserve Ratio
SSLFTA	Singapore-Sri Lanka Free Trade Agreement
STEM	Science, Technology, Engineering, and Mathematics
SWIFT	Society for Worldwide Interbank Financial Telecommunications
T&G	Textile and Garment

TFP	Total Factor Productivity
TRCSL	Telecommunications Regulatory Commission of Sri Lanka
TRIPs	Trade Related Intellectual Property Rights
TVET	Technical Education and Vocational Training
UGC	University Grants Commission
UNCTAD	United Nations Conference on Trade and Development
UNESCO	United Nations Educational, Scientific and Cultural Organisation
USD	United States Dollar
WEF	Word Economic Forum
WHO	World Health Organisation
WIPO	World Intellectual Property Organisation
WTO	World Trade Organisation

TOWARDS GROWTH AND STABILITY

1. Policy Perspectives

The Sri Lankan economy is making a painfully slow recovery after a series of setbacks, posting a gross domestic product (GDP) growth of around 3 per cent in the first half of 2019, down from just under 4 per cent recorded over the same period in 2018. On a quarterly basis, the country has seen 10 consecutive quarters of growth below 3.5 per cent, a significant laggard in a region of high growth in recent years. As prospective candidates line up to face an electoral test in the form of an all-important presidential election, the policy specialists drafting manifestos will clearly place growth revival at the top of the economic agenda.

An economy already under pressure suffered a further blow from a constitutional crisis during 26 October-13 December 2018. The sacking of the sitting Prime Minister Ranil Wickremesinghe by the country's Executive President Maithripala Sirisena – partners in the 'national unity government' formed in January 2015 – was as sudden as it was unexpected. The swearing in of Mahinda Rajapaksa as the replacement Prime Minister, the former president against whom the unity government partners joined forces, was entirely surprising.

A decision by the President a week later to dissolve Parliament plunged Sri Lanka into a constitutional crisis, with claims and counter claims on who is actually governing the country. It took the intervention of Sri Lanka's Supreme Court – which held the dissolution to be unconstitutional – for the fog of confusion to

On a quarterly basis, Sri Lanka has seen 10 consecutive quarters of growth below 3.5 per cent, a significant laggard in a region of high growth.

lift; on December 16 2018, after 52 eventful days, Ranil Wickremesinghe was once again sworn in as Prime Minister by the President of Sri Lanka.

That relations between the leaders of the national unity government were strained which came as no surprise to the Sri Lankan public. It was well known that cracks had begun to deepen following a poor showing at local government polls in February 2018. Three years of economic underachievement was partly to blame; Weak growth stacked up against unpopular higher taxes under Sri Lanka's Extended Fund Facility (EFF) undertaking with the International Monetary Fund (IMF). After the local government polls, it was not a coincidence that the key decision-making Cabinet Committee on Economic Management (CCEM) chaired by the Prime Minister was abolished by the President. Instead, economic decision-making was taken under the President's own National Economic Council (NEC).

The change had little or no impact in determining economic performance. Almost immediately, the Central Bank of Sri Lanka (CBSL) and the Ministry of Finance (MOF) were embroiled in attempts to manage a buildup of pressure on the Sri Lankan rupee. To ease import expenditures from rising oil prices, high gold imports and motor vehicles, the MOF slapped curbs by way of higher value added tax (VAT) on gold and excise duties on vehicles. For the CBSL, a steady outflow of foreign investors from Sri Lanka's treasury bills and bonds from April 2018 following a switch by the US Federal Reserve to an interest rate tightening phase presented its own difficulties in coordinating its monetary and exchange rate regimes.

Thus, by the time the government effected its own constitutional crisis in October 2018, the Sri Lankan currency had depreciated by 13 per cent for the year. The CBSL's holdings of official reserves had dropped to USD 7.9 billion from USD 9.9 billion in April 2018. In many ways, the timing of the political crisis could not have come at a worse time for the economy. The domestic political upheavals were unsettling for foreign investors and their exit intensified – foreign holdings in government securities that had declined from USD 2 billion in April 2018 to USD 1.5 billion by September 2018, fell to USD 900 million by December 2018.

Inevitably, by year end, the Sri Lankan rupee had depreciated by nearly 20 per cent, posing significant economy-wide risks to a country burdened by a hefty foreign currency denominated debt stock at nearly 60 per cent of GDP. Despite the careful pre-planning to shore up reserves over the year – raising USD 2.5 billion in international sovereign bonds (ISBs) in April 2018 and another USD 1 billion in October 2018 as a foreign currency term financing facility (FTFF) from the China Development Bank (CDB) – official reserves were down to 3.7 months of imports by end 2018. In the interim, Moody's and Fitch Ratings downgraded Sri Lanka's credit rating in November and December 2018, respectively. It was clearly not the best of times to face up to the task of financing a USD 1 billion ISB coming up for settlement in January 2019.

The CBSL was able to successfully settle the ISB by dipping further into its stock of foreign reserves. By the time Sri Lanka made up for lost time and issued a USD 2.4 billion ISB in March 2019, reserves were down to 3.4 months of imports, hovering just above the danger threshold of three months coverage. The run of bad news for the economy however was not over. The country at large suffered a severe blow from a brutal terror attack arising from an unexpected quarter on 21 April 2019, when groups linked to global Islamic militancy unleased a wave of bomb attacks across the island. Coming as it did on the eve of nearly

10 years of untrammelled peace in Sri Lanka, the disarray and disruption was immediate.

The greatest tragedy of the April 2019 terror attacks was the more than 250 innocent lives lost and hundreds more who were injured. While it will take some time for the socio-economic fallout to be fully quantified and assessed, Sri Lanka's tourism sector is bearing the most obvious and immediate brunt. In spite of retaining the coveted Lonely Planet's 'top country for travel in 2019' ranking, the opportunity cost for the industry is still considerable as Sri Lanka attempts to lure tourists back, with reassurances of being a 'safe' destination once more.

As expected, the sharp downturn in tourist arrivals has had economy-wide spillover effects, impacting the livelihoods of those closely engaged in ancillary activities such as handicrafts, home-stays, etc. These micro and small enterprises operate in the informal economy without adequate safety nets to absorb unanticipated shocks. The economic disruption has also had more unfortunate consequences in fracturing ethnic relations and impacting small Muslim-owned businesses in countless ways. In all this, foreign investors who may have already adopted a cautious wait-and-see stance in the run up to elections are also more likely to firm up decisions to delay investments until security risks are reassessed – i.e. whether it is perceived as an isolated incident or an endemic threat.

In the long-term, however, the economic impacts of the terror attacks are likely to be relatively limited. Nevertheless, the short-term costs are evident from a dip in economic output – with GDP growth in the second quarter of 2019 estimated to drop well below the 3.7 per cent recorded in the second quarter of 2018. Overall, the projected annual growth rate for 2019 was cut to 3 per cent from the earlier estimate of 4 per cent by the CBSL.

The outlook for growth enhancing measures in the remaining months of the government appears dim. In the absence of expenditure rationalisation and an already heavy tax burden to buttress revenues, interim measures to support growth through fiscal policy is limited. Despite 'Letter of Corporate Intent' with large loss-making state owned enterprises (SOEs), the hemorrhage from SOE operational losses keeps mounting. In the first half of 2019, tax collection has fallen behind while recurrent spending has gone up. On the plus side, there has been more restraint than usual in handing out election bonanzas, although some 'relief' measures have crept in by way of allowances to public sector workers, expansion in the numbers of 'Samurdhi' recipients, absorption of unemployed graduates to the public sector, etc., all of which will inevitably add to the fiscal burden in the long-term.

The outlook for growth enhancing measures in the remaining months of the government appears dim.

More effort has been expended to loosen monetary policy in view of high real interest rates prevailing in the economy. Over the course of the first eight months of 2019, policy interest rates have been reduced by 100 basis points and the Statutory Reserve Ratio (SRR) lowered by 100 basis points. With lending rates remaining stubbornly high, the CBSL has also resorted to more direct intervention, requiring banks and finance companies to cut deposit rates to force down lending rates. Arguably, by an old rule of thumb measure, Sri Lanka's nominal GDP growth rate of 7.7 per cent in 2018 against a lending rate of 12 per cent, does suggest that there is room to loosen monetary policy. Whether monetary policy signaling will be a sufficient inducement for investors to respond in the current climate of 'wait-and-see' is debatable. If intertemporal effects hold – i.e. investors make decisions based on the expectations of future income and wealth – the tendency will be to hold off from making major decisions until election-related uncertainties on political and policy stability, as well as on economic policy direction, are cleared.

Expansionary impacts of fiscal and/or monetary policy on the economy in the run up to elections and immediately after have to be watched. There is bound to be a buildup of suppressed investment and consumption demand in the Sri Lankan economy that can weigh in on the import bill. Given the rather insubstantial safeguards against pressure on the currency, vigilance is called for, especially as global economic conditions wax and wane. In August 2019, the Sri Lankan rupee depreciated in response to a net outflow of around USD 200 million, as foreign investors pulled out of government securities. The move reflected a sharp pullout from emerging markets globally, in response to fears of stagnant global growth as trade wars intensify.

The Sri Lankan rupee will continue to operate in a very thin forex market. Despite a contraction in the trade deficit in the first half of 2019, earnings from tourism and remittances are underperforming. The Sri Lankan rupee gains in the first half of 2019 are tied to debt-creating capital inflows; up to June 2019 alone, Sri Lanka had raised USD 4.4 billion through ISBs. With the passage of the Active Liability Management Act, Sri Lanka is set to float further bonds in the second half of the year – including a planned USD 500 million samurai bond – as funds especially earmarked for future foreign debt settlements.

Thus, the overall positioning of the Sri Lankan economy in 2019 is weak. This is despite significant gains from macro reform measures in fiscal, monetary and exchange rate policy management from mid-2016. Fiscal reforms in particular have had some success in restoring stronger macroeconomic fundamentals through a period of often painful adjustments. The most notable success is arriving at a primary account surplus after decades of being in the red – a surplus in the primary account is the first tentative step towards stabilising the country's large debt stock, estimated in 2018 to be 83 per cent of GDP.

But, worries about the economy are not just confined to the heavy overhang of government debt. The sluggish pace of economic growth is a major concern. That growth has slumped is not surprising; for countries with large debt, a moderation in consumption as taxes are increased to deal with heavy debt repayments can lead to a low growth outlook. For Sri Lanka, a recovery is also proving to be more difficult given that its domestic production structure is skewed towards non-tradables – i.e. goods that can only be consumed in the economy in which they are produced, and cannot be exported nor

The overall positioning of the Sri Lankan economy in 2019 is weak. This is despite significant gains from macro reform measures in fiscal, monetary and exchange rate policy management from mid-2016.

imported. In contrast, the adjustment would have been easier if the economy was more export-dependent – as domestic absorption of output falls, the excess can be exported.

Under such circumstances, to keep growth buoyant through a phase of macro policy reforms require supportive micro reform measures – the so-called 'structural reforms' to lift constraints on growth. These include policies to improve the efficiency of resources used by the public sector (such as public investment, SOEs), policies to improve economic incentives (such as trade), and policies to improve institutional efficiency (such as customs, tax administration). Structural reforms are intended to bring about a resource shift and change the pattern of production via a restructuring of the economy.

Some delayed reforms have been implemented, but these have gained little economy-wide traction. Attempts at reforms have also been met with stiff resistance. Concerns that a transformation process to 'economic efficiency' may come at the cost of equity, is often a concern. For instance, reform to bring about a resource shift can lead to unemployment owing to wage rigidities, skills mismatch, etc. Much will depend on whether or not the economy is able to adjust to relative price changes (lag effect) in the short-term to raise exports.

Globally too, as a result of such misgivings, sentiments on the free movement of goods, capital and labour across borders are changing. It has given birth to more nationalistic and populist fervor worldwide. In this volatile mix, clear and specific causes for any disgruntlement must be heeded. Sri Lanka too, has of late adopted a 'trade adjustment package' which is intended to offer potential disadvantaged firms and industries – and workers – some relief against adverse impacts of reform measures. Such adjustment

Some delayed reforms have been implemented, but these have gained little economy-wide traction.

packages typically aim for skills training, and generating alternative employment opportunities. Recognising the potential for such disruptive effects is a step in the right direction towards overall policy efforts to reduce inequality and socio-economic distress.

By virtue of the World Bank's new country classification by income level, Sri Lanka moved up to the upper-middle income category in mid-2019. Despite the 'high' income recognition, persistent inequities are to be found; the richest 20 per cent enjoy more than a half of total household income, while the poorest 20 per cent get only 5 per cent.[1]

Thus, given the many complexities in bringing about a long-term restructuring of the economy, the temptation for an incoming government to look at accruing more immediate gains will be high. Here, a boost to growth from expansionary macroeconomic policies and/or investments in mega infrastructure projects is the so-called 'low hanging fruit'. The USD 1.4 billion Colombo Port City is ready for its next phase of attracting investors; so are a slew of projects in energy, port terminals, and expressways. These will involve a mix of loans and foreign direct investment (FDI); the latter will help ease external sector pressure on the economy even as growth gets underway, but the long-term impacts need to be carefully assessed and understood. Policies that deliver short-term benefits can be at the cost of creating unsustainable debts in the future.

A shift in FDI inflows to infrastructure helped to solidify the resource switch to non-tradable activities in the Sri Lankan economy. Indeed, 75 per cent of total FDI inflows in 2018 was towards infrastructure. While productive investments in infrastructure has an important role in raising economic efficiency and competitiveness, if reforms in others sectors of the economy lag behind, it is unlikely to yield productivity gains in the long-term.

[1] Nanayakkara, Wimal. (2018, December 27). *A balancing act: Can Sri Lanka overcome regional income inequalities ?* Retrieved from http://www.ips.lk/talkingeconomics/2018/12/27/a-balancing-act-can-sri-lanka-overcome-regional-income-inequalities/

Being vigilant on promoting tradable growth is the only sustainable long-term strategy for a country of 20 million domestic consumers.

Being vigilant on promoting tradable growth is the only sustainable long-term strategy for a country of 20 million domestic consumers. Thus, a temptation to lean on infrastructure for growth must be tempered with efforts to tackle economic inefficiencies that make Sri Lanka uncompetitive in global markets. A start has been made with Sri Lanka's export share of GDP reversing its persistent decline in 2018, but at 13.4 per cent of GDP, it is still worryingly low.

Tradable sector growth – and the prospect of higher foreign currency earnings – is all the more important for Sri Lanka to comfortably manage its foreign debt repayment obligations. During 2019-2022 alone, an average of USD 4 billion per annum is already committed for debt settlements. It does not stop there; the repayments keep piling on even afterwards, especially from 2025 onwards once again.

Thus, the economic challenges for a new government are many. The economy will also weigh heavily on the minds of voters. It will not be only the nuts and bolts of an economic policy that will be weighed, but also its 'positioning' of Sri Lanka in today's intense geostrategic rivalries. As a country straddling major shipping routes, it is experiencing renewed attention from countries pursuing their own versions of 'development cooperation' - be it China, India, Japan or the United States (US). The leasing of the Hambantota port and leasing of land under the Colombo Port City project to China brought home the close intersection of economics and commercial diplomacy in today's multipolar world. In a continuation of this, the dissent against the US' Millennium Challenge Corporation (MCC) proposed grant funding to tackle land and transportation sector constraints to growth in Sri Lanka signals that economic diplomacy will weigh in at elections.

It is no surprise that national interests dominate the development cooperation efforts of any country. Emerging players like China and India are deploying whatever financial means available at their disposal to exert influence on other developing countries, particularly in Africa. Bankrolling infrastructure in strategic sectors is one such way. On the other hand, traditional donors like the US use grant funding to facilitate US business interests overseas. For Sri Lanka, there are both opportunities to be had and challenges to be met; either way, it must acquire the necessary geo-strategic analytical and diplomatic skills to safely navigate around these intensifying considerations.

The current US and China standoff for economic and political dominance is not going to go away anytime soon. Indeed, its contours are shifting from trade and currency wars, to technology. The most public manifestation is the fight between the US and the Chinese telecom giant Huawei. The US has put Huawei on an 'entity list' reserved for foreign companies that are deemed to pose a national security threat.

The confrontation over Huawei is only the tip of the iceberg for dominance over the industries of the future. If tech gurus are to be believed, the fourth industrial revolution (4IR) is upon us, presaging rapid changes to the way people work, live and interact with each other. It will determine who forges ahead and who falls behind.

In this race, countries like Sri Lanka too must understand and analyse the potential economy-wide impacts of the extraordinary technological progress in artificial intelligence (AI), robotics, 5G, 3D printing etc., to better prepare their populations to reap its benefits and/or counter the threats.

There is no gainsaying that the impacts of the 4IR will be uniform. On the one hand, the 4IR may allow countries to leapfrog development stages. Those with better established manufacturing bases or with resources to invest in technologies stand to benefit. At the same time, technological-driven productivity that drives down costs of production in advanced economies can hasten 'premature' deindustrialisation in others. For many, the threat of human labour displacement by automation is very real. But, countries with a large pool of relatively low-skilled labour may not even feel the creeping inroads of technological advancements for decades to come. If labour is plentiful and relatively cheap, investing in costly technology can be put off. This is likely to be true for many developing countries; at most, 4IR technologies will chip away at particular types of jobs and industries for the time being.

For Sri Lanka though, the demographics suggest that an assessment of the technological advancements of the 4IR, and what it means for the country's productivity growth, cannot be put off for too long. At its current per capita income level, Sri Lanka is an outlier in the category of countries with a rapidly ageing population. Fewer numbers are entering the labour force each year, with Sri Lanka's current rate of 4 per cent unemployment considered to be almost full employment. There is clearly some slack – demonstrated by low levels of female labour force participation for instance – but, overall signals are of growing labour force shortages. Indeed, Sri Lanka's first ever 'Labour Demand Survey' carried out by the Department of Census and Statistics (DCS) in 2017, points to already high levels of labour mismatch.

Encouraging more women to enter the labour force, persuading older workers to stay in the workforce for longer, or actively seeking

immigrant workers are some of the measures to counter growing labour shortages. But, the key to tie all the loose ends together is productivity growth in the economy at large. For an economy that faces the prospect of a diminishing pool of cheap labour, investing in technology is more urgent.

For Sri Lanka though, the demographics suggest that an assessment of the technological advancements of the 4IR, and what it means for the country's productivity growth, cannot be put off for too long.

It can be argued that Sri Lanka is yet to even come to terms with technologies of the third industrial revolution – electronics and information technology – leave alone those of the 4IR. The reality though is that the pace of change, or the quantum leap of technology from one revolution to another is so swift, that countries can no longer be complacent.

Unlike other industrial revolutions, 4IR technologies are significantly more invasive, complex, and evolve rapidly. These include AI, the internet of things (IoT), intelligent robotics, 3D printing, etc., that are rapidly impacting production processes and redefining the future of work, aside from other transformative impacts in areas such as genomics and neurotechnological brain enhancements. Indeed, the 4IR is changing the way people live, work and relate to one another.

Sri Lanka's readiness for the 4IR – in digital, human capital, and economic agility – is low. Internet usage is still 34 per cent of the population, national computer literacy rate is 23 per cent, with a gender gap in internet usage of 40 per cent and significant regional disparities in information technology (IT) literacy – urban (37 per cent), rural (22 per cent), and estate (9 per cent). On the plus side, 70 per cent of the population owns a mobile phone, with a 95 per cent mobile cellular networks cover across the country. In human capital, there are significant deficiencies despite high literacy rates. School census data show that that less than a quarter (23 per cent) of A-Level students is in the science

stream, and a further 10 per cent is in the technology stream. The majority (66 per cent) are in the arts and commerce streams.[2] As the global competition for tertiary educated skilled workers rise, many leave the country for better opportunities abroad.

Not surprisingly, and as a result of the above trends, the production structure of the Sri Lankan economy has changed very little over the decades; only around 7 per cent of manufacturing value addition is estimated to take place through medium hi-tech and hi-tech industries.

Thus, Sri Lanka is still a nascent economy in its preparedness for the 4IR. It remains vulnerable to socio-economic disruptions of new technologies owing to structural weaknesses and capacity constraints. The challenges need to be understood and opportunities grasped in the many areas of the economy where 4IR technologies will come into play.

The 4IR influences labour markets in many ways: occupational skill profiles are changing as some existing jobs become obsolete and new jobs are created, with this, required skills are also fast changing. The organisation of labour markets is also undergoing rapid changes: companies are sourcing different types of workers using different methods, with more flexible work arrangements. Such changes improve the efficiency and flexibility of the labour market, but it has the potential to make workers more vulnerable, as more and more workers prefer to be independent informal workers. Sri Lanka's labour market is also seeing information and communication technology (ICT) enabled jobs – such as gig workers – expanding. The threat of job displacements remains real; susceptibility to computerisation in jobs suggests that job disruptions due to automation in Sri Lanka can be quite high for cetain types of employment – such as clerks and clerical workers, skilled agricultural, foresty and fishery workers, and craft and related trade workers. Together, they account for about 35 per cent of total employed in 2017.

Education and skills training thus play a crucial role in preparing a workforce that can meet the needs of today's and tomorrow's labour markets. Apart from technology-related skills such as innovation and active learning, creativity, critical thinking, and problem-solving skills are also important. The share of workers with tertiary level education in Sri Lanka is very low; of the country's 15+ aged population, only around 3.5 per cent hold a degree or above qualification. At the university level, only a limited per cent is following science (12.1 per cent), computer science (4.4 per cent), engineering (6.6 per cent) and other technology related subjects. However, low tertiary enrolment also suggests that fresh opportunities exist in the 4IR to adopt new forms of on-line education, along with rethinking a 'future-ready' curricula, especially in science, technology, engineering, and mathematics (STEM) fields – to equip the workforce with skills sets in preparation for a more technologically-driven economy.

The migration of highly talented individuals is also limiting the number of skilled individuals available for technology driven jobs in Sri Lanka. Hyper connectivity and cloud technology enable a global workforce in a supply chain to be connected via a platform, disrupting traditional modes of migration. Indeed, today's world of work allows skilled workers to become more globally accessible, while at the same time

[2] Arunatilake, Nisha., & Abayasekara, Ashani. (2018, February 22). *Towards a knowledge based economy: Start with quality STEM teachers for every child!* Retrieved from http://www.ips.lk/talkingeconomics/2018/02/22/towards-a-knowledge-based-economy-start-with-quality-stem-teachers-for-every-child/

making them hire permanent and on-site skilled migrants. These developments, over time, will have profound impacts on Sri Lanka's labour market trends, its worker remittance patterns, and indeed, on the country's own on-going efforts to facilitate inward labour migration.

Access to computer literacy and ICT infrastructure are essential to address labour market inequalities, and broader development outcomes. Aside from regional disparities, gender disparities prevail in Sri Lanka. Current differences in the position of women and men in the labour market – inequity at workplace with more women in informal employment, unpaid care work, paid less than men for the same job – can be exacerbated in the 4IR. Female-dominated occupations such as clerical work, cleaners and helpers, and industries such as apparels which are heavily female-dominated, can see job disruptions. Significant gender disparities in STEM education and employment in Sri Lanka – including those in digital literacy (44.2 per cent for men and 36.3 per cent for women) need to be addressed.

There are other areas – such as health and financial inclusion – where 4IR technologies can yield significant socio-economic gains to Sri Lanka. As the country's health care system starts to adapt to new issues – the rise of non-communicable deceases (NCDs) and long-term care for elders – improvements in both preventive and curative care with 4IR technologies can be quite considerable. There is already some progress in rolling out digital health care services – patient centric telemedicine solutions and e-consultation clinic – gaps in inequitable access to health services can be better addressed. Similarly, 4IR technologies can help Sri Lanka's current efforts to deepen financial inclusion. Although nearly 74 per cent of Sri Lankan adults are estimated to have an account at a financial institution, with notable gender parity, high transactions costs, documentation requirements, long and cumbersome procedures and time lags related to transactions are seen as major drawbacks. Technology-based solutions such as mobile money banking, mobile insurance, use of biometrics, etc., are already making inroads, but more can be done to facilitate digital financial services in the country.

As digital technologies shape and change consumer behaviour, Sri Lanka is also seeing a marked change in e-commerce transactions. Technologies that help bring down transport and logistics costs, and help with the ease of doing business are of great value to drive export trade. In particular, these help small and medium enterprises (SMEs) to cut costs, as well as to help link to global value chains (GVCs). The adoption of new technologies can revitalise Sri Lanka's small-scale agriculture sector that is currently seeing a decline in its total factor productivity (TFP) growth. The prospects for 'smart farming' in the country are there; already, some agriculture technology is being pioneered – using drone technology, automated climate control systems and real-time weather solutions. Adapting or adopting technological innovations is vital to halt the degradation of land and water resources, and mitigate impacts of climate change. Indeed, for Sri Lanka, technological applications for clean energy, transport and logistics management, and weather and disaster resilience are some viable areas. With the country already ranked second in a 2018 global climate vulnerability index, there is a window of opportunity to employ 4IR tech innovations to attain sustainable development outcomes.

These and other related issues are dealt with at some length in the rest of this report. For policymakers, faced with more immediate concerns on Sri Lanka's economic front, the transformative appeal of the 4IR might seem a

long-term project. But, the application of rapidly evolving technologies can hasten or slowdown the process of the already overdue structural transformation of the economy. Sri Lanka's current share of workers with tertiary level education – a degree or tertiary level vocational training qualification – is very low. Of the annual university pass-outs (26,000 as undergraduates and 10,000 with post-graduate qualifications), only a limited per cent is following science (12.1 per cent), computer science (4.4 per cent), engineering (6.6 per cent) and other technology related subjects. Sri Lanka's 'National ICT Workforce Survey' conducted by the Information and Communication Technology Agency (ICTA) in 2018 shows a widening of the demand-supply gap for the country's ICT workforce, from a shortfall of 500 workers in 2013 to as much as 12,000 in 2019.

These trends do not bode well for an economy that must solidify a resource switch to make economic growth more reliant on tradables. Technological change will inevitably be a critical part of the policy adjustment. The fact that the 4IR is not merely limited to technological adoption, but that it also introduces new tools to assess and understand competitiveness will help in this process. Concepts such as entrepreneurial culture, disruptive ideas, multi-stakeholder collaboration, critical thinking, meritocracy and social trust – along with more traditional components like ICT and physical infrastructure, macroeconomic stability, property rights, and education – are defining features of economic success in the 4IR. Now is the time for these ideas and concepts need to be understood and factored in, as Sri Lanka prepares the groundwork for a fresh phase of economic growth and development.

The application of rapidly evolving technologies can hasten or slowdown the process of the already overdue structural transformation of Sri Lanka.

2. Sri Lanka: Economic Performance and Outlook

2.1 Introduction

The key challenge facing the Sri Lankan economy is the spectre of a growing debt overhang – with large medium-term foreign currency debt settlements to be made – in the face of a persistent slowdown in gross domestic product (GDP) growth. Economic growth has come in at under 3.5 per cent for a 10th successive quarter as of mid-2019; the underachievement comes despite a gradual reclaiming of macroeconomic stability, particularly on the fiscal front, from mid-2016 onwards.

Much of the explanation for persistent anxieties about the Sri Lankan economy is linked to political tensions within the ruling national unity government. These tensions spilled over publicly in the aftermath of a poor showing at local government polls in February 2018, and climaxed with an ultimately unsuccessful attempt by the President to unseat the Prime Minister in October 2018. The tumultuous 52-days of instability drained what remained of investor confidence – accelerating an early exit of foreign investors from government securities, and adversely impacting a struggling Sri Lankan rupee. And, as if the troubles were not enough, the economy was dealt a further setback by a terror attack in April 2019 that claimed more than 250 innocent lives across the country.

With elections around the corner, a last-minute dash to speed up implementation of government

The key challenge facing the Sri Lankan economy is the spectre of a growing debt overhang – with large medium-term foreign currency debt settlements to be made – in the face of a persistent slowdown in gross domestic product (GDP) growth.

economic programmes is underway. These include disbursement of subsidised loans under 'Enterprise Sri Lanka' – aimed mostly at the small and medium enterprises (SME) sector – and 'Gamperaliya' – aimed to deliver rapid rural development projects, alongside efforts to speed up implementation of large-scale infrastructure projects. The impacts of such efforts on broader economic outcomes will be rather negligible. Subsidised loans and credit have little material impact on raising incomes and generating jobs when the economy at large is underperforming. For most private investors, the all-important presidential election due before end 2019, is the hurdle to be crossed before serious investment decisions are taken. In the interim, the most propitious outcome for the Sri Lankan economy is that the gains on the macroeconomic front are retained, leaving room for a swift economic recovery once election uncertainties are laid to rest. This chapter will assess Sri Lanka's recent economic performance and near-term outlook.

2.2 Growth, Output and Employment

Regionally, Sri Lanka has been a significant outlier on the growth front. While South Asia has emerged as the fastest growing sub-region in the world, with an annual average growth rate averaging at slightly over 7 per cent, Sri Lanka's growth has been a half of that. By contrast, India and Bangladesh have seen robust and consistent growth in recent years.

Sri Lanka's growth rate of below 3.5 per cent for 10 consecutive quarters is troubling (Figure 2.1). The economy became skewed towards non-tradable sector growth, as public investments in infrastructure to drive growth helped to solidify a resource switch to non-tradable activities such as construction. Aside from the deviation towards a foreign borrowing related consumption boom that was a key driver of this phenomenon, fiscal policy also played its part.



Higher fiscal spending, not offset by a drop in private consumption, also encouraged an overall shift in demand to non-tradables. Fiscal policy missteps during 2015-2016 such as significant public sector wage and pension increases and ad hoc tax policy measures only served to deepen the problems. Indeed, the economy is yet to recover; overall investment rates dropped sharply in 2016, with only a partial recovery since (Figure 2.2). There has been no corresponding rise in savings; instead, overall savings have also dipped as higher taxes from 2016 started to bite into household disposable incomes.

Moderation in consumption as taxes are increased to deal with heavy debt repayments can lead to a low growth outlook. If the production structure of the Sri Lankan economy had been more reliant on tradables, the adjustment would have been easier – i.e. as domestic absorption of output falls, the excess can be exported.

Against this lacklustre economic performance, Sri Lanka's labour market and employment

Figure 2.1
Quarterly GDP Growth

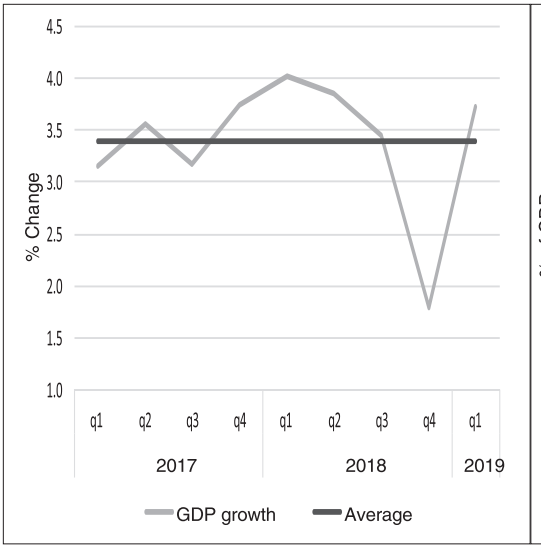
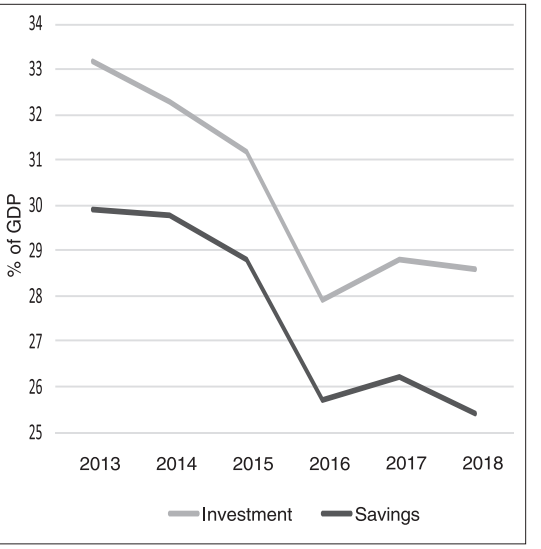


Figure 2.2
Savings and Investment



Source: Compiled with data from Central Bank of Sri Lanka. (Various years). *Annual report. Colombo,* Sri Lanka: Central Bank of Sri Lanka, and Department of Census and Statistics.

outcomes have also remained rather stagnant. Clearly, overall unemployment is not the problem. This has remained more or less static at around 4.4 per cent in recent years (Table 2.2). The problem is that while the economy has generated jobs, the rate at which jobs are being created is perhaps not at desired levels. Sri Lanka's labour force participation rate is stagnant or declining; this indicates that labour force growth is not keeping up with the population growth. More people may be opting to stay in education or other forms of training rather than joining the labour force for a variety of reasons such as available jobs not deemed to be of much quality. These trends are clearly evident from the first ever 'Labour Demand Survey' carried out in 2017 by the Department of Census and Statistics (DCS). It pointed to an overwhelming demand for manual workers, whereas job-seekers are no longer searching for these kinds of jobs.[1]

Moderation in consumption as taxes are increased to deal with heavy debt repayments can lead to a low growth outlook.

[1] Weerasekera, Harini. (2018). *Where have all the workers gone? 'Sectoral mismatch' between labour demand and supply in Sri Lanka.* Retrieved from http://www.ips.lk/talkingeconomics/2018/01/29/where-have-all-the-workers-gone-sectoral-mismatch-between-labour-demand-and-supply-in-sri-lanka/

Table 2.1
Employment and Labour Markets

	2013	2014	2015	2016	2017	2018
Unemployment rate, %	4.4	4.3	4.7	4.4	4.2	4.4
Labour force participation rate, %	53.7	53.2	53.8	53.8	54.1	51.8
Labour force	8,034	8,049	8,214	8,311	8,567	8,388
Employed	7,681	7,700	7,831	7,948	8,208	8,015
Unemployed	353	348	383	363	359	373

Source: Compiled with data from Central Bank of Sri Lanka. (Various years). *Annual report.* Colombo, Sri Lanka: Central Bank of Sri Lanka.

Thus, the need to reinvigorate growth in the Sri Lankan economy has to be matched by equal efforts to stimulate economic activity that will generate the right kind of jobs. With high educated and youth unemployment – with unemployment amongst 20-29 year olds at 15 per cent, and unemployment amongst those with G.C.E. Advanced Level (A-Level) and above at 9 per cent – at well above a national unemployment rate of 4.4 per cent, a key constraint on growth is the inadequacy of labour resources in Sri Lanka.



2.3 Fiscal Policy: Debt and the IMF' EFF Programme

Sri Lanka's efforts to clawback fiscal stability from mid-2016 under the three-year 'Extended Fund Facility' (EFF) arrangement with the International Monetary Fund (IMF) has taken its inevitable toll on medium-term growth prospects. Indeed, lower budget deficits and higher government

Table 2.2
IMF Fiscal Targets and Realised Outcomes, % of GDP

	2016	2017	2018	2019[a]
IMF tax revenue target	11.8	12.9	14.1	14.3
Realised tax revenue	12.2	12.4	11.9	13.3
IMF budget deficit target	-5.4	-4.7	-4.0	-3.7
Realised budget deficit	-5.3	-5.5	-5.3	-4.4
IMF public debt target	77. 2	75.5	73.1	70.7
Realised public debt	78.3	76.9	82.9	81.0

Notes: a: Projections.

Source: Compiled with data from Central Bank of Sri Lanka. (Various years). *Annual report. Colombo,* Sri Lanka: Central Bank of Sri Lanka.

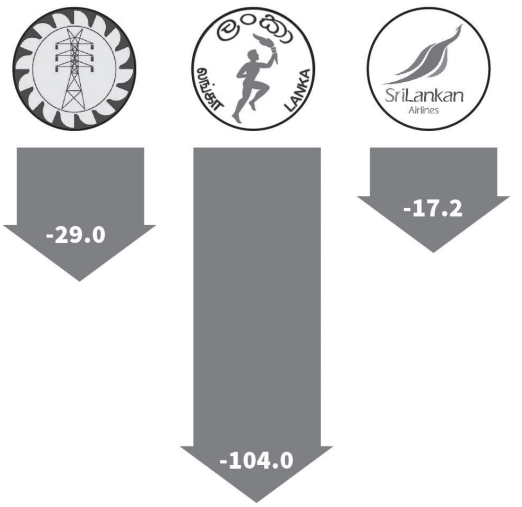
revenues are at the core of the USD 1.5 billion loan. With built-in elements of fiscal tightening, a soft inflation target and a flexible exchange rate regime into the EFF framework, Sri Lanka's 'twin deficit' imbalances are to be addressed in the short term by 'switching resources' (flexible exchange rate) rather than attempting to boost national income.[2]

Sri Lanka's realised fiscal outcomes have fallen short of the original targets set out in the EFF (Table 2.2). Nevertheless, a fundamental improvement in public finance management is clearly visible in successfully recording a primary balance surplus from 2017 onwards. A primary budget balance is the government fiscal balance excluding interest payments. A primary surplus is the first step towards achieving debt stability; debt begins to stabilise when the interest payment is exactly off-set by the primary balance. In 2018, Sri Lanka was able to record a primary surplus of 0.6 per cent of GDP, albeit well below the total interest payments incurred of nearly 6 per cent of GDP.

Ad hoc tax adjustments will be steadily phased off with the implementation as of April 2018 of the Inland Revenue Act No. 24 of 2017. The decline in the overall tax collection as a share of GDP to 11.9 per cent of GDP in 2018 came about largely as a result of a fall in excise duties as curbs on motor vehicle imports came into effect and a transition to a Revenue Administration and Management Information System (RAMIS) faces a few hiccups. Alongside more clarity and stability on the tax policy front, after the initial teething problems of an automated system are resolved, the revenue reforms will pay off dividends in the medium to longer term. Automated tax collection systems are important in the efforts to strengthen tax administration, compliance and broadening the tax base.

By contrast, little headway has been made in curbing losses incurred by the state-owned-enterprises (SOEs) on the expenditure front. This is despite the signing of 'Statements of Corporate Intent' with five SOEs (Ceylon Petroleum Corporation (CPC), Ceylon Electricity Board (CEB), National Water Supply and Drainage Board, Airport and Aviation Services Limited, and Sri Lanka Ports Authority) in 2017. In fact, losses of most SOEs doubled in 2018, with some such as the CPC being hit hard particularly by the sharp depreciation of the rupee by nearly 20 per cent.

SOE Operational Losses, Rs. billion in 2018



[2] Weerakoon, Dushni. (2016). *IMFs extended fund facility arrangement with Sri Lanka: It's mostly fiscal*. Retrieved from http://www.ips.lk/talkingeconomics/2016/07/07/sri-lankas-extended-fund-facility-arrangement-with-the-imf-its-mostly-fiscal/

Table 2.3
SOE Operational Losses, Rs. billion

	2015	2016	2017	2018
Ceylon Electricity Board	20.7	-13.2	-49.2	-29.0
Ceylon Petroleum Corporation	-19.9	69.6	3.5	-104.0
Sri Lankan Airlines	-16.4	-12.6	-28.9	-17.2

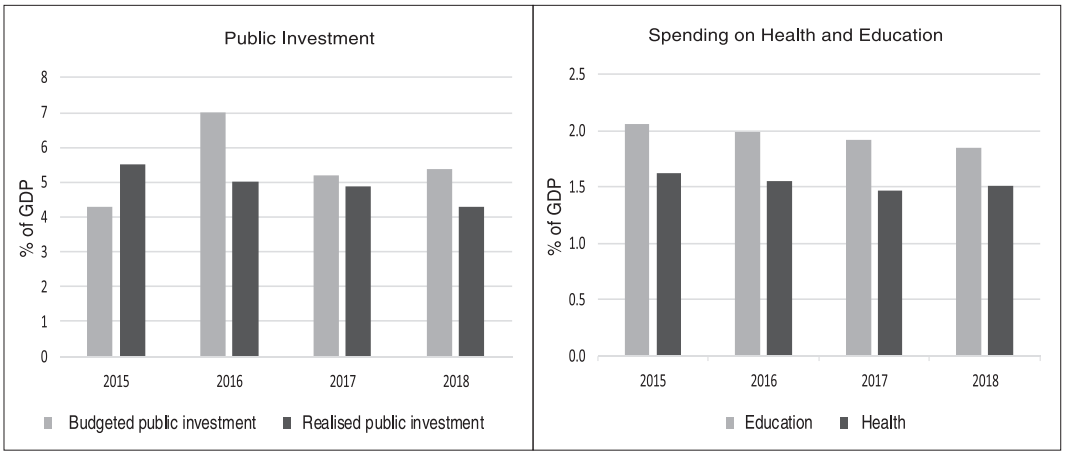
Notes: Profit/loss before tax.
Source: Compiled with data from Department of Public Enterprises, *Performance report 2018,* Ministry of Finance.

With the government hamstrung on the expenditure front, other critical areas of investment have suffered. Public investment has borne the brunt of adjustment with realised spending falling short of budgeted spending, particularly in years that overall fiscal deficit targets have come under pressure. More worryingly, public spending on key sectors of health and education has continued to decline consistently as a share of GDP. These spending patterns raise serious concerns about Sri Lanka's preparedness to face demands for better quality infrastructure and human resources that are necessary to stay competitive and forge ahead as a rising middle income economy.

These trends indicate as to why Sri Lanka must stay focused on fiscal consolidation as a long-term goal. The country's overall debt ratio jumped to 82.9 per cent of GDP in 2018 (see Table 2.2). Excessive government debt adversely impacts economic growth in multiple ways; it raises uncertainty on the future course of policy, including tax and interest rate policy measures that are necessary for course corrections on debt sustainability.

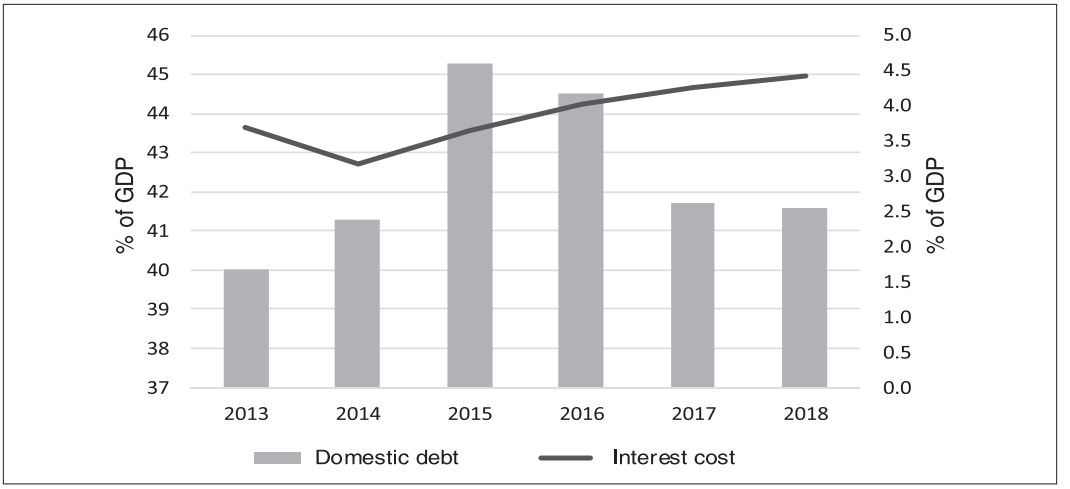
The impacts of high levels of government debt on interest rates are well known. The interest cost of domestic debt servicing has been rising

Figure 2.3
Public Investment and Social Sector Expenditures



Source: Compiled with data from Central Bank of Sri Lanka. (Various years). *Annual report.* Colombo, Sri Lanka: Central Bank of Sri Lanka.

Figure 2.4
Domestic Debt and Interest Cost



Source: Compiled with data from Central Bank of Sri Lanka. (Various years). *Annual report.* Colombo, Sri Lanka: Central Bank of Sri Lanka.

quite sharply in recent years despite the fact that Sri Lanka's domestic debt component in the total debt stock has been declining. In 2018, the domestic debt share stood at 50 per cent of Sri Lanka's total public debt, down from 58 per cent in 2015. A high debt stock places pressure on interest rates and continues to add to debt servicing costs in a vicious cycle.

Sri Lanka has little room to provide a fiscal stimulus to reinvigorate growth in the near term. Indeed, fiscal tightening via higher taxes on both households and private firms dampen aggregate demand, just as a decline in government expenditures would do the same. Other things being equal, this can depress the rate of growth of GDP – at least in the short run – and exacerbate debt burdens. This is the usual criticism directed at 'fiscal austerity' measures that come with the IMF programmes. The risks of tax increases and/or spending cuts leading to a stagnant or shrinking economy can be offset by strong private investment demand, along with stable growth in private consumption. Unfortunately for Sri Lanka,

Policy and political instability has continually undermined private investor demand in recent years, with little signs of any sustained pick up until election uncertainties are cleared.

policy and political instability has continually undermined private investor demand in recent years, with little signs of any sustained pick up until election uncertainties are cleared.

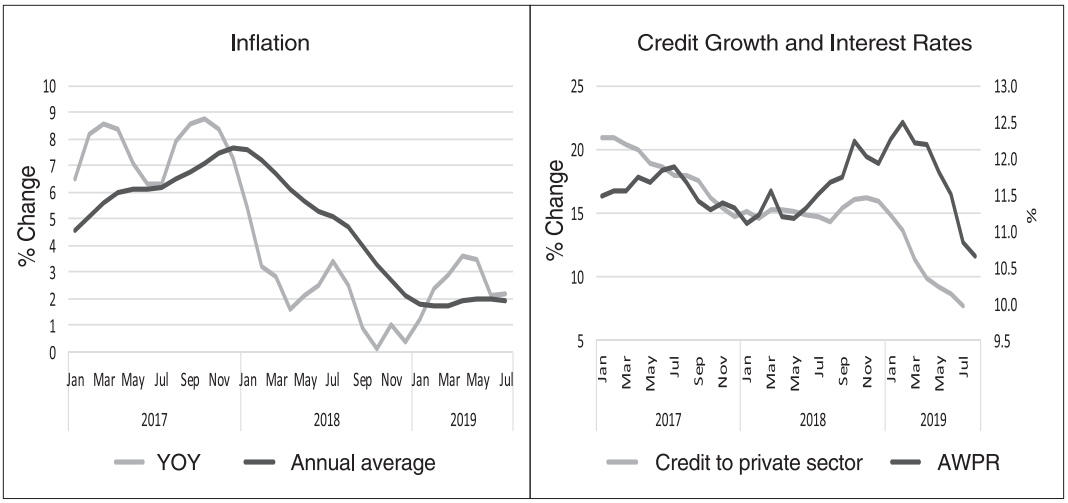
2.4 Monetary Policy: High Interest Rates and Moderate Inflation

Inflation rates in the economy – a combined result of both cost push factors from rising food prices and demand-pull factors from high credit growth – began to ease considerably from early 2018 in response to tighter monetary policy measures (Figure 2.5).

policy in April 2018, reducing the 'Standing Lending Facility Rate' (SLFR) by 25 basis points, but keeping the 'Standing Deposit Facility Rate' (SDFR) unchanged (Figure 2.6). By narrowing the gap between the deposit and lending policy rates, the CBSL aimed to nudge short term interest rates downwards. CBSL's treasury bill holdings, which had been drawn down substantively with an eye to tighten monetary conditions in the economy, was also reversed in line with a looser monetary policy stance.

In the face of sluggish economic growth, the argument for a looser monetary policy stance had to be weighed against the need to defend a struggling currency as well. Policy interest rates were raised in November 2018 – the SDFR by 75

Figure 2.5
Inflation, Credit Growth and Interest Rates

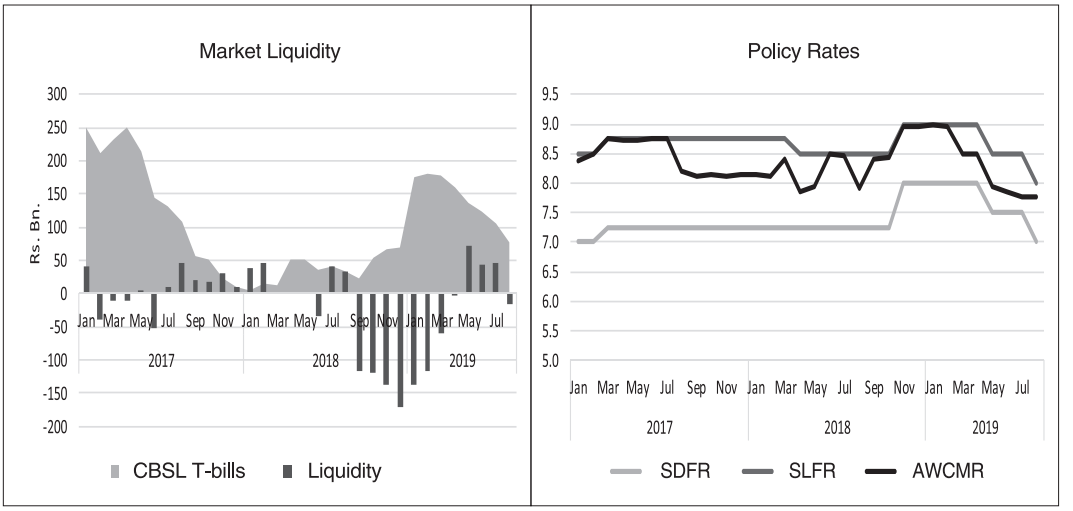


Source: Compiled with data from Central Bank of Sri Lanka. *Monthly economic indicators*. Colombo, Sri Lanka: Central Bank of Sri Lanka.

As inflation eased and credit growth to the private sector slowed, the bigger concern was rising interest rates. The Central Bank of Sri Lanka (CBSL) chose to cautiously ease monetary

basis points and the SLFR by 50 basis points. At the same time, the Statutory Reserve Ratio (SRR) was lowered by 150 basis points to 6 per cent to inject liquidity into the market. The

Figure 2.6
Policy Interest Rates and Market Liquidity



Source: Compiled with data from Central Bank of Sri Lanka. *Monthly economic indicators.* Colombo, Sri Lanka: Central Bank of Sri Lanka.

CBSL allowed for only a partial sterilisation of forex market intervention to ensure that interest rates do not go sky-high and stifle private investment and growth prospects altogether. Non-sterilised intervention in the forex market not only employs the interest rate channel to nudge short term interest rates, but it also sends signals of monetary authority intentions to shape expectations on future monetary and exchange rate policy.

An old rule of thumb measure of the tightness of monetary policy is gauged very simply by comparing nominal interest rates with nominal GDP growth. If interest rates are higher than the growth rate of nominal GDP, monetary policy is considered to be restrictive. By that intuitive measure, Sri Lanka's lending interest rates in the range of 12 per cent by end 2018 was well above the nominal GDP growth of 7.7 per cent. But, despite a downward adjustment to the SLFR, interest rates continued to remain stubbornly high, with real interest rates climbing steadily as inflationary pressures in the Sri Lankan economy began to decline. Indeed, in early 2019, Sri Lanka was identified by Bloomberg as the country with the highest real interest rate globally, at 6.2 per cent.[3]

The SRR was cut in March 2019 by a further 100 basis points. However, with lending rates remaining high despite, the CBSL resorted to more direct intervention in April 2019, requiring banks and finance companies to cut deposit rates to force banks to reprice lending rates. Deposits of three months or less was to be linked to the SDFR of the CBSL and longer-term rates to the 12-month treasury bill yield. As credit growth to the private sector kept falling, amidst weak GDP growth and the fallout from the April terror

[3] Bloomberg. (2019, January 21). *South Asia tops the ranks of world's highest real interest rates.* Retrieved from https://www.bloomberg.com/news/articles/2019-01-21/south-asia-tops-the-ranks-of-world-s-highest-real-interest-rates

attacks, policy rates were cut by 50 basis points in May 2019 and by a further 50 basis points in August 2019.

Clearly, dampened economic sentiments is also a contributory factor to low credit uptake by the private sector. Nonetheless, high real interest rates are also a disincentive for greater private sector participation in economic activities.

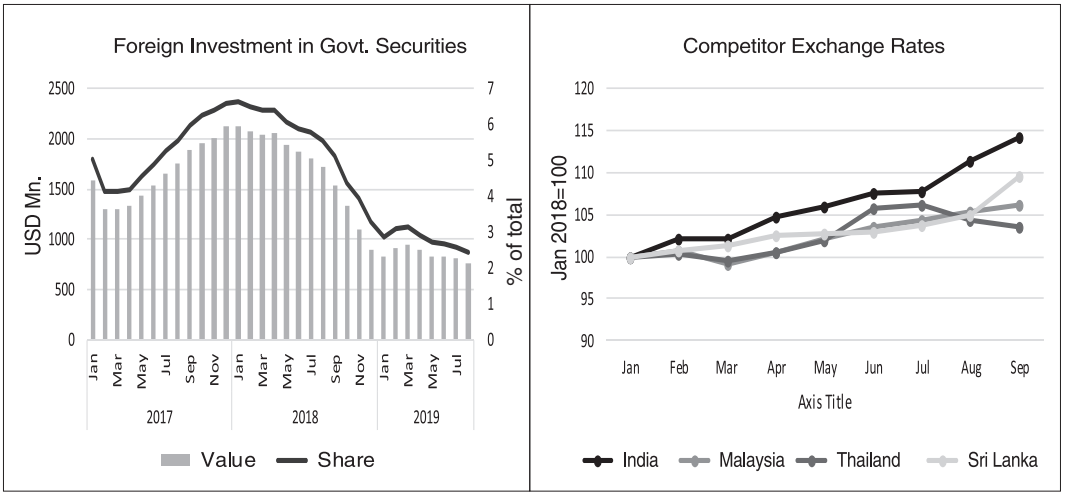
Sri Lanka's Cabinet of Ministers has also given the nod to bring about changes to the monetary law of the country to help the CBSL transition to a 'flexible inflation targeting' regime. Changes to monetary policy practices occur periodically as painful economic adjustments are witnessed. A flexible inflation targeting regime aims to anchor price stability as the prime factor of monetary policy. While it can bring more stability, predictability, and transparency to monetary policy, global experiences – not least under the post global financial crises era – show that central banks cannot always set interest rates through monetary policy.

2.5 Exchange Rate Policy: Managing Volatility

Steady progress by the CBSL in 2017 to build up non-borrowed reserves through net purchases in the forex market totaling nearly USD 1.7 billion reversed in the first quarter of 2018. With Sri Lanka's high reliance on foreign capital to finance investment when external financial conditions were favourable following the global financial crisis, the country became far more vulnerable to external shocks. As the US Federal Reserve entered an interest rate tightening phase in 2017, it disrupted emerging economies like Sri Lanka; US monetary policy tightening and a strengthening dollar dealt twin blows to severely undermine the Sri Lankan rupee.

First, higher US interest rates prompted a rapid exit of foreign investors from Sri Lanka's treasury bills and bonds. The share of treasury bills and bonds held by foreign investors dropped

Figure 2.7
Capital Outflows from Government Securities



Source: Compiled with data from Central Bank of Sri Lanka. *Monthly economic indicators.* Colombo, Sri Lanka: Central Bank of Sri Lanka.

continually to a low of less than 3 per cent by early 2019 (Figure 2.7). The 10 per cent threshold limit on foreign investor holdings that had prevailed since 2015 was adjusted down to 5 per cent in January 2019, ostensibly to move away from the disruptions of short-term capital flows.

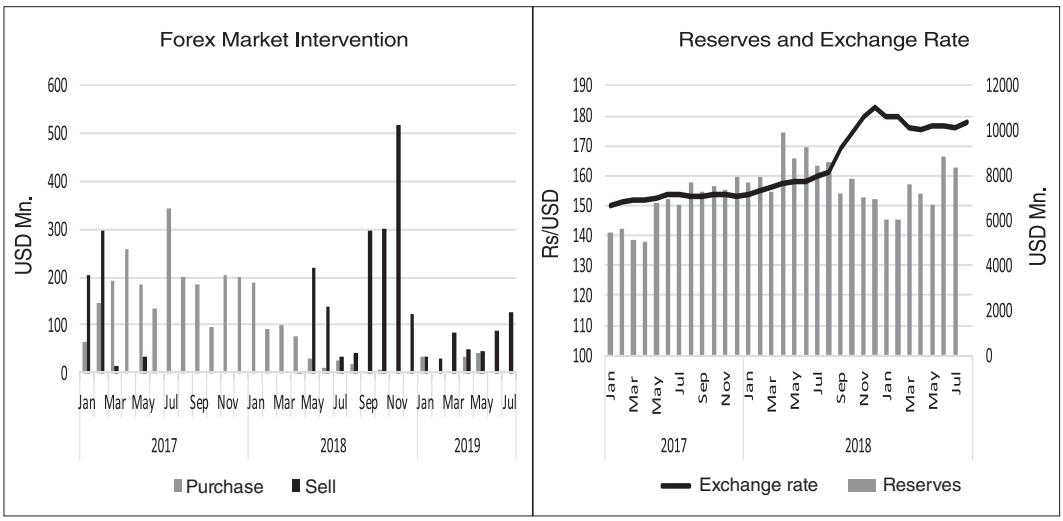
The pressure on the currency from the outflow of dollars in an already thin forex market was compounded by the appreciation of the US dollar. Indeed, Sri Lanka was not alone amongst emerging economies subject to currency turmoil as a result; By the third quarter of 2018, the Indian rupee had depreciated by nearly 15 per cent compared to a more modest 10 per cent depreciation of the Sri Lankan rupee (Figure 2.7).

Brakes on non-essential imports and measures to induce repatriation of export earnings were accompanied by intervention in the forex market to defend the Sri Lankan rupee. Unlike in previous episodes of heavy forex intervention that only served to delay the inevitable, CBSL intervention was more limited. Nonetheless, official reserves had fallen from USD 10 billion (5.5 imports months) in April 2018 to USD 7.2 billion (4 import months) by end September 2018.

Sri Lanka's increasingly volatile political cohabitation arrangement under the 2015 national unity government splintered in October 2018 with a surprise move by the President to sack the sitting Prime Minister. The instability accelerated the pull out of foreign investors from government securities, leading to a sharper depreciation of the currency. By end 2018, the rupee had depreciated overall by 20 per cent.

Despite pronouncements that the currency depreciation was not unique to Sri Lanka, the comparison offers little comfort in view of the country's hefty total external debt stock, unlike most of its neighbours such as India. With Sri Lanka's total foreign currency denominated debt at 60 per cent of GDP, a sudden sharp depreciation makes the economy-wide impacts of

Figure 2.8
Forex Market, Reserves and Exchange Rate



Source: Compiled with data from Central Bank of Sri Lanka. *Monthly economic indicators.* Colombo, Sri Lanka: Central Bank of Sri Lanka.

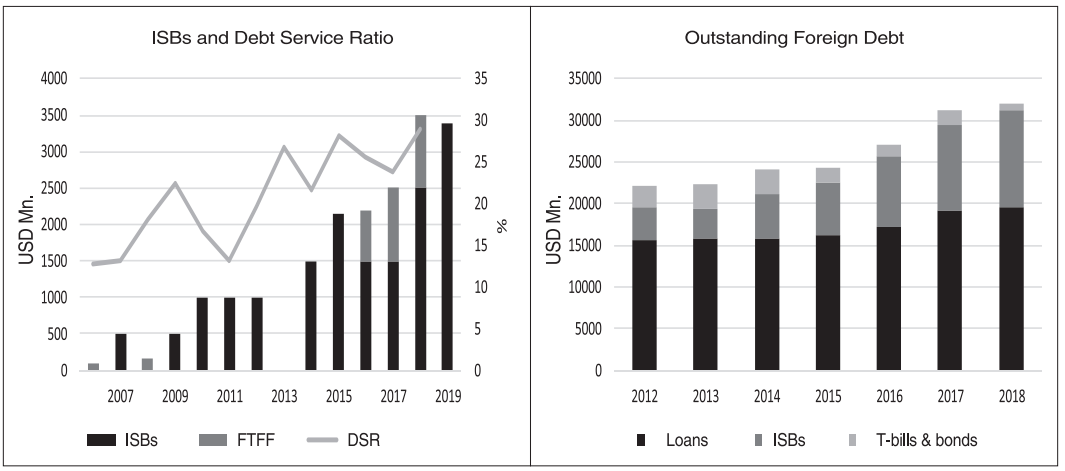
a currency depreciation far more risky. The risks for Sri Lanka are heightened further in view of the necessity to refinance a large volume of foreign debt settlements during 2019-2022.

Indeed, the settlement of a USD 1 billion international sovereign bond (ISB) in January 2019 put considerable stress on the country's foreign exchange holdings as previously planned refinancing schedules had to be put on hold owing to higher political risk perceptions by foreign investors following the October 2018 constitutional crisis. Moody's was the first to downgrade Sri Lanka's credit rating in November 2018, followed by Fitch Ratings in December 2018. The claims and counter claims on who forms the legitimate government in power dragged on for an interminable 52 days until a ruling by Sri Lanka's Supreme Court in mid-December 2018. With a return to the status quo, the CBSL was once more able to issue an ISB for USD 2.4 billion in March 2019 (USD 1 billion 5-year bond at 6.85 per cent and USD 1.4 billion 10-year bond at 7.85 per cent). The CBSL raised another USD 2 billion in June 2019 (USD 500 million 5-year bond at 6.35 per cent and USD 1.5 billion 10-year bond at 7.55 per cent). With these, Sri Lanka's official reserves position climbed to USD 8.9 billion (sufficient for 5.2 months of imports) once again. The foreign capital inflows – albeit a build up of additional foreign debt liabilities – saw the rupee appreciate by 3.5 per cent in the first half of 2019.

2.6 Foreign Debt and Debt Refinancing

A consistent feature of Sri Lanka's economic outcome has been a steady build-up of foreign debt liabilities, particularly in the form of ISBs and, more recently, in the form of foreign currency term financing facilities (FTFFs). The changes over the year in the cost and risk structure of Sri Lanka's foreign debt is well known; from a very low share of 7 per cent in 2006, non-concessional foreign borrowing has come to account for 55 per cent of the total in 2018. As the cost of the outstanding foreign debt stock has risen, so too has the country's debt service ratio in the absence of strong growth in earnings from exports of goods and services (Figure 2.9).

Figure 2.9
External Debt Trends



Source: Compiled with data from Central Bank of Sri Lanka. (Various years). *Annual report.* Colombo, Sri Lanka: Central Bank of Sri Lanka.

In absolute terms, government outstanding foreign debt stood at USD 32 billion in 2018. Over the period 2019-2022, Sri Lanka is estimated to require refinancing of approximately USD 4,000 million on average per annum. To help ease the debt refinancing process, an Active Liability Management Act that allows borrowing in excess of approved limits solely for debt settlements was enacted in 2018. Sri Lanka is set to make the first such borrowing of USD 500 million through the issuance of samurai bonds in the third quarter of 2019.

The most promising means of assuaging refinancing risks, particularly in today's volatile global economic environment, is to generate non-debt creating capital inflows in the form of foreign currency earnings and foreign direct investment (FDI) flows. Sri Lanka's performance in these areas has been mixed,[4] without visible signs of strong and sustained earnings from exports, remittances or FDI inflows. One of the more promising areas of earnings growth, tourism, suffered a serious setback with the advent of a terror strike in April 2019. While the long-term economic impacts of the terror attack are likely to be relatively limited, it is nonetheless a serious setback for an already struggling economy. Thus, despite a sharp contraction in the trade deficit – primarily from lower imports as a result of restrictions on vehicle imports, lower international oil prices, and the import compressing impact of a currency depreciation – the current account of the balance of payments (BOP) will still remain under pressure, owing to a slowdown in earnings from tourism and remittances. The BOP is recording an improvement overall, largely on account of the higher ISB related capital inflows (Table 2.4).

Table 2.4
External Sector Performance, January-June

	USD Million		% Change	
	2018	2019	2018	2019
Trade balance	-3,597	-5,709	20.2	-37.3
Exports	5,999	5,732	6.2	4.7
Imports	9,596	11,441	12.7	-16.1
Tourism earnings	2,186	1,893	16.6	-13.4
Worker remittances	3,624	3,270	0.9	-9.8
FDI	336	262	74.1	-22.0
Capital inflows to government				
Treasury bills and bonds	553	376	-24.2	-32.0
Long-term loans	821	750	19.2	-8.6
ISBs	2,500	4,400	28.2	76.0
Overall balance	1,148	1,827	-26.6	59.1

Source: Compiled with data from Central Bank of Sri Lanka. *External Sector Performance.* Colombo, Sri Lanka: Central Bank of Sri Lanka.

[4] See Chapter 3 of this report on "Global Economic Developments and Impacts on Sri Lanka".

Under these tight circumstances, retaining foreign investor confidence is critical to successfully refinance Sri Lanka's large foreign debt settlements over the next few years. A sustainable fiscal regime and growth enhancing economic reforms are priorities for this. The months leading up to Sri Lanka's all-important presidential elections by end 2019 will see only limited progress on reform initiatives as attention stays firmly on the country's policy and political outlook post-election.

The Sri Lankan economy is thus set to face testing times; dollar revenues need to be generated to match dollar-denominated debt service as never before, just as the next steps and their outcomes for the economy are likely to be heavily determined by the intersection of politics and economics in the country.

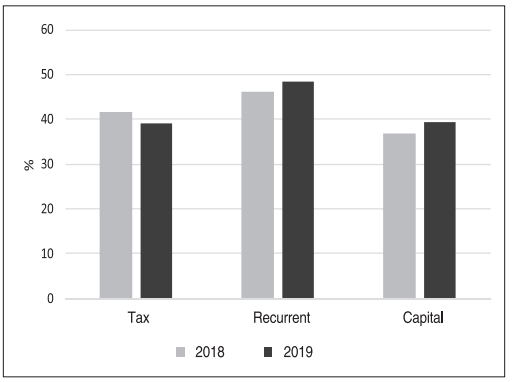
2.7 Near Term Economic Outlook

Electoral cycles encourage the practice of 'competitive populism' in Sri Lanka. This has commonly manifested in the form of perks offered to the country's substantial vote base of public sector employees, expansion in subsidies and transfers to households through programmes such as Samurdhi, amongst others. The 2019 Budget too offered some early pre-election 'relief' as anticipated, albeit with more restraint in order to retain the fiscal consolidation gains made since mid-2016. Nonetheless, with a decision to proceed on a 'Vote on Account' to allocate expenditure in the first quarter of 2020 to allow an incoming government to prepare and present a full budget for the year, the risks to fiscal targets being missed are high.

In the first half of 2019, achievements against projected targets are lower for tax collection, while spending – for both recurrent and capital expenditures – are higher relative to the mid-way point a year earlier (Figure 2.10). Current trends suggest that the deficit will remain near or slightly above the 5.3 per cent recorded in 2018, well above the projected 4.4 per cent of GDP for 2019. With high interest rates set to increase the cost of Sri Lanka already substantive public debt holdings, there is hardly any room for fiscal policy to provide any stimulus to uplift productive growth output in the economy.

Electoral cycles encourage the practice of 'competitive populism' in Sri Lanka.

Figure 2.10
Fiscal Outlook, First Half 2019



Source: Compiled with data from Central Bank of Sri Lanka. *Monthly economic indicators*. Colombo, Sri Lanka: Central Bank of Sri Lanka.

Signals of monetary authority intentions are clear – to bring down lending rates and encourage private investment in productive economic activities. The extent to which the policy direction will be successful is tied inextricably to the country's emerging political outlook. If intertemporal effects hold – i.e. investors make decisions based on the expectations of future income and wealth – the tendency will be to hold off from making major decisions until election-related uncertainties are cleared.

With the substantial output gap in the Sri Lankan economy at present with GDP expected to hover slightly above 3 per cent at end 2019 for a third successive year, suppressed consumption and investment demand is likely to be high. With major infrastructure projects such as the Colombo Port City ready for take-off, if political stability is reinstated, Sri Lanka may see a surge in foreign capital inflows for large scale infrastructure spending. Either way, a priority for any incoming government will be to try and revive growth within the shortest possible time. And, reviving growth is essential; at the same time, any incoming government must also be prepared to act swiftly on both fiscal and monetary policy fronts to rein in expansionary fiscal and monetary policy stances – and the risk of a sudden sharp bubble – at the first signs of the economy overheating.

Vigilance on the economic front is also warranted in view of rising global uncertainties. Expectations of an early resolution to the tit-for-tat trade wars – and encroaching into a currency war – among major powers, are fading. Additionally, even though international oil prices have fallen, the risks that prices can spike unexpectedly remain in view of heightened geo-political tensions. On the positive side, as central banks in major economies ease policy interest rates, Sri Lanka will stand to benefit from lower refinancing costs. However, in view of the creeping uncertainties on the global economic front, greater vigilance on external sector developments will be called for as Sri Lanka prepares for a renewed phase of economic policy formulation.

3. Global Economic Developments and Impacts on Sri Lanka

3.1 Introduction

Global economic activity slowed over the course of the year in 2018, with the sluggish momentum continuing through to 2019. Escalating trade tensions between the US and China, coupled with President Trump's protectionist stance – which has moved beyond relations with China – have been the biggest contributor to the dip in economic sentiment, globally. It is taking a toll on business confidence, and worsening financial market sentiment. As a result, financial market conditions are tightening for both vulnerable emerging economies as well as advanced economies. To add to concerns, China's economic growth rate is slowing due to regulatory tightening and trade tensions with the US, while the Euro area faces more challenges than expected.

In addition to the risks surrounding trade policy, the unclear terms of exit of the UK from the European Union (EU) has heightened uncertainty in the global economic environment. The Brexit debacle has dragged well beyond its March 29th exit deadline, leaving considerable doubt in its wake on the prospect of closure on a Brexit deal in 2019. To a large extent, these uncertainties have also created a vacuum in global leadership, which is increasingly being filled by Asian powerhouses – i.e. China and India. China, in particular, is changing the landscape of the global political-economy discourse with the steady expansion of its Belt and Road Initiative (BRI).

Under such toxic external conditions, Sri Lanka is set to face considerable challenges. In 2018, it felt the brunt of US monetary policy adjustments that saw the Sri Lankan Rupee (Rs) weaken considerably. Nonetheless, with foreign investors still seeking higher yields in emerging economies, Sri Lanka was able to successfully leverage external conditions to bulk up reserves by way of further international capital market borrowings. The risks remain high however; a continuing reliance on external borrowing for foreign debt rollover in the next few years leaves the country exposed to the threats of tighter global financial conditions.

Aside from capital market flows, Sri Lanka's external sector faces a multitude of challenges, including the spillover impacts of the ongoing trade wars, as it seeks to increase exports via several reform packages. A largely stagnant export basket, as well as overreliance on markets in the US and EU for exports do not help, as demand from these destinations could slow due to unfavorable external conditions. Other key revenue generating sources such as remittance earnings are also slowing down; the April 2019 terror attacks derailed what was otherwise a promising performance in tourism earnings. Thus, while the country's external sector resilience has marginally improved by mid-2019, much remains to be done to strengthen Sri Lanka's position, to effectively cushion against external shocks.

A largely stagnant export basket, as well as overreliance on markets in the US and EU for exports do not help, as demand from these destinations could slow due to unfavorable external conditions.

This chapter will examine some of these issues, paying particular attention to prospects for the global economy and its impacts on the Sri Lankan economy.

3.2 Prospects for the Global Economy

Although the global economy experienced an upbeat start in 2018, global expansion (albeit continuing) has weakened since the latter part of 2018. Growth projections by the International Monetary Fund (IMF) have been revised downwards, with the global economy projected to grow at 3.5 per cent in 2019 – down from 3.7 per cent in 2018 – with only a marginal pick up to 3.6 per cent in 2020.

3.2.1 Advanced Economies: Weakening Global Expansion, High Uncertainty

Advanced economies are projected to grow at 2 per cent in 2019, following an estimated growth of 2.3 per cent in 2018 (Table 3.1). A host of factors have slowed the growth momentum and heightened risks in advanced economies. The repercussions of tariff increases enacted in the US and China in 2018-2019 are being felt. Financial risks experienced in Italy, the introduction of new fuel emission standards in Germany and natural disasters experienced in Japan have also weighed on economic activity in large economies.[1]

Despite some of these factors being idiosyncratic, these events did, nevertheless, take place against the backdrop of "weakening financial market sentiment, trade policy uncertainty, and concerns

[1] International Monetary Fund. (2019). *World economic outlook – January*. Washington D.C.: International Monetary Fund.

about China's outlook".[2] Industrial trade and production has slowed, and business confidence has dipped. Tariffs imposed by the US, and subsequent retaliatory measures taken by China are largely to blame – this increase in protectionist rhetoric around trade has created uncertainty in trade policy, which has also translated into dampened investor sentiment.[3]

In line with this, the Federal Reserve raised policy rates. A stronger economy coupled with higher interest rates relative to other economies saw the United States Dollar (USD) appreciate against most currencies in 2018. Crucially for Sri Lanka, this has meant a heavy outflow of foreign investors from gilt-edged securities, as the Rs depreciated by 20 per cent against the USD, by

Table 3.1
World Output (% Change)

	Estimates		Projections	
	2017	2018	2019	2020
World Output	**3.8**	**3.7**	**3.5**	**3.6**
Advanced Economies	**2.4**	**2.3**	**2.0**	**1.7**
US	2.2	2.9	2.5	1.8
Euro Area	2.4	1.8	1.6	1.7
Germany	2.5	1.5	1.3	1.6
France	2.3	1.5	1.5	1.6
Italy	1.6	1.0	0.6	0.9
Japan	1.9	0.9	1.1	0.5
UK	1.8	1.4	1.5	1.6
Emerging Market and Developing Economies	**4.7**	**4.6**	**4.5**	**4.9**
Russia	1.5	1.7	1.6	1.7
China	6.9	6.6	6.2	6.2
India	6.7	7.3	7.5	7.7
ASEAN-5	5.3	5.2	5.1	5.2
Brazil	1.1	1.3	2.5	2.2

Source: International Monetary Fund. (2019). *World economic outlook – January.* Washington D.C.: International Monetary Fund.

Nonetheless, the US economy witnessed fast pace growth in 2018, due to tax cuts and increased spending which has, in turn, stimulated demand. year end.[4] Other developed countries whose economic statuses are of significance to Sri Lanka – primarily leading export markets such as

[2] International Monetary Fund. (2019). *World economic outlook – January*. Washington D.C.: International Monetary Fund.

[3] International Monetary Fund. (2018). *5 charts that explain the global economy in 2018.* Retrieved from https://blogs.imf.org/2018/12/20/5-charts-that-explain-the-global-economy-in-2018/

[4] Weerakoon, D. (2019). *Sri Lanka's political problems imperil a fragile economy.* Retrieved from http://www.eastasiaforum.org/2019/01/28/sri-lankas-political-problems-imperil-a-fragile-economy/?fbclid=IwAR1RaujTNPZtZu7JnyqXqXTtqy47kGy37UE39i0FyqHlAkFDLjD5fvENHQY

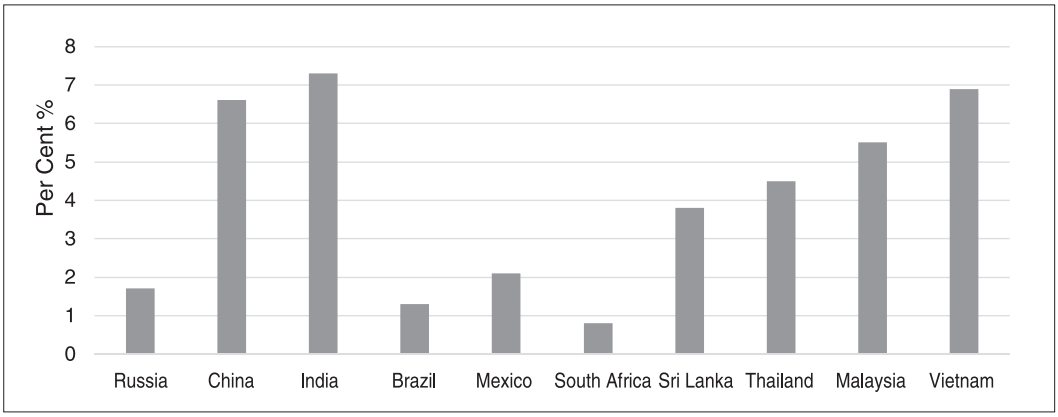
UK, Germany, and Italy – have not recovered as per predictions in early 2018. Economic growth in these countries has slowed over 2018-2019, posting rates ranging between 1.0-1.5 per cent. The uncertainty surrounding the UK economy's terms of exit from the EU, which has surpassed the agreed exit date on 29th March 2019, will further intensify in the months ahead. The projection of 1.5 per cent growth for the UK for 2019 is based on the assumption that a Brexit deal is reached, and that the UK gradually transitions into this new regime;[5] as the likelihood of this wanes, growth will potentially dip further due to heightened levels of uncertainty.

3.2.2 Emerging Markets and Developing Economies

Consistent with trends in recent years, emerging and developing economies continue to be the main drivers of global economic growth. Growth in these economies is expected to dip slightly to 4.5 per cent in 2019, and recover again in 2020 to a rate of 4.9 per cent.

China's slowdown is a key concern for 2019; growth is expected to fall from 6.9 per cent in 2017 to a projected 6.2 per cent in 2019. The combined effect of higher tariffs faced by China from trade tensions with the US, and financial regulatory tightening that is taking place in the country are largely responsible for the expected slowdown through 2019. Some headway has been made in rebalancing the Chinese economy and reining in debt; nevertheless, the Asian region in particular, must be watchful, as it is echoing China by reporting its weakest growth rates since the financial crisis.[6] Moreover, negative implications remain for China's trade partners, and for global commodity market prices. As once witnessed in 2015-2016, concerns about the health of China's economy can trigger abrupt, wide-reaching sell-offs in financial and commodity markets that place its trading partners, commodity exporters, and other emerging markets under pressure.[7]

Figure 3.1
GDP Growth of Emerging and Developing Countries (Selected Economies), 2018



Source: International Monetary Fund. (2019). *World economic outlook – January.* Washington D.C.: International Monetary Fund.

[5] International Monetary Fund. (2019). *World economic outlook – January.* Washington D.C.: International Monetary Fund.
[6] BBC. (2019). *Why China's slowdown should worry us all.* Retrieved from https://www.bbc.com/news/business-46942524
[7] International Monetary Fund. (2019). *World economic outlook – January.* Washington D.C.: International Monetary Fund.

India's economy on the other hand is poised to pick up in 2019, benefitting from a slower pace of monetary tightening than previously expected, as inflation pressures ease. Growth is expected to jump from 7.3 per cent in 2018 to 7.7 per cent in 2020. Meanwhile, in the Middle Eastern region, economic activity is expected to remain subdued due to weak oil output growth, US sanctions (on Iran) and continuing geopolitical tension across much of the region (Figure 3.1).

Overall, developing and emerging markets are not placed on a strong footing in 2019, as vulnerable markets in particular, have come under strain from strengthening of the USD. Many of these markets have witnessed an increase in external borrowing costs, albeit with the severity of these increases varying widely.[8]

3.3 World Trade and Commodity Prices

Continued turmoil amidst trade spats and subdued demand have impacted global trade prospects and commodity prices. In the case of the latter, geopolitical tensions too are playing a role in determining the outlook for international oil prices, a key commodity import for Sri Lanka.

3.3.1 Trade

In line with the moderation of global growth in 2019, global trade is also experiencing a dip in momentum. The World Trade organisation (WTO) downgraded its merchandise trade forecast for 2019 to 2.6 per cent – trade will continue to expand but at a more moderate pace than previously indicated. In early 2018, the WTO forecasted a fairly wide range of 3.1-5.5 per cent

Continued turmoil amidst trade spats and subdued demand have impacted global trade prospects and commodity prices. In the case of the latter, geopolitical tensions too are playing a role in determining the outlook for international oil prices, a key commodity import for Sri Lanka.

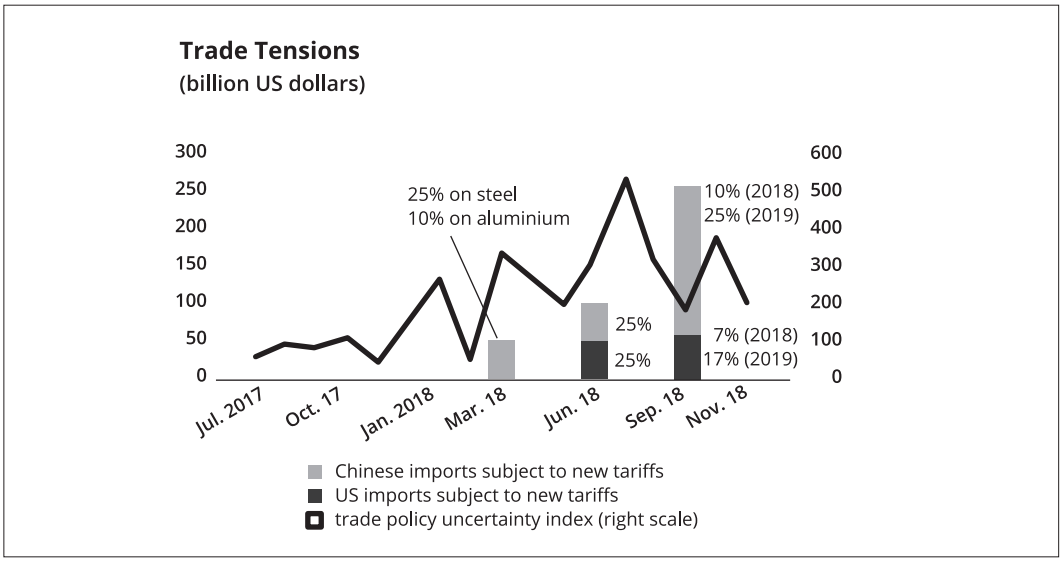
[8] International Monetary Fund. (2018). *5 charts that explain the global economy in 2018.* Retrieved from https://blogs.imf.org/2018/12/20/5-charts-that-explain-the-global-economy-in-2018/

within which world trade growth was expected to fall, in anticipation of looming trade tensions at the time. Following the unfolding of these events in late 2018, an estimated 3 per cent of growth was posted for merchandise trade growth in 2018.[9]

Some of the downside risks to the trade outlook which were noted in early 2018, have now come to fruition; a rise in trade measures targeting exports of larger economies has contributed to increased levels of uncertainty in markets, which has resulted in lower investment spending. Furthermore, monetary policy tightening in developed economies has also contributed to volatility in exchange rates. Moreover, although trade growth remains strong, the slowdown mainly reflects high tensions between major trading partners.

While a truce was reached in end-2018 between the US and China to temporarily halt retaliatory tariff measures, trade talks to arrive at a deal to prevent further escalation of a trade war have been ongoing in 2019. At end-2018, the US had imposed USD 253 billion worth of tariffs on imports from China (and USD 267 billion threatened additional tariffs), while China had retaliated with USD 130 billion worth of tariffs on US imports (Figure 3.2). Ongoing talks in the first half of 2019 failed in May, when the US imposed a further tariff hike on USD 200 billion in Chinese goods, from 10 per cent to 25 per cent. China then retaliated by hiking duties on USD 60 billion worth of US goods to as high as 25 per cent at the beginning of June. By end-June 2019, both parties agreed to resume trade talks; while this

Figure 3.2
US-China Tariffs



Source: International Monetary Fund. (2018). *5 charts that explain the global economy in 2018.* Retrieved from https://blogs.imf.org/2018/12/20/5-charts-that-explain-the-global-economy-in-2018/

[9] World Trade Organisation. (2018). *Global trade growth loses momentum as trade tensions persist.* Retrieved from https://www.wto.org/english/news_e/pres19_e/pr837_e.htm

is a welcome step, most analysts are of the view that long-term prospects for the global economy remain tricky. Uncertainty will continue to persist in 2019 on account of these tensions, delaying business decisions and hurting debt strapped firms in particular.

In addition, those developing countries experiencing capital outflows as developed countries increase interest rates, face negative consequences on trade. In terms of structural factors, China's economic rebalancing away from investment towards more consumption has a bearing on import demand, as the import content of investment is high.

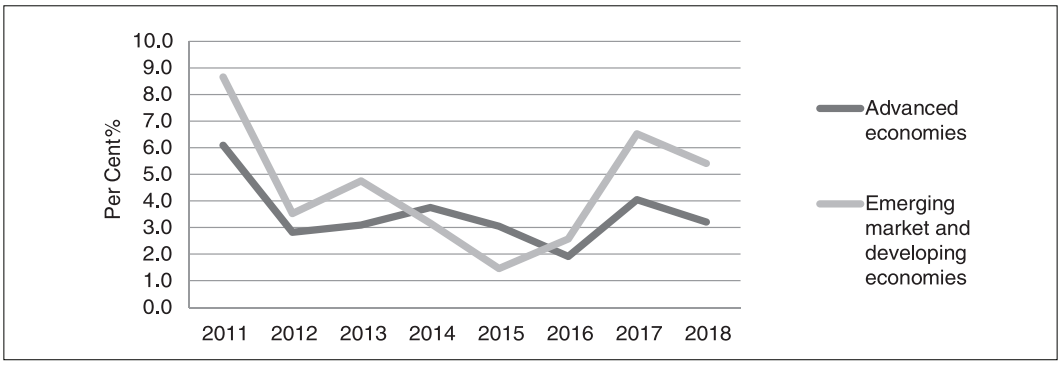
In terms of export growth across economies/ regions, advanced economies, developing economies and emerging markets all experienced a dip in 2019 (Figure 3.3). All regions recorded positive year-on-year trade growth in both exports and imports in 2018, albeit some performed better than others. North America posted the fastest export growth during this period at 4.8 per cent, followed by Asia (4.2 per cent) and Europe (2.8 per cent). Exports of other regions (Africa, the Middle East and Commonwealth of Independent States) increased by 2.7 per cent. For imports on the other hand, Asia posted the fastest growth (6.1 per cent) followed by South America (5.5 per cent), North America (4.8 per cent), Europe (2.9 per cent) and other regions (0.5 per cent).

3.3.2 Commodity Markets

Commodity prices have been driven by a number of factors in 2018; those already outlined in previous sections, such as trade tensions among major economies, rising US interest rates and USD appreciation, and financial market pressures in some emerging/developed economies have had a bearing, along with more commodity-specific supply disruptions.

Energy prices rose towards end-2018, with strong gains in oil, coal, and natural gas. Oil prices on the other hand, were volatile, with the price of Brent reaching a low of USD 70/bbl and peaking at USD 86/bbl in the latter half of 2018 (Figure 3.4).[10] The increase in prices reflects continued

Figure 3.3
Export Growth (2011-2018)



Source: International Monetary Fund. (2019). *World economic outlook – January.* Washington D.C.: International Monetary Fund

[10] World Bank. (2018). *Commodity markets outlook – October*. Washington D.C.: World Bank.

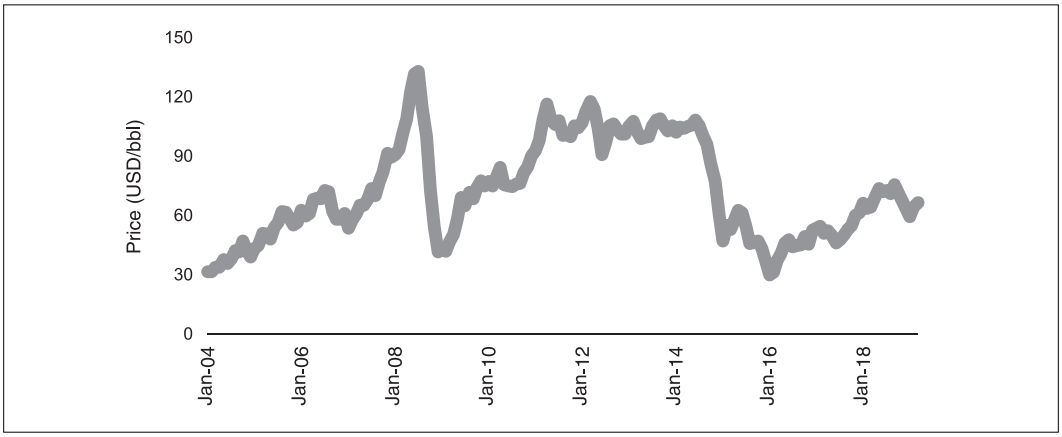
production losses in Venezuela, and concerns that the reintroduction of sanctions on Iran by the US may have a negative impact on Iranian oil production and exports. Production increases by other members of the Organisation of Petroleum Exporting Countries (OPEC) are expected to partly offset this decline. However, oil prices have moderated only slightly to USD 66/bbl by mid-2019. Even so, initial expectations that demand for oil will dampen in 2019 is being revisited, as the appetite for crude oil among emerging markets has remained strong.[11]

most notably due to ample supplies for most oilseeds and grains, and trade tensions which affect a range of agricultural prices (soybeans).[12]

3.3.3 Foreign Direct Investment (FDI) Flows

The flow of global foreign direct investment (FDI) experienced its third consecutive drop in 2018, falling by 19 per cent to USD 1.2 trillion. This drop has taken FDI flows back to the low reached at the time of the global financial crisis. The decline was

Figure 3.4
World Crude Oil Monthly Prices (USD/bbl)



Source: Data from World Bank on Commodity Markets Outlook –March.

Non-energy prices on the other hand are projected to be roughly stable, gaining just under 2 per cent in 2018 and an additional 1 per cent in 2019. However, prices of metals dropped due to weaker global demand, and concerns about the effects of the US-China trade dispute on Chinese growth, which accounts for 50 per cent of global metal demand. Agricultural prices are also falling,

largely concentrated in developed economies; large repatriations of accumulated foreign earnings from US multinational enterprises (MNEs) following tax reforms is estimated to have caused a 73 per cent decline in flows to Europe – one of the lowest figures witnessed since the 1990s.[13] North America also witnessed a 13 per cent decline in inflows.

[11] CNBC. (2019). *Why oil and gasoline prices are rising faster than analysts expected this year.* Retrieved from https://www.cnbc.com/2019/04/03/why-oil-and-gasoline-prices-are-rising-faster-than-analysts-expected.html

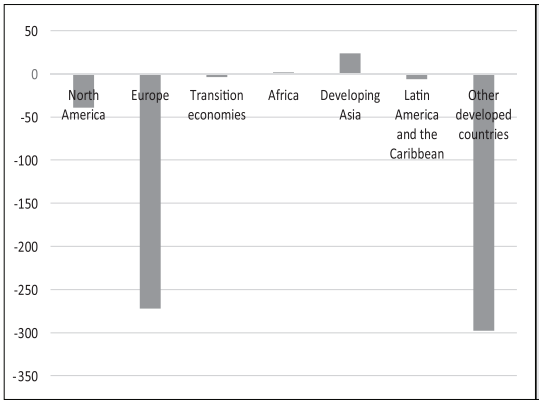
[12] World Bank. (2018). *Commodity markets outlook* – October. Washington D.C.: World Bank.

[13] United Nations Conference on Trade and Development. (2019). *Global investment monitor No. 31.* Geneva, Switzerland: United Nations Conference on Trade and Development.

In contrast, inflows to developing economies remained strong. In fact, 58 per cent of the global share of FDI now belongs to developing economies, with half of the top 10 host economies in the world being developing countries (Figures 3.5 and 3.6). East and Southeast Asia was the largest host region accounting for one-third of global FDI in 2018. China, the largest developing economy FDI-recipient, attracted USD 142 billion with a 3 per cent increase from 2017, largely due to the rise in investment in manufacturing. Flows increased by 5 per cent to USD 502 billion in developing Asia which showed the highest value of greenfield project announcements. Growth in FDI to this region was largely driven by a rise in FDI to Singapore.

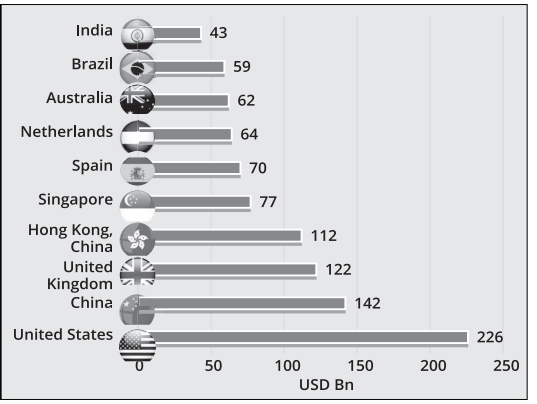
Despite the decline in the developed country share of global FDI, the US remained the top host country of FDI for 2018, with an estimated USD 226 billion in inflows. This is followed by China attracting USD 142 billion, and UK attracting USD 122 billion (Figure 3.6).

Figure 3.5
Regional Contribution to Global FDI Flows (USD Billion) 2017-2018



Source: United Nations Conference on Trade and Development. (2019). *Global investment monitor No. 31.* Geneva, Switzerland: United Nations Conference on Trade and Development.

Figure 3.6
Estimated FDI Flows (USD Billion) - Top 10 Host Economies 2018



Source: United Nations Conference on Trade and Development. (2019). *Global investment monitor No. 31. Geneva,* Switzerland: United Nations Conference on Trade and Development.

3.4 Implications of External Environment Developments on Sri Lanka

Sri Lanka benefitted from a brief upturn in global economic conditions in 2017; improved business confidence, a healthy appetite for investment, favourable oil prices and growth in key markets for Sri Lanka such as the US and EU, allowed the country some space to manoeuvre through its weak macroeconomic conditions. However, over the course of 2018-2019, the external environment has proved to be less conducive. Tighter global financial conditions, a resurgence in oil prices, riskier economic and political environments in key export markets (US, UK) and slower growth in major source economies for FDI/development loans (East Asia) have been some of the contributing factors. Given Sri Lanka's significant medium-term spike in foreign debt settlements

from 2019, a more disadvantageous external environment makes it all the more challenging.

In this climate, Sri Lanka is attempting a concerted push to drive up its exports. Yet, the trade deficit continued to balloon and began to ease only with the sharp depreciation of the currency as imports started to decline. In addition, key sources of foreign exchange such as worker remittances are also showing signs of a decline, while the tourism sector – performing more impressively in 2018 and early 2019 – suffered an unexpected setback following the April 2019 terror attacks. The latter certainly dealt a severe short-term blow to the sector which was poised for a 'good year'.

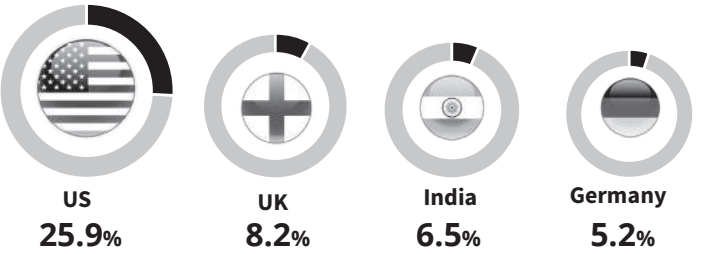
3.4.1 Merchandise Trade Overview

Sri Lanka's external sector performance faced significant stresses in 2018, due to a combination of domestic and external factors. While a commitment towards an outward-oriented growth path is reflected in several policy measures undertaken by the government to improve export performance, import growth outpaced export growth, which resulted in a worsening trade deficit. The heightened uncertainty in global trade, makes the rolling out of these export reforms packages all the more challenging.

Export earnings grew by 4.7 per cent in 2018 to an estimated USD 11.9 billion, which is the highest recorded export earnings figure to date (Figure 3.7). This is a 7 per cent growth from the peak reached in 2014, demonstrating that export growth is gradually moving beyond a short-lived resurgence towards a more sustained higher path. Furthermore, this expansion in exports earnings is driven by industrial exports (78 per cent). Export earnings continued to account for 13 per cent of gross domestic product (GDP) in

Given Sri Lanka's significant medium-term spike in foreign debt settlements from 2019, a more dis-advantageous external environment makes it all the more challenging.

Sri Lanka's largest export destinations



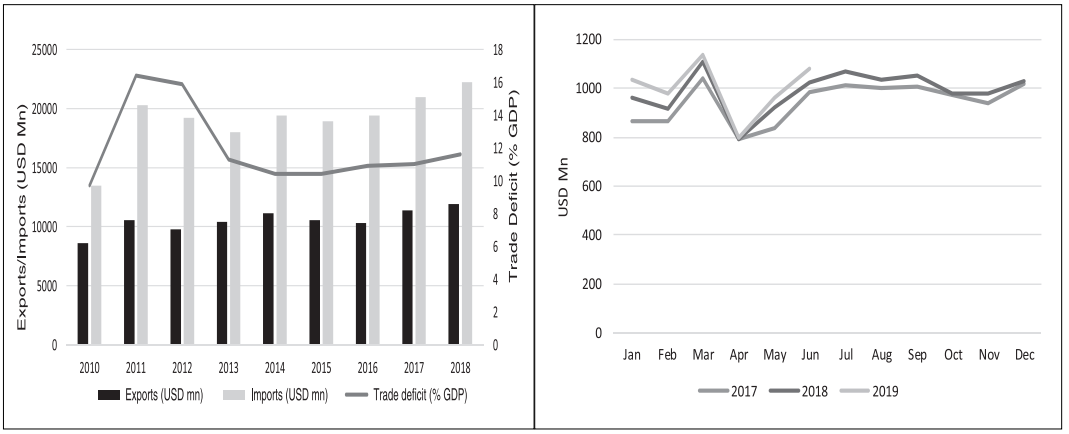
2018, as it did in 2017, when it marked the reversal of a progressive decline in the export share of GDP experienced over the years. In the first six months of 2019, exports recorded improved performance relative to those of the preceding two years (Figure 3.7). Sri Lanka's largest export destinations continue to be the US (25.9 per cent), UK (8.2 per cent) India (6.5 per cent) and Germany (5.2 per cent).

However, imports have been growing at a faster pace than exports. Imports amounted to USD 22.2 billion in 2018, exceeding the USD 20 billion reached in 2011. Hence strong export growth has been met with stronger import growth resulting in a sustained trade deficit of 11.6 per cent of GDP in 2018, which has barely narrowed since 2013. This is a reflection of difficult external conditions, which have made Sri Lanka's import bill higher, despite the rolling out of several reform packages to boost exports (as will be discussed in detail subsequently).

The textile and garment (T&G) sector continues to be Sri Lanka's largest revenue generating merchandise export. The contribution from this sector surpassed the USD 5 billion mark in 2018, to a level of USD 5.3 billion, claiming a 44.7 per cent share of total exports (Figure 3.8). Earnings to the T&G sector have expanded by 5.7 per cent; this is a reflection of steady demand for Sri Lankan goods that has been maintained

Strong export growth has been met with stronger import growth resulting in a sustained trade deficit of 11.6 per cent of GDP in 2018, which has barely narrowed since 2013.

Figure 3.7
Sri Lanka's Trade Performance



Source: Central Bank of Sri Lanka. (2018). *Annual report*. Colombo, Sri Lanka: Central Bank of Sri Lanka; *External sector performance review (Various)*. Colombo, Sri Lanka: Central Bank of Sri Lanka.

from EU markets since their post-recession economic recovery (except from the UK, where demand has dropped), as well as the benefits of the generalised scheme of preferences (GSP), GSP Plus facility, which was reinstated in May 2017. Overall, exports to the EU grew by 11 per cent in the 12 months following the reintroduction of this facility.[14] In addition, T&G posted higher earnings in the first six months of 2019, than in the preceding two years.

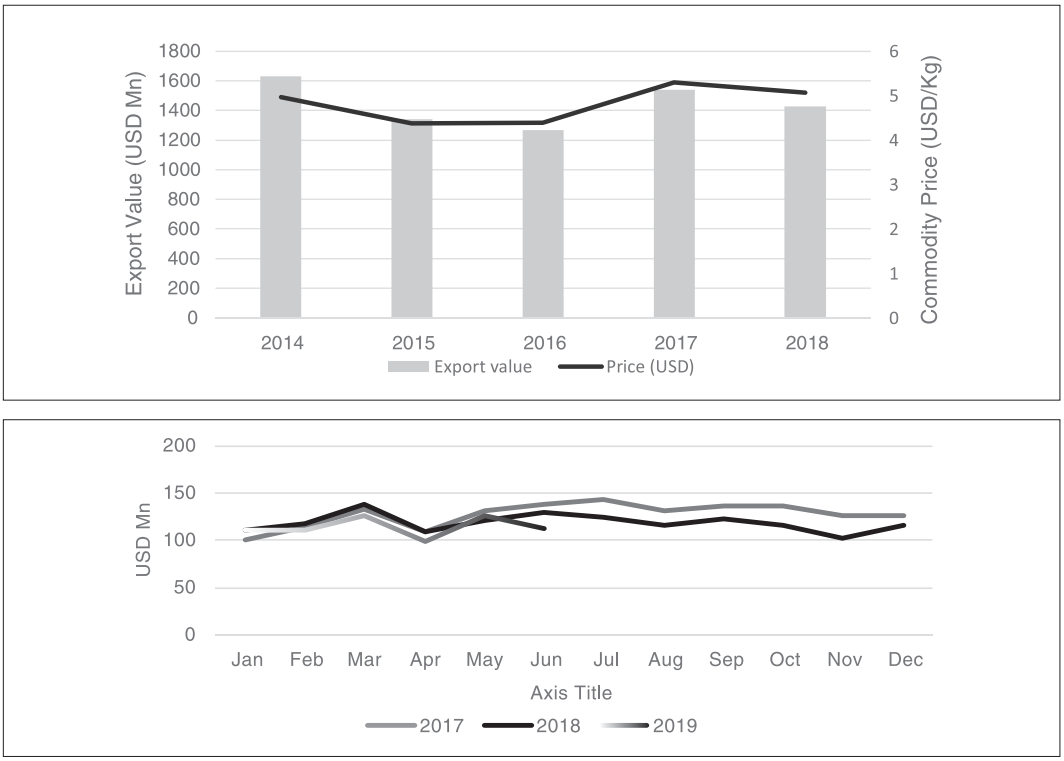
The US has been the leading market for T&G exports for the fourth consecutive year, with the EU closely following (Figure 3.8). Sri Lanka is highly reliant on these two markets with T&G exports to the US and EU collectively accounting for 87 per cent of total T&G exports. However, it is imperative that Sri Lanka starts taking steps to diversify the export basket away from these two markets, on several counts. Preferential access to the UK market (which accounts for one-third of Sri Lanka's exports to the EU) via GSP Plus is not guaranteed under the terms of agreement of a Brexit deal. Apart from the uncertainty surrounding the UK market's position in the EU, Sri Lanka will invariably lose GSP Plus access as it graduates to upper middle-income status; it is estimated that until 2023, Sri Lanka has to take the necessary steps to cushion this loss. Consequently,[15] the current policy thrust is aimed at diversifying into more Asian markets, through trade agreements which are to be negotiated with China, India and Thailand.

Sri Lanka's second highest export revenue contributor is the tea sector, which accounts for 12 per cent of total merchandise exports (Figure 3.9). The sector contributed USD 1.4 billion in earnings in 2018, contracting by 6.6 per cent on account of several obstacles. Although 2018 began on an optimistic note – on the back of high tea prices witnessed in 2017 – issues such as the

[14] Export Development Board & Ministry of Development Strategies and International Trade. (2018). *GSP plus impact.* Retrieved from http://www.ft.lk/opinion/GSP-Plus-impact/14-661186

[15] Export Development Board & Ministry of Development Strategies and International Trade. (2018). *GSP plus impact.* Retrieved from http://www.ft.lk/opinion/GSP-Plus-impact/14-661186

Figure 3.8
Apparel Exports to Primary Destinations and Monthly Apparel Exports

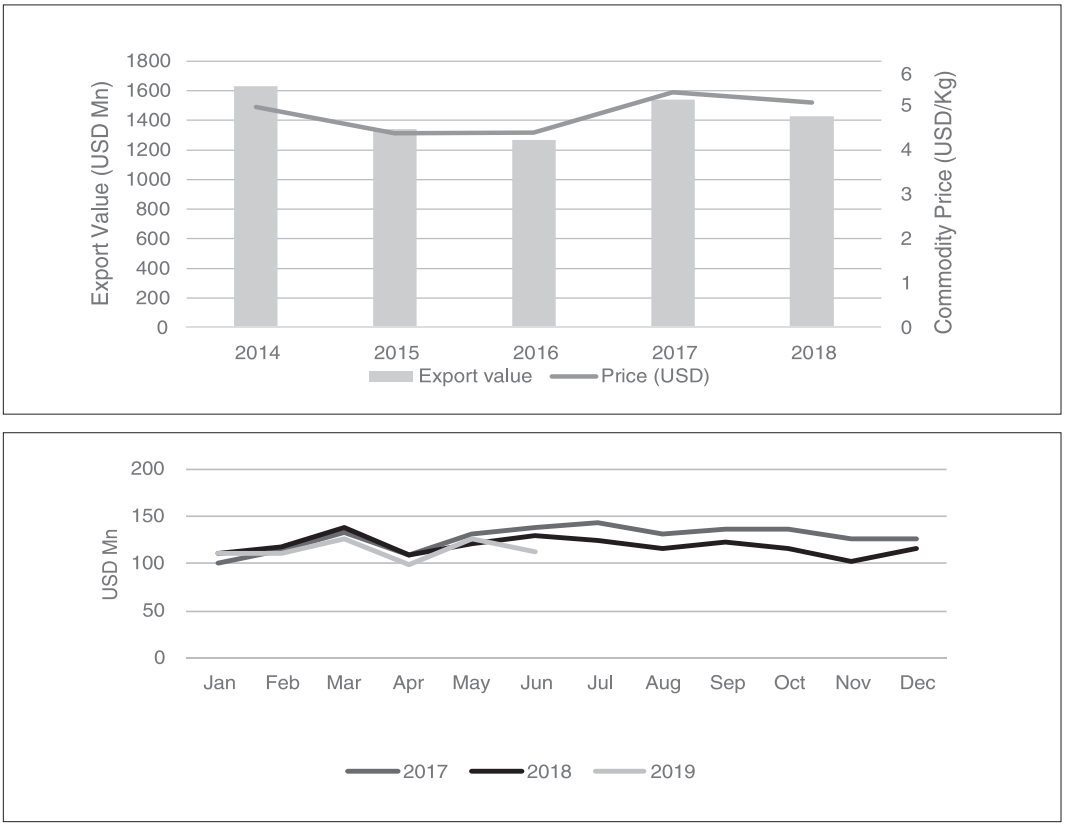


Source: Data from the Joint Apparel Association Forum and *External sector performance review (Various)*. Colombo, Sri Lanka: Central Bank of Sri Lanka.

government's glyphosate ban and US sanctions on Iran had a negative impact, hurting both prices and volumes. Following the glyphosate ban, tea growers and large plantations had to substitute for alternative weedicides; this resulted in a slowdown of exports to Japan due to additional testing requirements.[16] The ban was, however, lifted in July 2018, which was a welcome relief to the industry. In addition, imposition of sanctions on Iran by the US had an impact on auction prices in Colombo, for low grown teas in particular. There was some optimism surrounding tea prices bouncing back in mid-2018, due to strong oil prices and depreciation of the Rs; however, this did not materialise as key Middle Eastern markets and Russia also experienced depreciations of their currencies against the USD. As such, the sector showed poorer performance towards the latter part of 2018 and the first half ofy 2019, than it has in previous years (Figure 3.9). Turkey, Russia, Iraq and Iran were Sri Lanka's top four export destinations in 2018.

[16] Forbes and Walker Tea Brokers. (2018). *Tea industry's performance in 2018 and prospects for 2019.* Retrieved from http://www.ft.lk/agriculture/Tea-industry-s-performance-in-2018-and-prospects-for-2019/31-669246

Figure 3.9
Tea Exports and Auction Prices



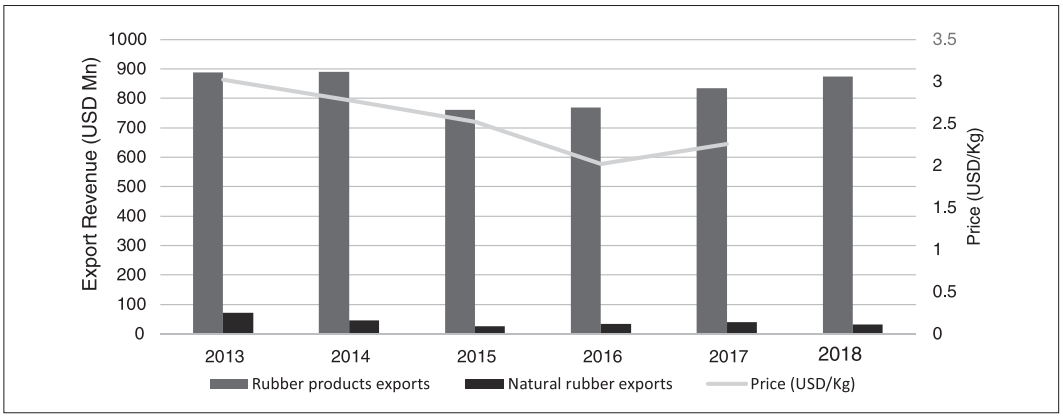
Source: Central Bank of Sri Lanka. (2018). Annual report. Colombo, Sri Lanka: Central Bank of Sri Lanka; Data from Tea Exporters Association Sri Lanka.

A recovery in global rubber prices in 2017 provided a boost to Sri Lanka's rubber products exports. The sector further grew by 4.8 per cent to USD 875 million in 2018 mainly due to improved performance in rubber tire exports (Figures 3.10). It is Sri Lanka's third largest export revenue contributor, accounting for 7 per cent of export earnings, and 9 per cent of industrial export earnings in 2018. The primary destination for Sri Lanka's rubber exports (rubber products and natural rubber) remains the US, with an export value of USD 274 million. Other major markets are Germany, Belgium, Italy and Canada.[17] Although the UK was a top market in previous years, it has fallen to eighth place in 2018. This is an indication that demand from the UK is gradually becoming strained – owing to political-economic turmoil surrounding Brexit – affecting key exports sectors in Sri Lanka such as T&G and rubber.

In sum, T&G, tea and rubber sectors have contributed nearly 20 per cent to total export earnings, and have consistently been Sri Lanka's leading export sectors in recent years. Moreover,

[17] Export Development Board. (2019). Export performance report. Retrieved from http://www.srilankabusiness.com/buyers/export-performance-report.html

Figure 3.10
Rubber Exports



Source: Central Bank of Sri Lanka. (2018). *Annual report. Colombo,* Sri Lanka: Central Bank of Sri Lanka; *External sector performance review-January 2019.* Colombo, Sri Lanka: Central Bank of Sri Lanka.

the momentum achieved in export performance in the country has been maintained in 2018 through to 2019. While this is encouraging in the short run, diversifying into alternative markets and products in the long run is becoming increasingly crucial, given the unfavourable conditions in key export markets, that have already been outlined in previous sections.

Of more concern is Sri Lanka's rising import bill, which is largely driven by intermediate goods imports. Expenditure on imports of intermediate goods accounted for 56 per cent of total imports expenditure, with a year-on-year increase of 9 per cent in 2018. Fuel is the largest import category, growing by 21 per cent to USD 4.1 billion in 2018. Aside from crude oil, Sri Lanka's imports of refined petroleum products grew due to the upturn in global oil prices and higher demand for domestic power generation. This is likely to be the case for 2019 as well, given the power shortages experienced so far in April 2019.

Sri Lanka had some room to relieve pressure on its import bill when oil prices dipped in 2015-2017 (Figure 3.11). However, crude oil prices have been on the rise throughout 2018, growing by 31.9 per cent to reach a level of 76.25 USD/ barrel in December 2018.[18] This is bad news for an energy import dependent country like Sri Lanka, facing a weak external reserves position and an exchange rate under pressure. The Organisation of Petroleum Exporting Countries (OPEC) and OPEC Plus (is a group of non-affiliated producers including Russia), cut supply in 2019 to halt a slump in prices that began in the second half of 2018, on the back of booming US production and fears of a global economic slowdown.[19] It is widely believed that oil prices will continue to rise in 2019 as the appetite for crude oil in emerging markets remains strong, despite financial contagion in many of these countries. Expectations of continued production cuts by the OPEC and US sanctions against Iran and Venezuela are also boosting prices.

[18] Central Bank of Sri Lanka. (2019). *Monthly economic indicators – February 2019.* Colombo, Sri Lanka: Central Bank of Sri Lanka.

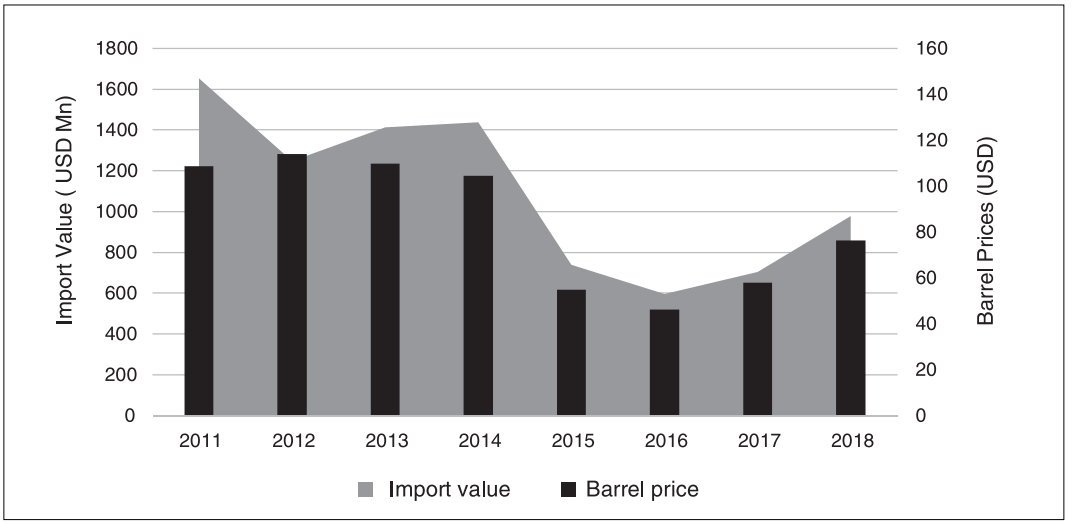
[19] CNBC. (2019). *US crude slips after setting new 2019 high.* Retrieved from https://www.cnbc.com/2019/03/18/oil-market-opec-supply-cuts-us-sanctions-in-focus.html

In response to growing import expenditures, the government implemented steps to curtail non-essential imports by way of increasing tariff and margin requirements, suspending the use of permits for vehicle imports, and reducing loan-to-value ratios.[20]

new products, as well as providing support for upgrading of technology, both of which are crucial in diversifying Sri Lanka's export basket.[21]

In addition, the Singapore-Sri Lanka Free Trade Agreement (SSLFTA) came into effect in May

Figure 3.11
Oil Imports and Global Prices



Source: Central Bank of Sri Lanka. (2018). *Annual report.* Colombo, Sri Lanka: Central Bank of Sri Lanka.

In summary, Sri Lanka's current trade position is treading on tricky waters due to an expanding trade deficit, despite moderate gains on the exports front. However, on a positive note, a supportive policy environment has developed post-2015 in terms of making concerted efforts to promote trade and investment. Institutional backing is being provided by the national export strategy (NES) which was implemented in September 2018, along with the 'National Innovation and Entrepreneurship Strategy 2018-2022'. These provide a framework for upgrading export competitiveness by identifying

2018; and more bilateral negotiations with Asian trade partners (China, India, Thailand) are underway with the objective of expanding Sri Lanka's presence in global value chains. To this end, a Trade Adjustment Programme (TAP) has also been developed to help firms face competition and smoothen out any adjustment burden on the economy. Further, as per the trade facilitation agreement (TFA) of the WTO, the trade information portal (TIP) was launched in July 2018, while the establishment of the national single window (NSW) is ongoing.

[20] Central Bank of Sri Lanka. (2018). *Annual report.* Colombo, Sri Lanka: Central Bank of Sri Lanka.

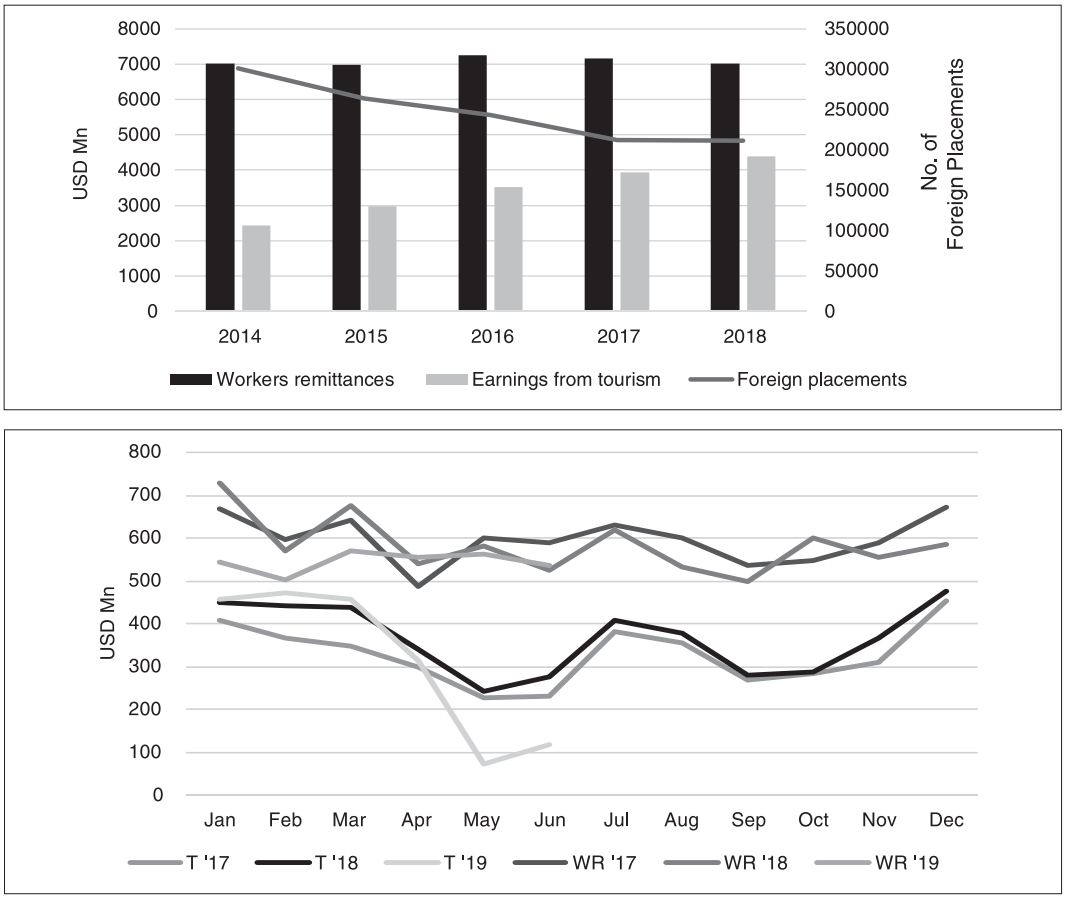
[21] Institute of Policy Studies of Sri Lanka. (2019). *Policies pave the way for Sri Lanka's economic transformation through technology.* Retrieved from http://www.ips.lk/talkingeconomics/2019/04/08/policies-pave-the-way-for-sri-lankas-economic-transformation-through-technology/

While these efforts at diversifying Sri Lanka's exports basket are the need of the hour, it is challenging for a heavily import dependent country like Sri Lanka to comfortably manage its exchange rate regime. To add to this, volatile conditions in the external environment create an additional source of vulnerability to a country such as Sri Lanka, that has a large stock of foreign debt and hefty medium-term debt repayment schedule.

3.4.2 Earnings from Tourism and Remittances

Earnings from tourism and worker remittances have been Sri Lanka's key sources of foreign exchange, outside of major export sectors such as T&G and tea. Earnings from tourism have grown steadily in recent years (Figures 3.12). However, remittances have declined in

Figure 3.12
Tourism Earnings, Worker Remittances and Foreign Employment



Source: Central Bank of Sri Lanka. (2018). *Annual report.* Colombo, Sri Lanka: Central Bank of Sri Lanka.
Note: T is Tourism earnings, WR is Worker Remittances.

2018 for the third consecutive year, confirming fears that the recent fluctuations in Sri Lanka's (once steady) remittance inflows are potentially on a downward trend. These movements are concerning given Sri Lanka's over-reliance on these sources for foreign exchange, in the context of severe pressure to build up reserves and service a large debt stock in the coming years.

The tourism sector suffered a severe blow on account of terror attacks that included targeting major hotels in Colombo in April 2019, leaving prospects for enhanced earnings dim, at least in the short run. The sector brought in earnings of USD 4.3 billion in 2018, a 11.6 per cent growth from 2017 (Figure 3.12). Tourist arrivals also picked up, growing by 10 per cent to reach 2.3 million arrivals in 2018. This is a vast improvement from the previous year, when arrivals grew by only 3 per cent and there were concerns that targets were not being met. This was owing to endorsements and accolades received from reputed international tourism organisations, aggressive promotional campaigns, and increases in investment in the industry, among other factors.[22] The 'So Sri Lanka' brand identity was launched in 2018, alongside other targeted promotional strategies. In addition, Sri Lanka was ranked 1st in the Lonely Planet's list of top travel destinations for 2019. All these efforts being culminated in the sector poised for a 'good year' in 2019; unfortunately, the loss in confidence in the country's security situation post-April attacks has resulted in a sharp drop in bookings. Reassuringly however, travel advisories have resumed to original status. Furthermore, Lonely Planet maintained that despite the events of April, Sri Lanka remains their top destination for travel in 2019.

Worker remittances on the other hand, have been experiencing fluctuations since 2015. Nevertheless, it is currently positioned well ahead of other top foreign exchange earners such as T&G and tourism, posting USD 7 billion in 2018 which amounts to 7.9 per cent of GDP. The number of foreign placements has also marginally declined year-on-year, but has dropped by 30 per cent between 2014 and 2018 (Figure 3.12). This is reflective of a number of external and internal factors affecting foreign employment. On the external front, geopolitical uncertainties in the Middle Eastern region – due to fluctuations in oil prices and sluggish global growth – have resulted in a moderation of migrant employment. In addition, structural changes to Sri Lanka's migrant stock have potentially impacted these fluctuations in earnings and placements. The government has been taking steps to upskill the migrant outflow, and in addition, the gender balance has been shifting away from female dominance towards a more male dominated migrant work force. While the former is expected to remit earnings to the family left behind, the latter may result in fewer remittances due to males migrating with their families.

Taking stock of both sectors, a short to medium term impact on foreign exchange earnings is likely to be experienced in Sri Lanka following the events of April 2019. The tourism industry, "despite once being well-positioned to continue its upward trend in foreign exchange earnings, is now likely to experience a temporary downfall, while international remittances, which was experiencing an incipient downward trend, is likely to experience a temporary upturn" in the aftermath of the attacks.[23]

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[22] Central Bank of Sri Lanka. (2018). *Annual repor*t. Colombo, Sri Lanka: Central Bank of Sri Lanka.

[23] Weeraratne, B. (2019). *Tourism vs. remittances: Impact of Easter attacks on Sri Lanka's foreign exchange earnings.* Retrieved from http://www.ips.lk/talkingeconomics/2019/05/23/tourism-vs-remittances-impact-of-easter-attacks-on-sri-lankas-foreign-exchange-earnings/

3.4.3 Capital Inflows: FDI and Capital Market Trends

Despite geographic and structural advantages, Sri Lanka has struggled to attract FDI inflows in recent years. Inflows have faced volatility due to the sensitivity of investor confidence on domestic issues. Although inflows increased in the aftermath of the war, and peaked in 2014, this was followed by a dip in 2015-2016. However, in 2017-2018, FDI inflows saw a resurgence; inflows peaked at USD 2.3 billion in 2018, growing by 38 per cent from 2017, surpassing the USD 2 billion mark for the first time.

However, these numbers are on the back of Hambantota Port transfer payments and telecommunication infrastructure, which drove the growth of FDI in Sri Lanka during the first half of 2018. The port terminals sub-sector (mainly the Hambantota Port) brought in USD 898.2 million in FDI from China in the first half of 2018. Alongside reasons to believe that these investments in high value infrastructure projects – including the Colombo Port City – will lead to stronger outflows in future, Sri Lanka must also attract FDIs from more diverse sectors.

Sri Lanka's FDI breakdown by sector shows that over the years, investments in the infrastructure sector have dominated (Figure 3.13). In 2018, infrastructure sector investments grew by 70 per cent from the previous year, for reasons discussed above. On the other hand, manufacturing and services sector investments have fluctuated over the years, but remained between a range of USD 250-350 million over the past five years. Attracting FDI into export-oriented manufacturing and services sectors is desirable to raise the competitiveness and efficiency of the economy, overall. More efficiency seeking investments rather than incentive seeking investments must be attracted, in order to maintain a sustainable inflow record. The Institute of Policy Studies of Sri Lanka (IPS), one of its study finds that the turnover of BOI manufacturing firms has been high between 2002-2016, due to concentration on incentive seeking investments in this period.[24]

China, Hong Kong, India, Malaysia and UK were the top five source countries of FDI inflows in 2018 (Figure 3.14). In recent years, FDI (excluding foreign loans) to Sri Lanka have been dominated by China, Singapore and India. Inward flows from China rose sharply to USD 872 million in 2018. Comparatively, growth in FDI from India, Singapore and Hong Kong have moderated in 2018.

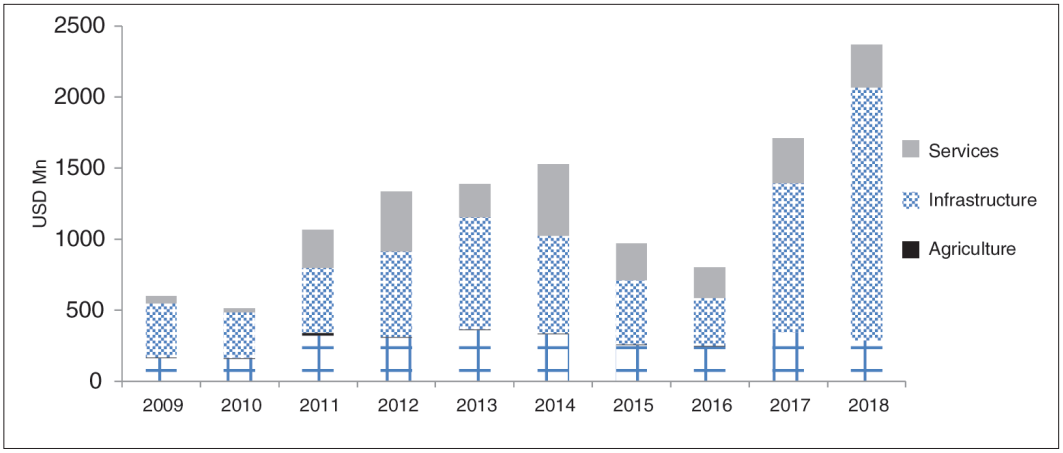
A policy thrust aimed at positioning Sri Lanka in global value chains through free trade agreements (FTAs) with regional partners, in order to encourage investments to the country from more diverse sectors and markets is underway. The SSLFTA which came into effect mid-2018, is expected to bring in investments from the Southeast Asian region. Furthermore, the government proposes to gradually phase out para-tariffs which can discourage manufacture-based investment flows in particular. While 1,200 para-tariff lines have been phased out in 2017, the Budget 2019 includes provisions to completely phase out almost all para-tariffs over a period of five years.[25] In addition, Sri Lanka climbed up 11 ranks in the ease of doing business index 2018.

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[24] Hewage, K. V., & Weerasekera, H. (2018). *Firm-level analysis of manufacturing sector investment in Sri Lanka.* Colombo, Sri Lanka: Institute of Policy Studies of Sri Lanka.

[25] Parliament of Sri Lanka. (2019). *Budget speech 2019.* Retrieved from https://www.parliament.lk/en/budget-2019/budget-speech-second-reading-of-the-appropriation-bill

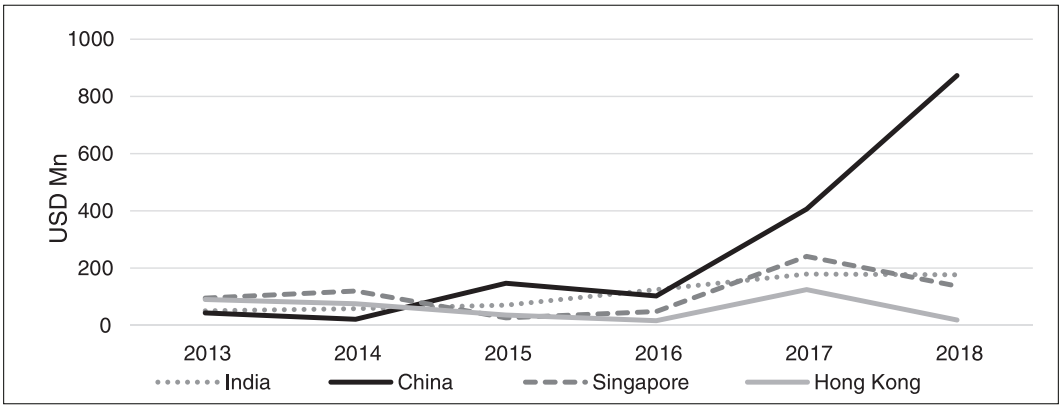
Figure 3.13
Annual FDI and FDI Composition



Source: Data obtained from the BOI.

Note: Includes loans, excludes inflows to non-BOI companies and direct investments in listed companies in the CSE.

Figure 3.14
FDI Inflows of Top Source Countries 2013-2018



Source: Central Bank of Sri Lanka. (2018). *Annual report.* Colombo, Sri Lanka: Central Bank of Sri Lanka.

Note: Excludes foreign loans to BOI companies.

On the downside, the political crisis in the latter part of 2018 resulted in heightened uncertainty affecting business and investor confidence. Moody's downgraded Sri Lanka's credit rating and outlook from stable to negative in November 2018, as the political crisis exacerbated refinancing risks, amidst tightening global financial conditions and concerns on Sri Lanka's low reserve adequacy. While the crisis was resolved in early 2019, such events have a negative impact in instilling positive investor sentiment for a country which is heavily dependent on external lender's willingness to refinance debt as well as invest in the country.

Moody's downgraded Sri Lanka's credit rating and outlook from stable to negative in November 2018, as the political crisis exacerbated refinancing risks.

Sri Lanka's capital market too experienced heavy outflows in 2018. This is a turnaround from a positive spell experienced in 2017, where foreign investment flows to the primary and secondary markets of the Colombo Stock Exchange (CSE) boomed, amounting to a net surplus of Rs. 20.5 billion. However, in 2018, net capital flows amounted to a deficit of Rs. 29.1 billion; it is noteworthy that of this, Rs.17.1 billion of the deficit was accounted for by the fourth quarter of 2018, when the political crisis took place.

Nevertheless, this deficit moderated in the first quarter of 2019 to Rs. 7.1 billion. In addition, net outflows from the government securities market too moderated in January 2019, compared to the second half of 2018.[26] Meanwhile, the government repaid the International Sovereign Bond (ISB) of USD 1 billion that matured in January 2019, and Sri Lanka issued fresh ISBs amounting to USD 2.4 billion in March 2019. The borrowed capital accounts for the bulk of Sri Lanka's capital inflows, which does not bode well in terms of having the necessary space for the country to mitigate external shocks.

3.5 Concluding Remarks: Sri Lanka's Positioning

Sri Lanka is already a straggler in regional economic growth. To add to this mix, it is a heavily indebted country facing unprecedented levels of foreign debt settlements over the next few years, and where its "economic fortunes have also come to be intimately intertwined with competing regional and global geo-political interests".[27] In the absence of adequate foreign

[26] Central Bank of Sri Lanka. (2019). *External sector performance review-January 2019.* Colombo, Sri Lanka: Central Bank of Sri Lanka.

[27] Weerakoon, D. (2019). *Counting the cost: Terrorism and its impact on the Sri Lankan economy.* Retrieved from http://www.ips.lk/talkingeconomics/2019/05/06/counting-the-cost-terrorism-and-its-impact-on-the-sri-lankan-economy/

Box 3.1
Colombo Port City

Port City, Colombo (PCC) is Sri Lanka's flagship project featuring in China's Belt and Road Initiative (BRI). Leveraging on the country's strategic positioning in the Indian Ocean, it is envisioned that the PCC will be a city linking Asia and the West, positioned in the epicenter of the South Asian region. With the reclamation of the land completed in 2019 at a cost of USD 1.4 billion as FDI, the PCC is now expected to begin generating USD 15 billion investments to create a city that will host a city population of 250,000 and 83,000 new jobs.

A temporary halt of the PCC project in 2015, coupled with fears of environmental harm surrounding the project's marine structures, led to concern among the public and policymakers alike, on the project's progress and viability. It has also been erroneously included into the debate on China's debt trap diplomacy. Keeping these misconceptions aside, the project has the potential to generate positive economic spillovers, if key phases of the project are correctly prioritised and timed. However, a negative investor outlook – due to mixed publicity on the project, uncertainties generated by political instability in October 2018 and the April 2019 terror attacks – just as the project completed its land reclamation and readied for investor promotion, has not helped.

Additionally, more project feasibility and demand assessments need to be done to assure investors of financial returns that in turn mitigate downside risks of high construction costs. Overall, getting the PCC completed over a time span of 25 years will pose significant challenges, with considerable implications for the absorptive capacity and its impacts on the domestic economy. Nevertheless, leveraging on the potential for the project in creating high value jobs, gaining technology transfers from foreign companies, and creating increased tourist activity, will be key. These outcomes will be heavily dependent on political leadership, and as to whether appropriate priority areas that can generate economic value are rolled out in the most efficient manner.

Source: China Harbor Engineering Company. (2019). Port City Colombo Masterplan

financing, Sri Lanka, like many other developing countries is increasing engagements in China's ambitious BRI project. This comes with its own set of challenges for the country, as Sri Lanka's historic ties to India comes under pressure with country's seeming 'tilt' towards China. Although the government expressed intentions in 2015 to 'rebalance' international relations among competing geopolitical interests in the Indian ocean, not much has changed since. Economic relations with China continue to flourish; it overtook Japan to become the country's largest bilateral source of development finance, and is close to overtaking India as the country's largest source of imports and tourist arrivals. As discussed in previous sections, China is also Sri Lanka's largest source of FDI. Having said this, relations with the West and India have improved, which manifested in the reinstatement of EU GSP Plus, grant funds received from the US Millennium Challenge Corporation (MCC) and short-term swap arrangements from the Reserve Bank of India (RBI) in times of stress on Sri Lanka's foreign reserves.

Against this backdrop, engagements with regional neighbours through FTAs are being negotiated as a strategy to move away from dependency on Western markets and to 'piggyback' on Asian economic prowess. Negotiations with China and India continue, with more recent initiation of talks with Thailand and Malaysia. However, in the short run, Sri Lanka continues to draw the same type of investments into infrastructure, export low-value goods, and rely on economies that are facing a degree of volatility as its key sources of export markets and foreign capital. The faster these aspects – FDI, exports, export markets – are diversified, the faster will be a steadier flow of earnings that can better cushion the Sri Lankan economy from unfavorable external conditions. The need for this is more pressing than ever, given the high-risk trade outlook, increasing protectionist rhetoric and burgeoning oil prices facing the global economy.

TRANSFORMING SRI LANKA'S ECONOMY IN THE FOURTH INDUSTRIAL REVOLUTION (4IR)

4. Gearing Up for the Fourth Industrial Revolution (4IR)

4.1 Introduction

Technological evolution and transformation has become a cornerstone in human interactions across spectrums, be it economic, social, cultural, or otherwise. The first industrial revolution of the mid-18th century transformed the manufacturing process. The second industrial revolution in the late 19th and 20th centuries, commonly known as the 'Technological Revolution', created significant changes in the economic and social dynamics within communities and critically, across borders. The third industrial revolution, which was based on digitisation during the mid-20th century, ushered in the era of computerisation and digital space.

Similar to its predecessors, the fourth industrial revolution (4IR) too is also expected to make notable changes to the way people work and live. However, unlike other industrial revolutions, 4IR technologies are significantly more invasive, complex, and evolve rapidly. There is some debate on the exact scope, pace, and dynamics of the 4IR. Yet, the tangible changes to social and economic structures already taking place in developed and developing countries alike are observable.

Against this backdrop, the importance of the 4IR and Sri Lanka's preparedness for it are also gaining growing interest. Popular measures of preparedness are innovation and digital readiness, which are complemented by factors influencing economic readiness such as infrastructure, human capital, and economic agility. Sri Lanka's performance in these areas, benchmarked against competitor economies, will prove to be vital if the country is to successfully leverage the 4IR for a rapid transformation of its economy and society. This chapter therefore aims to provide an overview of the 4IR, discuss competing narratives on the topic, and proceed to detail its current dynamics and influences on existing socio-economic structures and policy responses in both developed and developing countries. The chapter in its conclusion aims to lay the framework to assess Sri Lanka's readiness to face the 4IR as detailed in subsequent chapters of this report.

4.2 What is the 4IR?

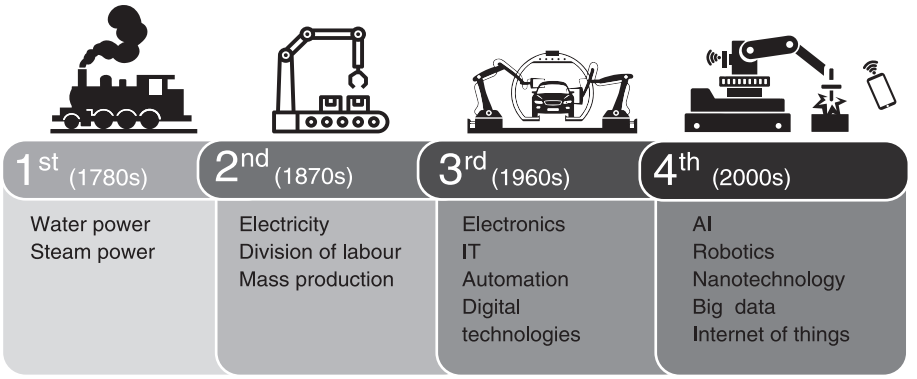
Technological innovation has historically been the fundamental catalyst for industrial revolutions. During the 18th and 19th centuries in Europe and North America, the innovation of the water wheel and steam engine led to the first industrial revolution that led to rapid urbanisation and industrialisation in societies were previously agrarian and rural. Similarly, the introduction of electricity and the internal combustion engine led to the mass mechanisation of the industrial process during the second industrial

revolution between 1870 and 1914. Likewise, the third industrial revolution, was driven by the advancement of technology that transformed economies and societies from analog electronic and mechanical devices to digital technologies in the 1980s.

Building on its predecessors, the 4IR is introducing significant advancements in technology, such as the internet of things (IoT), intelligent robots, and neuro-technological brain enhancements. Effectively, the 4IR is a conflation of different technologies that is bringing about change in multiple spheres at the same time. In doing so, 4IR is argued to "blur the lines between the physical, digital, and biological spheres".[1]

Whereas the first three industrial revolutions occurred with a gap close to a century between them, the fourth is taking place only a few decades since the third.

Figure 4.1
Evolution of Industrial Revolutions



Source: Schwab, K. (2015). *The fourth industrial revolution: What it means and how to respond.* Foreign Affairs. Geneva, Switzerland: World Economic Forum.

The thrust of the 4IR and its distinctiveness from the third industrial revolution is in its speed of transformation and scope of impact. Whereas the first three industrial revolutions occurred with a gap close to a century between them, the fourth is taking place only a few decades since the third. This is mainly due to the unprecedented rate at which innovation and technological transformation is taking place. Secondly, whilst the 4IR revolves around the transformation of manufacturing processes, its impacts and uses are much wider in scope.

[1] Schwab, K. (2015). *The fourth industrial revolution: What it means and how to respond*. Foreign Affairs. Geneva, Switzerland: World Economic Forum.

Amidst these dynamics, however, developing economies in particular struggle to fully embrace or generate the required capacity to effectively prepare for the economic and social disruptions that will occur due to the 4IR. For instance, the second industrial revolution is yet to be experienced by nearly 1.3 billion people (or 17 per cent of the population) due to the lack of access to electricity. Similarly, more than a half of the world's population lacks access to the internet and therefore are yet to fully experience the fourth industrial revolution. That said, emerging technologies appear to diffuse at a much faster rate and more widely than previous ones. This is due to the growing integration of different discoveries and disciplines that are taking place through 4IR. As a result, the 4IR has the potential to allow developing economies to circumvent the linear model of technological transformation and catch up on rapid development.

4.2.1 What Technologies are Driving the 4IR?

The 4IR is best conceptualised through the technologies that are at the forefront of the revolution. *Artificial intelligence* (AI) is arguably the foremost technology; it enables computers to 'think' like humans, aside from its use in many different fields such as in the identification of mega trends in large volumes of data, to simple functions such as autocorrect on mobile phones. New computational technologies such as *quantum computing* can supercharge AI and make computers a million times more powerful. The creation of technologies that can sort through highly complex data models in seconds and lead to even further scientific discoveries and socio-economic impacts hold profound implications.

Another innovation of AI and associated technological developments is *blockchain;* a secure, decentralised, and transparent means of recording and sharing technology. While blockchain is popularly associated with cryptocurrencies such as Bitcoin, it is being used to trace supply chains in agricultural and manufacturing processes, secure medical data anonymously, combat voter fraud, and even improve the efficiency linkages within bureaucracies. For instance, blockchain-based initiatives are helping to distribute humanitarian aid,[2] and provide digital identities for displaced refugees.[3]

In "combining the digital, physical, and biological worlds",[4] through the development of *biotechnology*, 4IR helps harness cellular and biomolecular processes to develop new technologies and materials. These technologies and materials are being used to develop new pharmaceuticals, more efficient industrial manufacturing processes, and cleaner and greener energy sources.[5] The development of what is considered as the strongest biomaterial ever for instance,[6] along with other innovative

[2] World Food Programme. (2017). *Blockchain against hunger: Harnessing technology in support of Syrian refugees.* Retrieved from https://www.wfp.org/news/news-release/blockchain-against-hunger-harnessing-technology-support-syrian-refugees

[3] Allen, Mathew. (2018). *Swiss blockchain platform gives Rohingya identities.* Retrieved from https://www.swissinfo.ch/eng/politics/refugee-crisis_swiss-blockchain-platform-gives-rohingya-identities/44020630

[4] Schwab, K. (2015). *The fourth industrial revolution: What it means and how to respond.* Foreign Affairs. Geneva, Switzerland: World Economic Forum.

[5] McGinnis, Devon. (2018). *What is the fourth industrial revolution?* Retrieved from https://www.salesforce.com/blog/2018/12/what-is-the-fourth-industrial-revolution-4IR.html

[6] Mittal, N., Ansari, F., Gowda, V. K., Brouzet, C., Chen, P., Larsson, P.T.,… Söderberg, L.D. (2018). *Multiscale control of nanocellulose assembly: Transferring remarkable nanoscale fibril mechanics to macroscale fibers,* May 2018. ACS Nano, *12*(7), 6378 – 6388.

materials such as plastics and metal alloys, is starting to revolutionise entire sectors, including manufacturing, construction, and health care.

Each of these advancements are complemented by developments in ancillary technologies that are enabling more people to gain access and reap the benefits. The *IoT*, for example, is the concept of everyday items being connected to the internet and be recognisable by other items. This expands traditional two-dimensional interactions between humans and devices (humans-humans and humans-devices) to also include interactions between devices, whilst also opening up the possibility of simultaneous three-dimensional interactions (human-device-device). Some estimates suggest that there will be 26 billion connected devices by 2020.[7] The IoT effectively opens up endless opportunities for better transportation networks, or 'smart cities' to reduce waste and improve energy, amongst others.

Other 4IR technologies include 3D printing, virtual reality, robotics, and energy capture. *3D printing* has completely transformed the traditional manufacturing process by allowing firms to print their own accessories with less tooling, at a lower cost, and faster pace. This means a shift in the concept of international trade and supply chains, since the necessity for parts and components to be traded across borders might become redundant. *Virtual reality* (VR) meanwhile offers immersive experiences while *augmented reality* (AR) mergers the digital and physical spheres. These technologies are used in sectors such as education and health care, where realistic experiences can improve outcomes for the user (e.g. students and doctors during surgeries). Finally, the technologies discussed above have facilitated advancements in *robotics* and robots have become increasingly sophisticated. Robots are increasingly used in manufacturing, health and safety, disaster relief, and human assistance, with attempts, for instance, to develop a humanoid bot that can navigate through an industrial disaster area.[8]

4.3 Impacts of the 4IR

This section briefly discusses some key socio-economic areas that are expected to be influenced and consequently transformed through the 4IR.

4.3.1 Future of Production

Technology and innovation have been central in influencing the evolution and transformation of production processes. Over the past 20 years, for instance, worker productivity in the US across industries is estimated to have increased by 47 per cent, driven primarily by technology adoption and innovation.[9] Therefore, it is unsurprising that production processes are set to undergo a paradigm shift during the 4IR and add significant value to global manufacturing. Whilst it is difficult to ascertain the exact scale and form of these changes, the future of production is expected to be influenced by three technological megatrends: connectivity, intelligence and flexible automation.

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7 Gartner. (2017). *Leading the IoT: Gartner insights on how to lead in a connected world.* Connecticut: Gartner, Inc.

8 Houser, K. (2018). This robot superhero could be the future of disaster relief operations. Retrieved from https://www.weforum.org/agenda/2018/03/a-six-foot-tall-humanoid-robot-could-come-to-your-rescue-during-a-disaster

9 US Bureau of Labour Statistics. (2017). *Manufacturing sector: Real output (OUTMS)-November 2017.* Federal Reserve Bank of St Louis. Washington D.C.: US Bureau of Labour Statistics.

With several companies in the technology industry working on close to 700 IoT platforms for industrial use, and major telecom companies investing in hyper-scalable IoT platforms, connectivity in production is being strengthened.[10] With AI, advances in computing power and the availability of big data are allowing machine learning algorithms to excel, even though the full potential of AI is yet to be realised due to the underutilisation of data. The production process, therefore, could take on functions which are far beyond the current capacities of human intervention and existing computer technologies. Finally, the potential for flexible automation is high given that only 60 per cent of all manufacturing tasks thus far are estimated to be carried out through automation. The use of automation in developing economies is even less.

By combining these three technologies, radical shifts in production are expected in the short to medium term. Amidst these opportunities, however, estimates suggest that fewer than 30 per cent of manufacturing companies in developed countries are actively rolling out 4IR technologies at scale. Many have been piloting such technology for extended periods of time and do not take the decision to scale up its use. This is also referred to as 'pilot purgatory'. The transformation of production systems will face even bigger challenges at the global scale, with as many as 90 per cent of countries in Latin America, Africa, Middle East, and Eurasia categorised as those least ready for the future of production.[11]

With AI, advances in computing power and the availability of big data are allowing machine learning algorithms to excel, even though the full potential of AI is yet to be realised due to the underutilisation of data.

[10] World Economic Forum. (2018). *The next economic growth engine: Scaling fourth industrial revolution technologies in production.* White Paper. Retrieved from http://www3.weforum.org/docs/WEF_Technology_and_Innovation_The_Next_Economic_Growth_Engine.pdf

[11] World Economic Forum. (2018). *Readiness for the future of production report 2018.* Insight Report. Retrieved from http://www3.weforum.org/docs/FOP_Readiness_Report_2018.pdf

4.3.2 Future of Work

Disruptive shifts in the production process due to the 4IR have undoubted consequences on the future of work as well, with significant job creation and job displacement. Similarly, labour productivity will rise while at the same time many countries face a widening skills gap. Historically, labour-saving technology, combined with globalisation, has led to the displacement of jobs in the manufacturing sector, especially in developed economies. This trend appears to hold with technologies of the 4IR as well. Almost a half of American workers are predicted to face risks of their jobs being automated by 2030.[12] Developing countries too will be affected by these changes, as the demand for manufacturing jobs in emerging economies will reduce with the increase of automation in developed economies. This is particularly worrisome as youth unemployment is rapidly increasing in emerging economies with the likes of India and China required to create jobs for nearly half a billion youth during the next 15 years.[13]

Crucially, unlike its predecessors, job displacements associated with the 4IR are not exclusively related to low-skilled manufacturing sector work. It will also have impacts on high-skilled professions such as financial analysts, paralegals, lawyers, and tax experts. For instance, owing to complex algorithms and automation, financial firms find that four traders can be replaced with one computer engineer.[14] That said, whilst technology will undoubtedly lead to job displacement, it will simultaneously lead to job creation as well – often in new professions – aligned with emerging modern technologies such as AI, IoT, social media, and cyber security. In fact, some studies predict that as much as 56 per cent of new jobs created will be in brand-new professions.[15]

The rate of change in the labour markets, both in advanced and emerging economies, is dependent heavily upon the rate of technological advancement as well as other factors such as the ease of commercialisation, public adoption of new technologies, and existing labour laws. Routine-based, middle-skilled, white-collar job roles such as data entry clerks, accounting and payroll clerks, secretaries, auditors, and cashiers are among the most vulnerable. It should be noted, however, that these trends are not universally applicable. Variations are likely to occur across industries as well as across regions, and levels of economic and technological advancement. As such, it is vital that countries 'future-proof' their labour markets by equipping the future labour force with relevant skills through educational reforms and means of reskilling employees that may experience disruptions to their labour force participation.

4.3.3 Future of Education

Education is a key element in determining the success or failure of the 4IR, by minimising disruptions to job markets via improved mobility and better productivity. Therefore, an educational system that is geared to future requirements can mitigate impacts of the productivity paradox – the

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[12] Frey, C.B., & Osborne, M. A. (2013). *The future of employment: How susceptible are jobs to computerisation?*. Retrieved from https://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

[13] World Bank. (2013). *World development report 2013: Jobs.* Washington D.C.: World Bank.

[14] Byrnes, N. (2017). *As goldman embraces automation, even the masters of the universe are threatened.* MIT Technology Review.

[15] Lund, S., & Manyika, J. (2017). *Five lessons from history on AI, automation, and employment.* Retrieved from https://www.mckinsey.com/featured-insights/future-of-work/five-lessons-from-history-on-ai-automation-and-employment

time lag between technological innovation and productivity gains.[16] The foremost priorities in this regard are to equip workers with the required skill set to join the labour force during a period in which technological innovations will transform economic and production systems at a rapid pace. Estimates suggest that a third of the skill sets required to perform today's jobs will be wholly new by 2020.[17]

Skills that will be important for the 4IR are inter-alia complex problem-solving, high-level technical skills, and social skills. Therefore, countries are beginning to support the development of 'innovative learning ecosystems', alongside a larger focus on science, technology, engineering and mathematics (STEM) education. Overall, however, very few countries appear to be adequately preparing students for automation. Middle-income countries, especially in South and Southeast Asia, are particularly vulnerable due to shortcomings in basic skills education. Whilst low-income countries are also likely to be affected, they will be affected less by automation than their middle-income counterparts.[18]

4.3.4 Future of Migration and Urbanisation

As in the past, the 4IR will have significant impacts on human mobility and vice versa. Migrant entrepreneurs were at the forefront of technological innovation in the third industrial revolution. Similarly, migrants will form an essential and expanding market for 4IR technologies, due to their mobility and transnational perspectives.

Middle-income countries, especially in South and Southeast Asia, are particularly vulnerable due to shortcomings in basic skills education. Whilst low-income countries are also likely to be affected, they will be affected less by automation than their middle-income counterparts.

[16] Penprase, B. E. (2018). The fourth industrial revolution and higher education. In N.W. Gleason (Ed.), *Higher education in the era of the fourth industrial revolution.* Springer, 207-229.

[17] World Economic Forum. (2017). *Realising human potential in the fourth industrial revolution.* White Paper. Geneva, Switzerland: World Economic Forum.

[18] The Economist Intelligence Unit. (2018). *The automation readiness index.* The Economist.

However, there is also a likelihood of low-skilled migrant labour being displaced through automation. Historically, disruptions to the labour market due to technology has led to some scepticism about the benefits of migration. The advent of populism in advanced economies in recent times (e.g. election of Donald Trump and Brexit) are symptoms of this backlash. Such sentiments can gain a stronger foothold if the disruptions of 4IR to the labour market are not managed adequately.

The influences of 4IR on migration, however, are not limited to expected consequences and experiences of past industrial revolutions. In fact, 4IR technologies have the potential to influence factors beyond production, in areas such as migrant management and border control, directing migration flows, and facilitating migrant integration. In fact, governments and international organisations are increasingly utilising drone technology for border control and humanitarian action. For instance, the use of lightweight drones equipped with facial recognition capabilities is proposed as a much more efficient and cost effective alternative to building a border wall in the US.[19] Similarly, drones with video, infrared sensors, and chemical detection are being deployed to provide data on migrant flows and facilitate rescue missions of migrants in the Mediterranean Sea.[20] Moreover, AI can be used to gain insights on migration patterns and trends much better, helping countries to identify skills gaps that economic migrants and refugees can fill, to successfully integrate into the host country.

In addition, 4IR technologies can also have profound impacts in building smart and resilient infrastructure and services in cities as urban migration grows. Singapore is already using the concept of 'agile cities' to accommodate flexible planning laws, and the first country to allow autonomous (driver-less) taxis. Dubai is fast becoming one of the early movers in the 4IR. Its vision is to become the 'happiest city on earth' by improving city services by utilising 4IR technologies. 'Smart Dubai' has mobilised all sectors in the city administration, involving 30 government entities and selected private sector organisations, to design digital services that enhance and optimise the city's administration. The goal to is to become the first city on blockchain by 2020.[21]

These 4IR technologies also provide opportunities to negate the necessity for migration, either internal or across borders. Given the IoT, combined with technologies such as virtual reality and robotics, an employee could potentially fulfil all their duties remotely from home rather than migrating or travelling to an office. Already, the installation of fibre optics along with robotic technology has allowed medical professionals to conduct remote surgery from distances as far as 400kms away.[22] Such developments depend heavily on the technological infrastructure of a country and accompanying labour law reforms. Developing countries with significant gaps in internet connectivity between rural and urban areas, and archaic labour laws that do not facilitate flexible work options will fail to leverage such technologies.

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[19] Biryukov, N. (2017). *Department of homeland security flooded with bids to build border drones.* Retrieved from https://www.nbcnews.com/news/us-news/department-homeland-security-flooded-bids-build-border-drones-n754071

[20] Scammel, R. (2016). *How 150,000 people were saved in the Mediterranean*. Retrieved from http://www.thenewhumanitarian.org/analysis/2016/01/07/how-150000-people-were-saved-mediterranean

[21] Smart Dubai. (2019). *Initiatives.* Retrieved from https://www.smartdubai.ae/

[22] Eveleth, R. (2014). *The surgeon who operates from 400km away.* Retrieved from http://www.bbc.com/future/story/20140516-i-operate-on-people-400km-away

4.3.5 Future of Gender Equality

Existing structural constraints will be one of the biggest determinants of any adverse impacts on gender equality as a consequence of the 4IR. As noted in previous sections of this chapter, a majority of new employment created through the 4IR will be STEM related. However, STEM education among females has been low albeit with a gradual increase, due to structural barriers to entry, especially in developing economies. This consequently translates to low levels of female labour force participation in STEM related employment as well. Moreover, sectors in which most female labour force participation takes place are those that are at more risk of being disrupted. As such, under current conditions, women may be disproportionately impacted negatively through disruptions to labour markets during the 4IR.

Some estimates suggest that where women lose five jobs for every job gained due to 4IR, men will lose three jobs for every job gained.[23] This can be of some concern for economies such as Sri Lanka where women account for a significant majority of jobs in the textile and garments sector. The International Labour Organisation (ILO) estimates that as much as 80 per cent of garment, textile, and manufacturing jobs in Asian economies could be lost as 'sewbots' replace humans.[24]

With the 4IR, more people are expected to shift from long-term contract-based employment to one-off contracts for highly specified services (the gig economy). The rise of the gig economy has gender implications as well, due to women's disproportionate participation in non-standard forms of employment and self-employment. The growth of online platforms could potentially improve access to employment for women, who face structural barriers to enter formal employment. But yet, as discussed earlier, this could also lead to the erosion of safety nets and benefits such as paid maternity leave that are not available in the gig economy.[25]

A widening technology gap could further exacerbate gender disparities. For instance, it is estimated that women are 10 per cent less likely than men to own a mobile phone, which translates to 184 million fewer women owning mobile phones than men.[26] Even amongst mobile owners in low and middle-income countries, women are 18 per cent less likely than men to use transformational services such as mobile internet. This further demonstrates that the negative implications of the 4IR on gender are based more on existing structural barriers rather than something exclusive to the nature or technology associated with the industrial revolution. Therefore, immediate policy changes that address structural inequalities are paramount to enable women to fully leverage the benefits of the 4IR.

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[23] World Economic Forum. (2017). *Accelerating gender parity in the fourth industrial revolution.* White Paper. Geneva, Switzerland: World Economic Forum.

[24] International Labour Organisation. (2019). *The future of work in textiles, clothing, leather, and footwear.* Working Paper No. 26. Geneva, Switzerland: International Labour Organisation.

[25] Organisation for Economic Co-operation and Development. (2017). *Going digital: The future of work for women, policy brief on the future of work.* Retrieved from https://www.oecd.org/employment/Going-Digital-the-Future-of-Work-for-Women.pdf.

[26] GSMA. (2018). *The mobile gender gap report 2018.* Retrieved from https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2018/04/GSMA_The_Mobile_Gender_Gap_Report_2018_32pp_WEBv7.pdf

4.3.6 Future of Health

Health care is arguably one of the sectors that will experience the most significant transformations due to the 4IR. Among a plethora of potential benefits, 4IR is likely to transform disease management outcomes by effectively embedding them into a patient's daily life. As non-communicable diseases (NCDs) spread, the IoT for instance, enables devices with sensors to be interconnected in a way that enhances patient monitoring and help physicians in disease management. For example, a patient with a respiratory disease could have sensors embedded in household objects which can identify when breathing is laboured and remind the respective patient to take necessary precautions (e.g. using an inhaler).

Another potential outcome is the widespread use of precision health care; tailoring treatments to individuals to improve outcomes while reducing costs. The health sector is also benefitting immensely from technological innovations that appeared in other sectors, such as 3D printing. In recent years, the medical sector has succeeded in using 3D printed prosthetics, skin for burn victims, and airway splints for babies that are designed to grow with the patient, etc. 3D printing has also seen the creation of a 'poly-pill' – a single capsule that can house multiple drugs at once, with its own release time. The ability to use 3D printing in this way not only helps with higher levels of precision being created for a patient, but also reduces the cost. As the cost of 3D printing technology reduces further through economies of scale, health care costs can also be reduced with its use.

Finally, one of the most significant, albeit controversial developments in medical innovation is the development of gene editing. Commonly referred by its acronym, Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) is a technology that allows scientists to edit genes of living cells and considered the most revolutionary technology in medicine today. The CRISPR has been used to eliminate malaria in new mosquito strains and develop an antibiotic to selectively target super-resistant bugs. It has the potential to be used for several other purposes such as curing genetic diseases, detecting and treating cancers, bioengineering new plants and crops, and treating HIV by blocking replication in human cells. However, the technology is also garnering controversy on issues such as 'gene edited babies', throwing up a critical aspect of the 4IR and its impacts, in regards to ethics and moral limits.[27]

4.3.7 Future of Agriculture

An 'agri renaissance' of higher yields, reduced costs, and higher nutritional value of foods is a much anticipated outcome of the 4IR related smart technologies. The focus is also on ensuring a sustainable form of agriculture as traditional means of agricultural growth places a higher burden on natural resources in a country. Moreover, the necessity to transform is heightened due to growing concerns regarding food security around the world. The agricultural sector, however, has been slow to benefit from technological developments compared to other sectors, especially due to accessibility constraints.

Fragmented rural markets, poor infrastructure, and regulatory burdens place high costs while revenues are constrained by sensitive consumer preferences. As a result, there is limited investment of new technology in the agricultural sector. Yet,

[27] Belluck, P. (2019). *Gene-edited babies: What a Chinese scientist told an American mentor.* Retrieved from https://www.nytimes.com/2019/04/14/health/gene-editing-babies.html

large-scale change is possible through emerging 4IR technologies such as digital building blocks (e.g. big data, IoT, blockchain), new physical systems (e.g. autonomous vehicles, advanced robotics, nanotechnology), and advances in sciences (e.g. genomics, next generation biotechnologies, new energy technologies). These changes can occur both from a demand perspective as well as in terms of improving supply side value chains.

For instance, food-sensing technologies to improve the identification of food quality, safety, and traceability can significantly lower food waste, supported by blockchain technology and the IoT on the supply side that can improve traceability and transparency. Similarly, big data and advanced analytics can improve farmers' decisions and protect crops from oversupply.[28] Developing countries are currently facing a shift in employment from the agricultural sector to manufacturing and services. Therefore, the automation of vehicles and equipment would be beneficial to a sector that may have an undersupply of labour in the future.

Both the government and private sector of countries such as South Korea, Australia, Ireland, Thailand, and others, are pursuing "smart farming" techniques. But a significant majority of these new technological innovations and implementation in the agricultural sector are taking place in advanced economies. As a result, developing countries could potentially be left behind in a new agricultural revolution that takes place alongside the 4IR. This would significantly increase existing inequalities between countries. Developing nations, therefore, should focus on integrating existing technologies to the agricultural process with a vision towards encouraging the application of scalable modern technology.

4.3.8 Future of the Environment

4IR technologies can improve the management and governance of the environment while facilitating the systems changes that are required to create clean, resource-secure, and inclusive economies. At the most basic level, the efficiency gains in production and resource allocation can yield benefits by way of reduced carbon emissions and resource drain through the production cycle. The potential benefits of 4IR technology, however, extend beyond that. The ability to access and analyse data is critical in identifying causes, effects, and solutions to create climate change mitigation and adaptation strategies. Therefore, big data can help identify harmful emissions and pressure points in a supply chain. Trase, for example, is a platform that "follows trade flows to identify sourcing regions, profile supply chain risk, and assess opportunities for sustainable production." [29]

Similarly, high-tech sensors are being introduced to monitor climate change patterns; networked cameras monitor changes in vegetation; lasers track carbon flow in coastal redwood forests; and environmental sensors monitor microclimates experienced in different habitats. These allow for a better understanding of contributing factors and improve predictive powers of climate change effects on ecosystems. At the same time, blockchain technology not only helps improve the visibility of supply chains, it also decentralises resource management and addresses information asymmetries that curtail effective implementation of policies. Many of

[28] Food and Agriculture Organisation. (2019). *E-agriculture in action: Blockchain for agriculture.* Geneva, Switzerland: Food and Agriculture Organisation and International Telecommunication Union.

[29] Trase. (2019). *Transparent supply chains for sustainable economies*. Retrieved from https://trase.earth/?lang=en

these technologies are yet to be fully operational and are still at a trial stage or recently introduced, as has been highlighted in other sectors as well, Even then, these are focussed almost exclusively in developed economies. However, it is developing countries that are expected to suffer most from climate change related disasters.

4.4 Policy Challenges for Developing Economies

Even though some technologies are still at a nascent stage, several countries, both developed and developing, are taking initiatives to prepare for the 4IR. This is particularly important due to the exponential pace at which technology is being developed and adopted in different spheres. Governments, therefore, need to be proactive rather than reactive in policymaking for the 4IR. These policies include steps to facilitate the development and adoption of technology whilst at the same time preparing the socio-economic sphere for the impacts of technological disruption.

The 4IR technological adoption is fast paced and mainly concentrated in developed economies. That said, developing countries need to be proactive in investing in leading or at least preparing for the digital transformation. Failure to do so could potentially lead to certain technologies being too overwhelming to adopt and adapt to, leading to countries being left behind in the development process. Developing countries, therefore, are required to address both existing structural reforms as well as pre-emptive policymaking. On structural factors, low access to electricity and the internet, low computer literacy rates, and low levels of labour mobility are issues that require urgent attention.

Meanwhile, the mobilisation of cheap labour is arguably one of the biggest comparative advantages of many developing countries. However, the 4IR is likely to displace jobs mostly in these sectors. Therefore, developing countries will have to focus on reforms to its educational and training systems, from primary to tertiary and vocational, to ensure that the labour force can adequately respond to any displacement that may occur. Successfully transitioning to a 'knowledge economy' requires a greater focus on Science, Technology, and Innovation (STI) policies. Not only does this require an environment that facilitates investment in research and development, but also one that mitigates factors such as 'brain drain'.

Developing countries, therefore, are required to address both existing structural reforms as well as pre-emptive policymaking.

Among emerging Asian economies, Thailand is one of the leaders in responding to the 4IR, in large part to its already high level of industrial growth. In 2016, Thailand launched its 4.0 strategy, which sets out to develop high-value added industries that includes the development of technology clusters and start-ups around 4IR technologies. The strategy is already paying dividends with Thailand currently hosting four robotics research centres and exporting more than 2,500 multipurpose industrial robots.[30] Similarly, Indonesia also launched its 4IR-oriented strategy, focussing on five sectors: food and drinks, automotive, textile, electronics, and chemicals. Further, the Philippines introduced its Inclusive Innovation Industrial Strategy (i3S) in 2017 that is focussed on educational reforms to align with industry 4.0 requirements, enhancing faculty training on innovation and entrepreneurship, and government subsidies for university research and extension.[31] As evidenced by these policies, the focus is not exclusively on responding and adapting to technologies that are developed in advanced economies, but rather to create an enabling ecosystem to catalyse technological innovation and transformation from within.

Policy responses will be heavily influenced by 'agile governance'. Companies are routinely introducing new products and services, which require governments to recognise, measure, and mitigate their potential negative impacts. Concurrently, citizens are demanding more responsibility and proactive policies from the private sector as well, especially in regards to ethics in digital industries. Therefore, policymaking in the era of the 4IR requires 'agile governance' – which recognises that policy development is no longer exclusively limited to governments, but rather a multi-stakeholder effort. The key attributes of agile governance are threefold: (i) focussed on achieving policy goals rather than box-ticking regulatory requirements; (ii) open to elements such as data-driven government and pilot programmes and adjusting goals accordingly; and (iii) open to inputs from a wider group of stakeholders and open to transparency.[32]

Agile governance, therefore, requires significant private-public collaboration; this could involve the drafting and adoption of regulations as done in Rwanda to successfully launch projects such as Zipline – a cost effective drone delivery network for critical medical products.[33] Agile governance also requires a degree of flexibility – for instance, to adopt enhanced best practices in lieu of regulation as in the case of cyber-security rules in the US. Finally, agile governance might mean allowing the private sector to lead on regulatory policies, as in the case of firms such as Microsoft Mobile, Dell, HP, and Philips coming together to devise policies to tackle e-waste management in many African countries.[34]

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[30] International Federation of Robotics. (2017). *World robotics 2017: Industrial robots*. Frankfurt, Germany: International Federation of Robotics.

[31] Government of Philippines. (2017). *Philippine inclusive innovation industrial strategy 2017.*

[32] World Economic Forum. (2018). *How can policy keep pace with the fourth industrial revolution?.* Geneva, Switzerland: World Economic Forum. Retrieved from https://www.weforum.org/agenda/2018/02/can-policy-keep-pace-with-fourth-industrial revolution/

[33] Cheney, C. (2018). *Rwanda could become a model for drone regulation*. Devex. Retrieved from https://www.devex.com/news/rwanda-could-become-a-model-for-drone-regulation-91868

[34] Bates, M. (2013). *Europe's electronic waste has become Africa's burden.* Retrieved from https://theconversation.com/europes-electronic-waste-has-become-africas-burden-17123

Box 4.1
4IR and National Security

Following the Easter Sunday terrorist attack in Sri Lanka, there is a renewed discussion on the use of internet-based platforms. Along with the attacks in Sri Lanka, recent events in cities such as Christchurch, Paris, Brussels, and Charlottesville demonstrate how social media platforms, in particular, can be used for the recruitment, dissemination, and incitement of violent extremism. Therefore, the expansion of an internet-based society during the 4IR is likely to heighten these concerns. Traditionally, the onus of security has been on securing physical space; the 4IR will create a necessity for the security of cyber and virtual space as well. The appropriate response, however, is not to block social media and other online platforms (which can easily be circumvented), but rather to use 4IR technologies to find solutions that can improve intelligence and strengthen national security.

Several nations have introduced AI and data processing to analyse metadata and recognize potential threats online. Moreover, the Transport Security Administration (TSA) in the US is pursuing a 'Disaster Aviation Risk Management System' (DARMS) for airport security. This system integrates information from the aviation sector and personalises a security profile for each person on a per-flight basis. The system thus creates an automated system that inspects each passenger, eliminating inefficient security measures and the potential of human error. Other measures such as real-time crime mapping, biometric platforms, and gunshot detection using sensors are widely used for national security as well.

On the battlefront, the integration of AI and robotics, has led to the increased use of drones and the evolution of lethal autonomous weapons. While this may reduce the harm to soldiers, critics argue that this would make it easier for nations to resort to war.

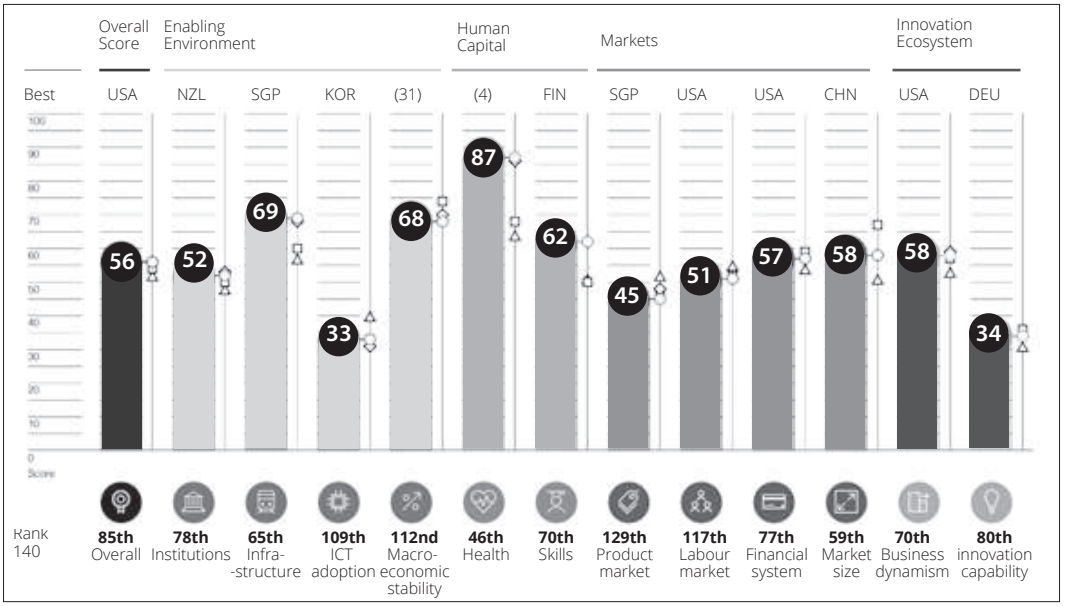
Sources: McFadden, C. (2018). *A brief history of military robots including autonomous weapons*. Retrieved from https://interestingengineering.com/a-brief-history-of-military-robots-including-autonomous-systems ; Transport Security Administration. (2016). *TSA 2017 budget – A commitment to security.* Washington D.C.: Transport Security Administration. Retrieved from https://www.tsa.gov/news/testimony/2016/03/01/hearing-fy17-budget-request-transportation-security-administration ; World Economic Forum. (2018). A*gile cities: Preparing for the fourth industrial revolution.* Geneva, Switzerland: World Economic Forum.

4.5 Sri Lanka and the 4IR

Similar to other developing countries, Sri Lanka too has to focus more on technological preparedness as well as creating a complementary economic ecosystem to benefit from the 4IR. The former requires attention to the country's digital readiness and its capacity to stimulate innovation. The latter, on the other hand, requires reforms in developing the necessary infrastructure and human capital whilst also enabling economic agility.

Effectively, these drivers of future productivity and prosperity are represented in an economy's level of competitiveness. Sri Lanka's worst performing indicators in the Global Competitiveness Report for 2018 are in information and communication technology (ICT) adoption and innovation capability (Figure 4.2). Meanwhile, its best performing indices are related to human capital. These indices, demonstrate Sri Lanka's strengths and weaknesses very generally in responding to the 4IR. As such, Sri Lanka's economy appears to be still at a nascent stage when benchmarked against the requirements to successfully leverage the 4IR.

Figure 4.2
Performance Overview 2018 - Sri Lanka



Source: World Economic Forum. (2018). *Global competitiveness report 2018.* Geneva, Switzerland: World Economic Forum.

4.5.1 Digital Readiness and Technological Innovation

At its most basic level, a significant proportion of 4IR technologies are emerging around the use of computers and the IoT. Therefore, low levels of computer literacy and internet access create considerable obstacles for Sri Lanka to absorb, implement, and leverage 4IR technology. A mere 34 per cent of the population uses the internet. Whilst this amounts to a rapid rise from less than 1 per cent in 2000 and is higher than most other South Asian economies, it is significantly lower than comparator economies such as Malaysia, Thailand, and Vietnam.[35] This lack of internet usage corresponds with a low national computer literacy rate of 22.9 per cent in 2018 as well.[36]

Notably, however, Sri Lanka has over 32 million cellular mobile subscriptions (70 per cent of the population owns a mobile phone), albeit with just over 7 million fixed and mobile broadband subscriptions (approximately 21 per cent of the population). Meanwhile, mobile cellular networks cover 95 per cent of the country's population.[37] Recognising this high level of access to facilitating technologies and yet low levels of internet usage, these disparities are likely to primarily stem from structural factors related to gender and socio-economic factors. For instance, the gender gap for internet usage is estimated to be as high as 40 per cent.[38] Furthermore, there are significant disparities in IT literacy levels between urban

There are significant disparities in IT literacy levels between urban (36.9 per cent), rural (22.0 per cent), and estate (8.6 per cent) sectors. These disparities thus indicate significant structural weaknesses of Sri Lanka's digital readiness for the 4IR era.

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[35] International Telecommunication Union. (2018). *World telecommunication/ICT development report and database.* Geneva, Switzerland: International Telecommunication Union. Retrieved from https://data.worldbank.org/indicator/IT.NET.USER.ZS?end=2017&locations=LK&start=1960&view=chart

[36] Department of Census and Statistics. (2018). *Computer literacy statistics – Sri Lanka.* Retrieved from http://www.statistics.gov.lk/education/ComputerLiteracy/ComputerLiteracy-2018Q1-Q2-final.pdf

[37] Telecommunications Regulatory Commission of Sri Lanka. (2019). *Statistics – 2018 December.* Retrieved from http://www.trc.gov.lk/images/pdf/statis_q42018.pdf

[38] GSMA. (2018). *Mobile for development: Mobile internet in Sri Lanka.* Based on the Mobile Gender Gap Report 2018. Retrieved from https://www.gsma.com/mobilefordevelopment/programme/connected-women/mobile-internet-in-sri-lanka-the-numbers-do-not-add-up/

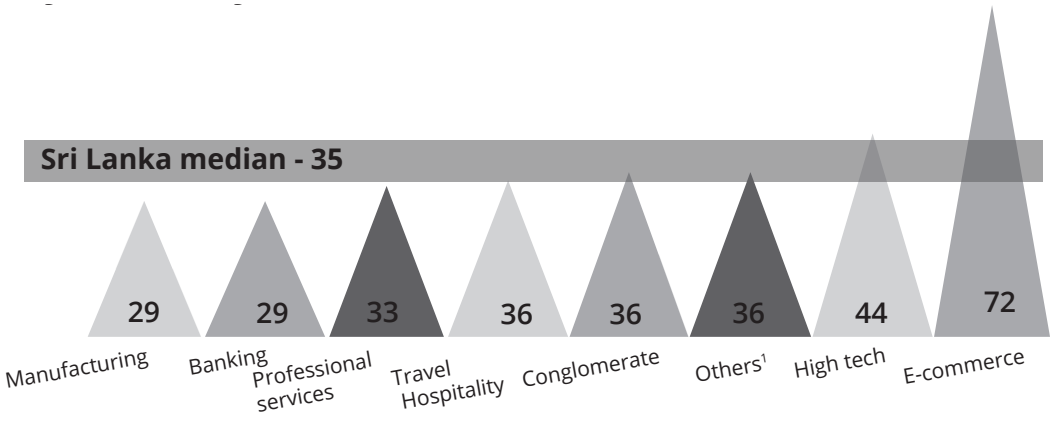
(36.9 per cent), rural (22.0 per cent), and estate (8.6 per cent) sectors.[39] These disparities thus indicate significant structural weaknesses of Sri Lanka's digital readiness for the 4IR era.

Vast disparities in technological maturity and use also exist at the firm-level in Sri Lanka. One in five companies in the country are considered as digital laggards, while 60 per cent are digital followers.[40] These variations in digital maturity extend to industry specific disparities as well. E-commerce and high-tech industries are the most digitally mature while manufacturing, banking, and professional services lag behind considerably relative to the leaders.

prepare for the 4IR and ensure that the benefits of these technological and economic disruptions are equitably distributed, Sri Lanka needs to urgently improve its digital maturity across the spectrum through proactive initiatives both by the government as well as the private sector.

On innovation, amidst marginal gains in recent years, Sri Lanka continues to be ranked considerably low in the 'Global Innovation Index' by the World Intellectual Property Organisation (WIPO). While it performs relatively well in the infrastructure sub-index, Sri Lanka's performance is poor in all other sub-indices compared to the rest of the world, which include institutions,

Figure 4.3
Digital Maturity Quotient in Sri Lanka, by Industry



Source: McKinsey & Company. (2018). *Unlocking Sri Lanka's digital opportunity.* Retrieved from https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/unlocking-sri-lankas-digital-opportunity

Companies with high levels of digital maturity are found to achieve two to five times more revenue growth and returning value than their peers in Sri Lanka. Therefore, to adequately

research, market sophistication, business sophistication, knowledge and technology outputs, and creative outputs.[41] In fact, Sri Lanka's worst performances are in regards to institutions

[39] Asian Development Bank. (2015). *Country gender assessment: Sri Lanka.* Retrieved from https://www.adb.org/sites/default/files/institutional-document/172710/sri-lanka-country-gender-assessment-update.pdf

[40] McKinsey & Company. (2018). *Unlocking Sri Lanka's digital opportunity.* Retrieved from https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/unlocking-sri-lankas-digital-opportunity

[41] World Intellectual Property Organizsation. (2018). *Global innovation index 2018.* Retrieved from https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2018.pdf

(especially on the regulatory environment) and research; two critical pillars of success in the 4IR. Therefore, while current digital maturity levels are of concern, low levels of innovation and complementary factors within the economy, highlight weaknesses which heighten concerns for the future as well.

Box 4.2
Evolution of Digital Economic Policies in Sri Lanka

The Sri Lankan telecommunication sector was liberalised in 1991, and subsequently, a partial privatisation of the telecommunications industry took place in 1997, which led to a monumental transformation in Sri Lanka's ICT sector. The partial privatisation of Sri Lanka Telecom (SLT), the government monopoly at the time, allowed for a higher level of market penetration, which led to an increase in the number of fixed line users. In subsequent years, with the entry of wholly private sector firms as well, Sri Lanka ushered in a significant level of telecom infrastructure investment along with the availability of new technologies to consumers. These developments were complemented with the establishment of the Information and Communication Technology Agency (ICTA), which was tasked with promoting the use of ICT, especially in the public sector.

In 2010, SLT extended its services to include a high speed, ultra-reliable Optical Fiber cable network spanning almost 10,000 km covering the entire island including the Northern and Eastern provinces, which were recovering from the conflict. In the same year, ICTA launched the 'Policy and Procedures for ICT Usage in Government', a mandatory guide for government agencies. The successful implementation of e-Governance allows for effective public sector performance, increasing citizens participation in government decision and policy making and improves accountability of politicians and civil servants. Sri Lanka has successfully implemented e-Government practices in some sectors. For example, the Department of Immigration and Emigration has adopted ICT tools to improve efficiency and effectiveness in the issue of passports to citizens. Since computerisation of the process, Sri Lanka is one of five countries in the world where a passport can be processed within a day. Furthermore, the Government Information Centre (GIC), an online platform, allows the public to easily access any information related to any government department.

Sri Lanka was the first in South Asia to commence mobile phone services in 1998 and to introduce commercial internet connectivity in 1995. At present, around 53 per cent of the population has access to 4G internet, with Sri Lanka being the first country to trial 5G internet in South Asia as well. Moreover, internet connectivity in Sri Lanka is argued to be more affordable than other Asian countries, and the government has shown interest in increasing internet access via public access to WiFi. In 2017, Sri Lanka had more active mobile phone subscriptions than people – 124 users per 100 persons. The proliferation is largely attributed to the high level of competition in the sector.

Most recently, the Ministry of Education (MOE) has commenced introducing 'Cloud Smart Classrooms' to promote ICT education, announcing plans to provide all high school G.C.E. Advanced Level (A-Level) students in the country (around 175,000), along with 28,000 teachers, with their own tablets. The Ministry of Telecommunication and Digital Infrastructure (MTDI) is designing and developing a 'National Digital Economic Strategy'. Despite such initiatives, Sri Lanka's digital economic progress continues to be hindered by significant structural issues.

Sources: Kelegama, S. (1993). *Privatisation in Sri Lanka: The experience during the early years of implementation.* Colombo, Sri Lanka: Sri Lanka Economic Association.; Irfan. M., & Ibrahim, M. (2017). The role of e-governance in administrative efficiency and combating corruption: Case of Sri Lanka. *Global Journal of Management and Business Research*.; De Zylva, A., & Wignaraja, G. (2018). *Is Sri Lanka sitting on the bench of Asia's booming digital economy?* LKI Policy Briefs. Colombo, Sri Lanka: Lakshman Kadirgamar Institute.

4.5.2 Human Capital Readiness

Human capital readiness refers to the ability of an economy to respond to shifts in labour markets from both the demand and supply side. In addition, it depends on a current labour force's capacity to adopt and use emerging technologies while also cultivating the right skills and talents for a future workforce. Therefore, as discussed in previous sections, an economy has to create a high-skilled, agile, and multi-faceted labour force with transferable skills in order to succeed amidst potential disruptions during the 4IR. Sri Lanka has been long touted for its high literacy rate. However, basic literacy and numeracy-based employment are likely to suffer most due to the 4IR. The country's relatively low-level of enrolment in tertiary education is, therefore, a cause for concern.

The main causes for this low-level of tertiary enrolment include "capacity constraints of the state university system, unavailability of a proper parallel higher education system with private sector involvement, and an underdeveloped technical education and vocational training (TEVT) sector".[42] In fact, only 10 per cent of age 20 years and above population has a formal professional or technical training relevant to their occupation. Even among those in university, a vast majority of graduates are in Arts subjects and relatively fewer graduates in STEM subjects – which is a priority area under the 4IR.

Under such circumstances, Sri Lanka is badly placed in terms of responding to disruptions caused by the 4IR. Moreover, the economy will also be challenged to benefit from technology spill-overs and other ancillary benefits that may come through foreign direct investment (FDI) and integration into global value chains as its labour force becomes unattractive to high-tech, 4IR-based industries and investments.

4.5.3 Economic Agility

The rate and scope of technological and socio-economic change occurring through the 4IR have placed a premium on economic agility – the forward-looking ability and responsiveness of an economy. This means, an economy's production processes, complexity of its product space, and

[42] Institute of Policy Studies of Sri Lanka. (2017). *Sri Lanka state of the economy report 2017* (pp. 81-83).Colombo, Sri Lanka: Institute of Policy Studies of Sri Lanka.

networks to trade and value chains are geared to the future of production, and relies on current rates of technological absorption and ability to increase in the future.

Sri Lanka's current economic structure is still at a very early stage of introducing 4IR technology and has in fact been left behind on some counts. On complexity and the future of production, the product space of Sri Lanka's manufacturing and agriculture sectors has largely remained stagnant over the years. According to the 'Economic Complexity Index' (ECI), Sri Lanka ranks as the 101st most complex economy, exporting 204 products.[43] Sri Lanka's export basket has undergone limited diversification in recent decades and the economy has also failed to successfully integrate into regional and global value chains.

Notably, only 6.7 per cent of Sri Lanka's manufacturing value addition is estimated to take place through medium hi-tech and hi-tech industries.[44] This leads to a dependence on industries that are highly susceptible to losing value and be made obsolete during the 4IR. For example, industries such as textiles and garments are likely to be most affected in terms of labour displacement as a result of technological disruption. Therefore, Sri Lanka's overwhelming dependence on a limited spectrum of industries that employ low-skilled labour is likely to pose a significant challenge in the future and diminish its economic agility further.

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[43] Harvard University Centre for International Development. (2018). *Sri Lanka growth diagnostic analysis.* Retrieved from https://growthlab.cid.harvard.edu/files/growthlab/files/growth_diagnostic_for_sri_lanka_1.pdf

[44] World Economic Forum. (2018). *Future of production report 2018.* Retrieved from http://www3.weforum.org/docs/FOP_Readiness_Report_2018.pdf

Sri Lanka's agricultural sector suffers from slow growth in productivity as well. However, although its contribution to gross domestic product (GDP) has declined, the sector continues to hold an important place in the economy, employing over 25 per cent of the population and accounting for nearly 24 per cent of exports.[45] Given the sector's increased vulnerability to extreme weather conditions and diseases, 4IR technologies create ample opportunities to address these concerns and respond in a manner that can improve its productivity. Governments have attempted to introduce some e-agriculture technologies to better improve information flows and promote best practices. However, a distrust of new technology along with the unavailability of necessary capacities have somew hat hindered the integration of technology into the production process.[46] That said, private sector firms such as CIC Holdings and Hayleys Holdings have successfully introduced precision agriculture practices (smart farming) using drones and GPS technology to improve the efficiency of fertilizer use, albeit on a limited scale.

Furthermore, automation in the agriculture sector can potentially help address rising labour shortages, especially in the plantation sector. Since more workers are moving out of agriculture due to rising environmental challenges, socio-economic vulnerabilities, and socio-cultural preferences, the integration of labour replacing technology can lead to a growth in productivity without causing much disruption to the labour market.[47] Therefore, from being stagnant over the years, 4IR technology can potentially transform Sri Lanka's agricultural sector since its marginal productivity gains are likely to be high. However, this will require a concerted effort to improve trust in new technology, and usage capacity of farmers and other stakeholders in the sector.

Despite the growing contribution of the services sector to GDP, a significant portion of growth in the sector has been in non-tradable services such as transport and retail. Even though these services have not experienced any significant introduction of the 4IR technology, the eventual prevalence of technologies like self-driving vehicles will create considerable disruptions to the labour market as well as the structure of the sector. At the other end of the spectrum, information and communication technology (ICT), business process management (BPM), and professional services have become one of the fastest growing exports in Sri Lanka, combined with a high-level of technological maturity in the industry as well. For instance, the ICT industry is the fourth largest export earner to the country and was ranked 11th in A.T. Kearney's 'Global Services Location Index'.[48] Therefore, among Sri Lanka's exports, the ICT industry is arguably one of the best placed to leverage existing technological maturity to diversify and scale up its operations in an economically agile manner.

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[45] Central Bank of Sri Lanka. (2019). *Annual report 2018.* Retrieved from https://www.cbsl.gov.lk/en/publications/economic-and-financial-reports/annual-reports/annual-report-2018

[46] Senaratne, Athula., Thibbotuwawa, Manoj., Wickramasinghe, Kanchana., & Hirimuthugodage, Dilani. (2018). *Bridging the climate information and communications gaps for effective adaptation decisions: An integrated climate information management system (ICIMS).* Colombo, Sri Lanka: The Institute of Policy Studies of Sri Lanka.

[47] International Labour Organisation. (2019). *Future of work in Sri Lanka*. Retrieved from https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---ilo-colombo/documents/publication/wcms_677026.pdf

[48] A.T. Kearney. (2017). *Global services location index.* Retrieved from https://www.atkearney.com/documents/20152/799350/The+widening+Impact+of+Automation.pdf/95d8d519-e2b0-0e4f-994d-15e8716b339e

4.6 Conclusion

The scope and pace of technological change and its consequent impacts pose considerable challenges and opportunities alike to both developed and developing economies. However, developing countries such as Sri Lanka are particularly vulnerable to being left behind and unable to adequately respond to socio-economic disruptions due to existing structural weaknesses and capacity constraints. As highlighted above, the 4IR can easily be integrated into any facet of socio-economic policy and is uniquely capable of being tailored to address narrow policy objectives as well as wider issues. However, while the technology is modern, its efficacy depends on how agile and complementary a country's economic and social ecosystems are for technological absorption, implementation, and innovation. Therefore, developing countries should focus on policy priorities related to: digital readiness and innovation, human capital, and economic agility.

Under these circumstances, while experiencing a significant change in the digital and communication spheres, in particular, Sri Lanka is still considered a nascent economy in its preparedness for the 4IR. To a large extent, much of the basic physical infrastructure required (i.e. mobile and internet coverage) is already available and can be used as a meaningful platform. However, the country has not thus far created a conducive ecosystem that facilitates the integration of modern technologies into economic and social facets of daily life. Success, therefore, depends heavily on identifying and addressing wider structural and institutional impediments, followed by a careful diagnostic of each economic sub-sector and recognising how the 4IR can be leveraged for greater and more inclusive economic growth.

5. 4IR and the Future of Work in Sri Lanka

5.1 Introduction

Scientific breakthroughs in a broad spectrum of fields including genetics, artificial intelligence (AI), nanotechnology and 3D printing, are feeding into innovations that are redefining the way people reproduce, grow food, live, work and interact with each other. Cheaper access to high speed computers were already revolutionising production processes in the last quarter of the 20th century. However, the changes which are happening at present are not limited to computerisation that makes production processes easy. Present day transformations take place in a variety of fields, which have resulted in innovations in new raw materials, new forms of energy and new ways of production. Moreover, the changes that are taking place are not limited to adjustments in the physical space, but are also penetrating the cognitive space,[1] constantly creating and altering production processes and revolutionising the operations of a large spectrum of industries.

These trends are shifting the nature and organisation of the labour market in many ways. Industrial transformations are changing the occupation skill profiles of labour markets. Automation and new forms of production are making many jobs redundant. At the same time, new and different types of jobs are being created that require different types of skills. The nature of jobs that manage to survive these transformations are also changing rapidly, as innovations redefine job roles and the skills required to perform these jobs.

Innovations are also creating new opportunities for firms and people, and redefining the structure and organisation of the labour market. These changes are influencing employer-employee relations, working conditions and the organisation of firms. Technological developments bring together people from a variety of fields, much faster, and at a lower cost. Firms get its tasks performed using a diverse workforce hired through a variety of ways. Individuals with wider access to markets are resorting increasingly to be independent workers. Innovations are also allowing firms to provide more flexible work arrangements to their core workers.

The above-mentioned transformations improve efficiency and productivity of economic activities and offer workers better and more flexible work arrangements. But, these also create challenges to policy makers. It is challenging for the education and training sectors of even the most advanced countries to match the supply of the workforce, in order to meet the ever-changing demand. Further,

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[1] Desire2learn. (2018). *The future of work and learning - In the age of the 4th industrial revolution.* London, United Kingdom: Desire2learn.

social protection programmes in many countries are linked to formal sector employment. The changing structure of the labour market and the increasing share of independent workers as the informal sector are reducing the share of workers covered by social protection, making workers more vulnerable. Some studies indicate that as more workers become independent workers, they are losing their bargaining power.[2] Not all workers are able to benefit from the technological transformations that are taking place. Policy reforms are needed to ensure that no one is left behind by technology driven developments associated with the labour market.

This chapter details how technological change is affecting industries and labour markets in general, and examine how these are shaping the labour market in Sri Lanka. First, it examines how technology is changing labour markets globally. It then examines the technology readiness of the Sri Lankan labour market, and how technology changes are influencing the labour market. Finally, it discusses what Sri Lanka must do to be better prepared to get the best out of the technological changes that are taking place.

5.2 How Technology is Changing the Labour Market

Technological changes and related industrial transformations are affecting labour markets in many ways. The occupation skill profiles of the labour market are changing as existing jobs get outdated, and new jobs are created. The demand for skills in the market is also changing as new industries create new job roles. Also, the facilitation of Information and Communication Technology (ICT) in connecting markets makes labour markets more flexible, changing the employer-employee relations as well as the level of independence of workers who engage in the labour market. This section highlights on certain aspects as to how these changes are taking place.

5.2.1 Effect of Technological Change on Occupation Skill Profiles and Demand for Skills

An adequate supply of workers with required skill levels is needed to avoid labour shortages that lower productivity and restrict growth. A shortage of skilled workers can restrict the ability of firms to innovate and adopt new technologies, and thereby lower their competitiveness.[3] Workers cannot be trained overnight, whereas skilled workers take a longer time span to train. For example, the minimum time required to train an entry level medical doctor is five years. It will take a longer timeframe if that doctor is to become a specialist. The same is true for training other types of skilled workers. Further, not all those who finish school can enter higher education. The general education of an individual should lay the foundation for tertiary level education. Hence, ability to predict the future demand for workers, and creating avenues for the young to obtain training to meet this demand, are important to sustain industry growth and productivity.

The ongoing technological changes make it challenging to predict the occupation and skill profiles of future labour markets. Some jobs are

[2] Risak, M. (2017). *Fair working conditions for platform workers.* Berlin, Germany: Friedrich-Ebert-Stiftung.

[3] Bakhshia, H., Downingb, J. M., Osborneb, M. A., & Schneiderd, P. (2018). *The future of skills: Employment in 2030.* Oxford, London: University of Oxford.

getting obsolete due to innovations. At the same time, the nature and skill requirements for other jobs are changing. While some jobs are becoming out-dated due to innovations, other jobs are being created. For example, tellers are no longer needed at banks, automatic teller machines (ATMs) can issue cash as well as accept deposits. Although the bank tellers are being replaced by machines, different types of workers are needed to maintain the ATM machines and to write software for ATM machines.

Another way technology is changing the labour market is by increasing the demand for skills of existing jobs. For example, a couple of decades ago, a motor car mechanic was a low skilled worker, who could learn the necessary skills on the job. But, today's cars come with many electronic components and therefore computer aided equipment need to be deployed to identify defects. As such, unlike before, motor car mechanics today need the skills to operate computers to identify and fix cars. According to a survey conducted for the 'Future of Jobs in India' report, the occupation skill profile of jobs in India in 2022 will be much different to the present-day jobs.[4] According to this survey, 9 per cent of the jobs in 2022 in India will be those that are not in existence today, 37 per cent of the jobs in 2022 will be radically changed jobs that require a different set of skills to perform, and only about 54 per cent of the jobs will remain unchanged.

The ongoing technological changes make it challenging to predict the occupation and skill profiles of future labour markets.

The seminal work by Autor, Levy and Murnane (2003) first brought to notice how increased computerisation is changing the occupation skill profiles in the labour market.[5] Using the United States (US) Census and Current Population Survey data from 1960 to 1998, they find that with the exponential increase in the use of computers, the occupation skill profiles of workers are also changing with time. Specifically, it shows that the demand for workers who engage in routine manual and cognitive tasks have declined over time, while the demand for workers doing complex non-routine tasks, problem solving tasks, and communication tasks have increased. This is due to the fact routine manual and cognitive tasks

[4] Ernst and Young. (2017). *Future of jobs in India - A 2022 perspective*. Hyderabad, India: Ernst and Young.

[5] Autor, D. H., Levy, F., & Murnane, R. J. (2003). The skill content of recent technological change: An empirical exploration. *The Quarterly Journal of Economics,* pp. 1279-1333.

that are rule -based, can easily be computerised. While tasks that are not rule-based, tasks that require processing a large number of information for making decisions, and tasks that involve problem solving are not easily computerised.

Autor, Levy, and Murnane (2003) mainly looked at how computerisation is changing occupation skill profiles. But technological change today is not only driven by computerisation. As explained before, more affordable access to fast computers has facilitated the advancement in other branches of sciences which are also contributing to the transformation of industries. This has made predicting the future demand for workers even harder. During the last couple of decades, jobs were mainly displaced through the computerisation of production processes. But today, the production process itself is being changed with innovation. For example, in apparel industry, smart computerised machines are able to sew and assemble garments more efficiently and more precisely, replacing skilled machine operators. Now, 3D printing technology has changed the way garments are produced, eliminating the need for sewing altogether.

Technological changes are increasing the demand for skilled workers. The skills demanded by the market for entry level jobs are constantly changing along with change of technology. For example, as mentioned earlier, even blue-collar workers such as motor car mechanics are now required to handle computers to diagnose mechanical and electronic problems in vehicles, prior to repairing these. Technological advancements have redefined jobs and skill demands of the labour market throughout the history. The difference about the present-day transformations is its rapid speed and complexity.

Globally, 40 per cent of employers have reported difficulties in filling vacancies.[6] This figure varies across countries. One reason for difficulty in filling vacancies is the mismatch between the supply of skills and those that are demanded by firms. In the Organisation for Economic Cooperation and Development (OECD) countries, for which much data is available, such mismatches are noted not only during the school to work transition of youth, but also when workers change jobs. According to the OECD data, about 20 to 70 per cent of workers who change occupations and industries are displaced.[7] This is also due to the fast changing industrial and occupational transformations in the world.

Furthermore, the type of skills that are in demand in the present-day market are not limited to hard skills such as knowledge in mathematics, sciences, and other related subjects. It can be noticed that there is a growing demand for soft skills such as leadership and communications. For example, in the US, the growth in jobs since 2015 has been mostly in jobs that are social-skill intensive.[8] This is partly due to the fact that skills such as leadership skills, communication skills and problem-solving skills, are those that cannot be computerised.

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[6] Bakhshia, H., Downingb, J. M., Osborneb, M. A., & Schneiderd, P. (2018). *The future of skills: Employment in 2030*. Oxford: University of Oxford.

[7] *Ibid*, page 7.

[8] *Ibid.*

5.2.2 Effect of Technological Change on the Organisation of Firms Linkages

The types of workers engaged by firms traditionally were limited to permanent workers and temporary workers. Firms that have already functioned with a core group of workers are now relying on a diverse set of workers hired under vmany approaches to get the work carried out. In addition, some tasks were contracted out to consultants or other firms. Increasing automation of tasks has helped firms to get work performed by various types of workers, including off-site workers and off-shore workers.

Technology has not only replaced and complemented the work that people carryout, but has also changed the way people work. Computerisation of routine tasks allows firms to reach a wider market to source workers. Specifically, this allows firms to obtain the services of off-site or off-shore workers. Such flexibilities change the operations of firms.

Technology has not only replaced and complemented the work that people carryout, but has also changed the way people work.

The different types of workers who supply services to firms can be classified in various ways (Figure 5.1). Firstly, they can be classified based on who is issuing the contract and supervising the performance of tasks. Some workers are directly hired by the main employer while others are hired through secondary firms. Those who are directly hired by the primary employer are contracted and supervised by the respective employer, whereas those who are hired by secondary firms are contracted by the secondary firm but are supervised by both the secondary firm, as well as the primary employer.

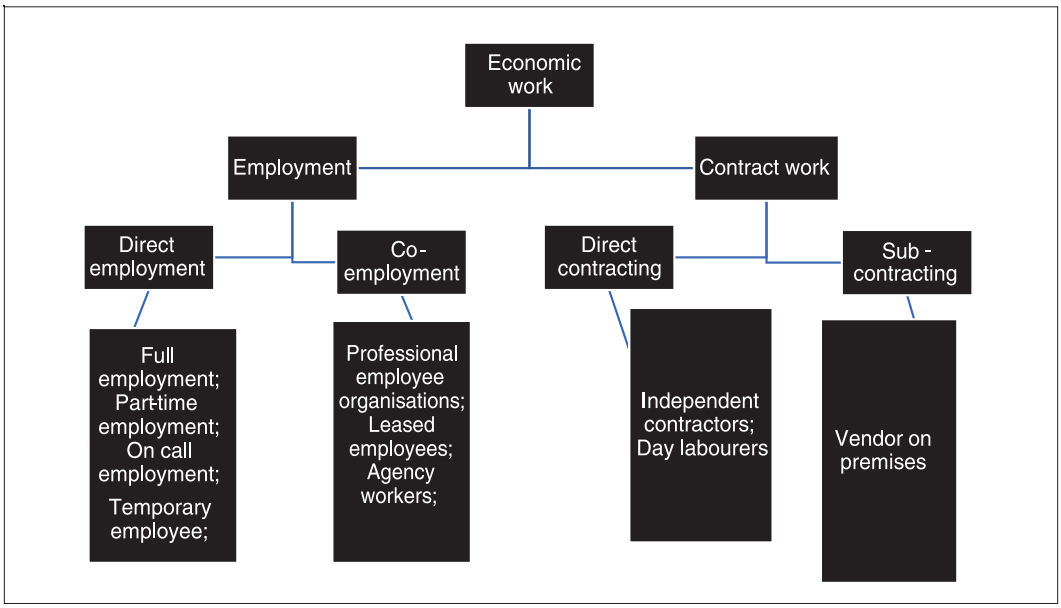
Even those who are directly hired and supervised by the primary firm are not carrying out jobs that are routine or standard as in a traditional labour market. These jobs vary depending on the number of hours worked, and the nature of their contract. Not all workers work the same number of hours. Some are full-time workers who work eight to nine hours on all five days of the week. Some are part-time workers who either work lesser hours each day, or work only some days of the week. There are also on-call workers who are called-in to work to complete tasks from time to time. Workers also differ according to the duration

of contracts. Some are permanent workers who enter into long-term contracts with firms. Others are short-term workers who are hired for a shorter duration. Some others are temporary workers, who are hired for a very short period to perform specific tasks. Workers can also be classified based on the location of their work. Some workers work on premises, while others work off-site via the internet.

Secondly, co-workers –at times referred to as contract workers, are those who are contracted by secondary firms but are reporting to both the company who is hiring them as well as the company they work for. Both white-collar and blue-collar workers are hired through secondary firms. For example, some contract workers provide janitorial, housekeeping or security services to firms, while other contract workers provide professional services such as preparation of company accounts.

Thirdly, some firms outsource the services it require. Some contracts are directly handled by the firm, while other are awarded to sub-contractors for supervision. For example, a firm may contract another firm or an individual to prepare an annual report or they may award a contract to a gardener. Outsourced work of this nature also differs according to the location of the outsourced company. With easier access to the internet and the availability of fast and cheap connectivity across countries, it is now quite common for firms to outsource work to firms located in other countries. Today, with the proliferation of the platform economy, firms are also able to source workers to perform specific tasks more easily.

Figure 5.1
Classification of Economic Work Arrangements



Source: Robles, B., & McGee, M. (2016). *Exploring online and online informal work: Findings from the enterprising and informal work activities (EIWA) survey.* Washington: Board of Governors of the Federal Reserve System. Retrieved from https://doi.org/10.17016/FEDS.2016.089.

Technological change has also enabled firms to offer more flexible work hours for workers who are directly hired by organisations. Advanced technology allows firms to monitor tasks carried out by workers, who are not physically located at the firm. Such flexible work arrangements are beneficial to workers as well as firms. The workers are better enabled for work life balance having sufficient time for personal activities, due to flexibility in work arrangements. Also, workers save on travel time and cost, by working from home. The firms are able to reduce their overhead costs by allowing homeworking for workers. Also, firms are in a position to hire workers at lower costs, as workers are willing to lower their wage expectations, taking into account the savings made through reduced travel costs.

5.2.3 How Technological Change is Affecting Self-Employed and Entrepreneurs

The availability of more affordable and user-friendly technology has enabled workers to access large markets through the internet. People and businesses are able to sell their products, source workers or offer their services to a wider market through ICT enabled services. Such workers are able to decide on the type of work they want to offer and the number of hours to work. Traditionally, most workers were engaged in one job, contributing full-time for a single employer, at a given time. Today, many individuals are freelancers working for multiple employers. Both white-collar workers as well as blue-collar workers have benefitted from these developments.[9] Such workers are referred under various types in literature, including independent contractors, on-demand workers, etc.

The growth of independent workers has been facilitated by technological advances. Some of these workers provide services online. While others offer services, sell goods or rent assets using on-line platforms that link clients with service workers (Figure 5.2). Depending on where they work, platform workers are if two types: those who conduct tasks on the web (cloud workers) and those who obtain tasks via the web, but conduct them locally (gig workers). Both these types of workers can either be contracted individually, or through tasks given to crowd workers.

The difference between workers in the above mentioned and those mentioned in this section and the are latter firms are involved in developing new technologies, rather than using existing technologies.

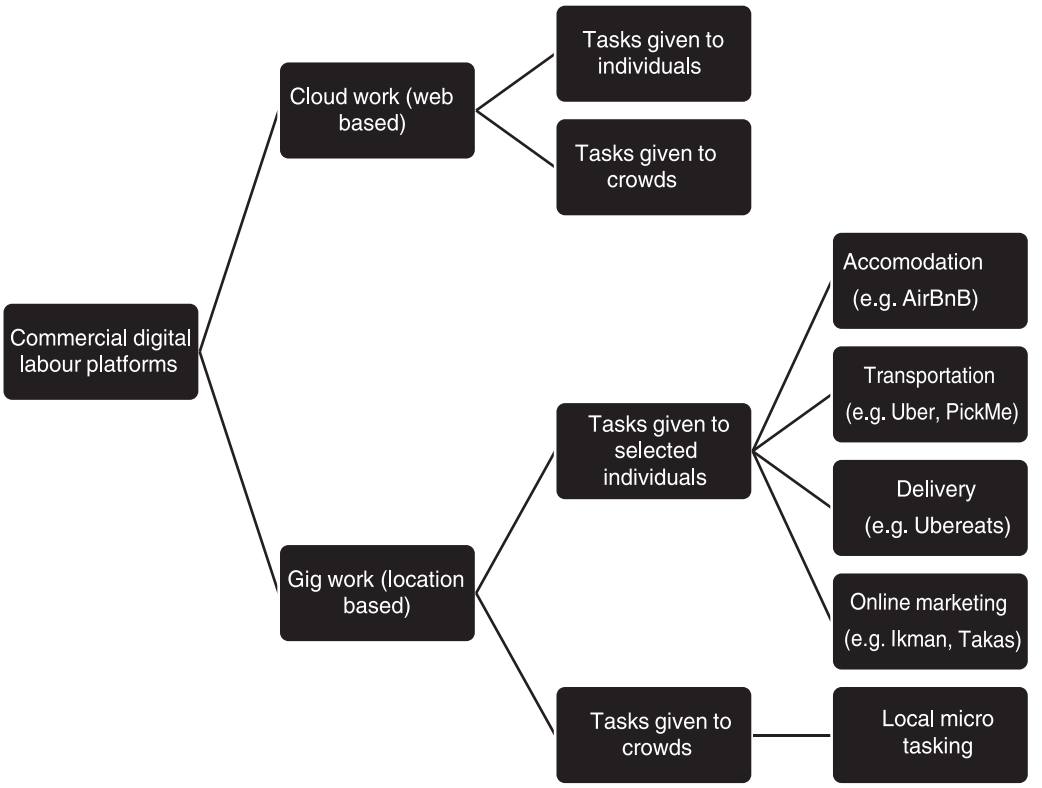
A special category of independent workers is 'cloud-workers' are typically independent workers in a free market economy where temporary task-based work is common. They work on short assignments with diverse employers. The proliferation of ICT based platforms have facilitated the growth in these types of workers. A large number of on-line employment opportunities have been created for white-collar workers such as software developers, creative multimedia professionals, writers' translators, and data entry operators.[10]

Another area which is transforming the nature of work is the platform enabled employment

[9] Ernst and Young. (2017). *Future of jobs in India - A 2022 perspective.* Hyderabad, India: Ernst and Young.

[10] Manyika, J., Lund, S., Bughin, J., Robinson, K., Mischke, J., & Mahajan, D. (2016). *Independent work: Choice necessity and the gig economy.* New York: Mc Kinsey & Company.

Figure 5.2
Organisation of Platform Workers



Source: Adapted from Risak, M. (2017). *Fair working conditions for platform workers.* Berlin, Germany: Friedrich-Ebert-Stiftung.

opportunities, which help to bring together inefficient markets though the Internet. According to the 'Future of Jobs in India' report, the internet and technological advancement have created a range of employment opportunities for informal 'gig workers'.[11] 'Gig workers' are workers who source work through the web, but conduct their economic activities locally. Such workers include those that provide labour, sell products or services, as well as those who rent assets. One example is the market for taxis. In traditional taxi markets, customers and service providers are connected physically or though telephones. The online platforms enable customers to locate taxis near their homes easily. In addition, they are also provided with additional information on the time taken for the trip, cost and the quality of the driver. Such platforms have improved the efficiency of traditional markets and increased the incomes of service providers. Another area which has benefitted from the internet is the e-commerce sector, which has enabled firms to connect customers to small-scale producers, including artisans and small entrepreneurs.

[11] *Ibid.*

In addition, a fair number of small tech-startup firms have emerged, benefitting from technological advancements. These firms provide services in a variety of sectors including education, health, finance and agriculture.

5.2.4 How Technological Change is Affecting Labour Market Policies

The traditional labour force surveys (LFS) that are conducted by different countries are unable to capture the economic activities of platform and gig workers, given their temporary nature and complexity. On one hand, all gig workers do not work full-time as gig workers. Some have regular jobs and conduct gig work to supplement their income. On the other hand, others work primarily as gig workers, but also do regular part-time work. Many are engaged in multiple economic activities.

The traditional labour force surveys (LFS) that are conducted by different countries are unable to capture the economic activities of platform and gig workers, given their temporary nature and complexity.

A clear understanding of these different ways in which workers engage through online platforms is essential for developing labour market policies that regulate and provide social protection to workers. 'Enterprising and Informal Work Activities (EIWA)' was conducted by the Federal Reserve System in Washington D.C. in 2016 to specifically better understand various ways in which individuals are engaging in enterprising and informal economic activities (E&I activities). A special focus of the survey was to identify types of economic activities that may not be fully captured by traditional labour market surveys. The survey results show that people engage in online and offline economic activities in different ways, at varying degrees. For example, of the qualified respondents, 32 per cent were engaged in selling new or second hand goods online, 13 per cent were conducting on-line tasks for pay, 26 per cent were engaged in offline paid activities (such as housekeeping, janitorial, landscaping,

and other maintenance work on premises), 16 per cent of respondents sold goods and services offline at temporary locations, and around 20 per cent of the respondents were engaged in multiple economic activities, both online and offline.

The proliferation of independent work has both pros and cons. The mobile platforms are able to attract females, students, and retirees back to the labour market facilitated by the flexibility and easiness of accessing markets. A large proportion of qualified EIWA survey respondents are engaged in informal work activities while being non-working according to traditional measurements. They identify themselves in many ways, making it difficult to categorise their work status. Furthermore, some respondents traditionally assumed to be non-working such as students (7 per cent), retirees (12 per cent) and home makers (8 per cent) were engaged in on-line and off-line paid work in different ways. For example, some respondents are self-reported as 'self-employed retiree' or 'disabled homemaker with part-time home-based business'. It is likely that in future, such work identities will become more and more common, as workers take advantage of low-cost opportunities enabled by having access to the internet.

Platform work is more flexible and efficient. Traditionally companies were involved in training workers, sourcing clients and offering services. For example, a traditional taxi firm would buy a fleet of vehicles, train drivers, find clients and sell their services. In this model, the employer is the link between the employee and the client, linking individual taxi drivers to clients using ICT technology. Platforms reduce the need for the employer, thereby reducing transaction costs. In this model, employees who belong to the traditional work environment are now independent workers. They have the freedom of making choices, deciding when to work, how long to work, and what type of work to do. In the traditional taxi firm example, some taxi drivers would work only in the night, while others would only operate in a specific geographic area. Many workers find this flexibility attractive due to work life balance, having ample time to allocate for personal life.

Despite the attractiveness of platform work, platform workers also face many obstacles. Mostly, platform workers are not organised and can be exploited. Further, as platform workers are self-employed, they are also not covered by social security for which workers in regular jobs are entitled to. Traditionally, social protection schemes are linked to formal sector employment. Independent workers, by definition are self-employed informal sector workers. As such, they are not covered by the usual social protection laws that are applicable to workers in the formal sector.

Additionally, platform workers are responsible for investing in improvements to their employment activities. They are responsible for upgrading intangible assets such as their own skills and securing and maintaining physical/tangible assets necessary for their work. This will increase the vulnerability of these workers to economic, social and adverse shocks including those personal.

5.3 How Technology Ready is the Sri Lankan Labour Market?

Not all countries can benefit fully from the innovations. The above-discussed changes are mostly noticeable in developed countries. Nevertheless, these changes are also making inroads into developing and middle-income

countries. The extent to which the industrial changes are affecting countries depend partly on the availability of infrastructure, the ability of legal and policy frameworks to facilitate technology, education and skills of the population, as well as social cultural attitudes towards technological change.[12]

5.3.1 Development of Technology Enabling Institutions and Infrastructure

In all countries, the foundations for fourth industrial revolution (4IR) related technology starts with the penetration of ICT. In Sri Lanka, ICT infrastructure expansion took off with the telecommunication liberalisation policy in the 1990s. The global system for mobile communication (GSM) technology was launched in Sri Lanka in the mid-1990s, which provided access to voice and low speed data. However, with the increasing demand for high speed data and the subsequent introduction of the 3rd generation (3G) and 4th generation (4G) connectivity, access to high speed internet services improved throughout the country. The connections to Southeast Asia–Middle East–Western Europe-4 (SE-ME-We-4) submarine cables increased the speed and accessibility of Sri Lanka's internet connections with the rest of the world.

The establishment of the Information and Communication Technology Agency (ICTA) by the Information and Communication Technology Act No. 27 of 2003 and various initiatives by the agency have helped in the expansion of the ICT sector and related industries in the country.[13] The ICTA is responsible for implementing all activities relating to ICT in the country. The e-Government was one such initiative which connected more than 500 government organisations through the Lanka Government Network (LGN). Along with this, the Lanka Government Cloud (LGC) was launched to enable cost effective, efficient and reliable access to ICT infrastructure for government organisations. This initiative has not only improved the efficiency of government activities, but also improved the ease, speed, and convenience of access to government services to the general public. The ICTA has also played a major role in implementing laws that have facilitated the development of the ICT industry. These include laws that enable the use of e-transactions and laws for preventing electronic crimes. In recent times ICTA has focused on enabling innovations. Spiralation – a government funded startup accelerator programme – launched in 2011 was created to promote startups in the country through providing assistance for finance, training and market access. Recognising the need to support innovations through sciences outside of ICT, the Coordinating Secretariat for Science, Technology and Innovation (COSTI) was established in 2013 with the objective of coordinating science, technology and innovation related activities in the country and assisting in the commercialisation and value addition of innovations in line with the National Science Technology and Innovation (STI) strategy.

Sri Lanka Institute of Nanotechnology popularly referred by the acronym SLINTEC, is Sri Lanka's first public-private research institute, initiated in 2009 by the Government of Sri Lanka (GOSL)

[12] International Labour Organisation. (2019). *Future of work in Sri Lanka - Shaping technological transitions for a brighter future.* Colombo, Sri Lanka: International Labour Organisation.

[13] Information and Communication Technology Agency. (2019). *Industry development.* Retrieved from https://www.icta.lk/industry-development/.

in collaboration with successful private firms in the country. The company mainly focuses on nanotechnology-based research and is well-equipped with expertise in nanotechnology and advanced machinery. SLINTEC is driven by the aim of discovering and developing innovative products dominantly targeting on six major areas namely; advanced materials, smart textiles, advanced agriculture, synthetic biology, synthetic organic chemistry and nanomedicine and process and engineering systems. The workforce at SLINTEC since its inception in year 2009 has grown from just around 20 people to 85. SLINTEC is home for many young workers who possess a degree and high educational qualifications specifically in the field of Science and one of the leading maestros in facilitating Sri Lanka, in its transition to an innovation-driven economy.

In addition to the above-mentioned initiatives, the private sector has also shown interest in promoting technology based economic activities. In 2008, Sri Lanka Association of Software and Service Companies (SLASSCOM) was created specifically for the advancement for the information technology (IT)/ business process management (BPM) industry.[14] In 2009, the first IT park was created as a private venture with 550,000 sq. ft of developed space to promote the ICT industry. The technology development agenda of SLASSCOM made a major shift in 2013, where the emphasis was changed from development of technology to innovation, transformation, and entrepreneurship.

According a survey by SLASSCOM, biggest obstacles faced by entrepreneurs in new technologies are:[15] 1) a convenient means of making and receiving payments online (60 per cent), 2) more reliable and cheaper access to bandwidth (52 per cent) 3) access to debt capital from banks (53 per cent), 4) Sri Lanka brand recognition and global marketing to attract foreign clients (49 per cent), 5) affordable work space (57 per cent). Access to expert advice, ease of doing business and access to talent were also constraints, but of less importance.

5.3.2 Education and Skills of the Population

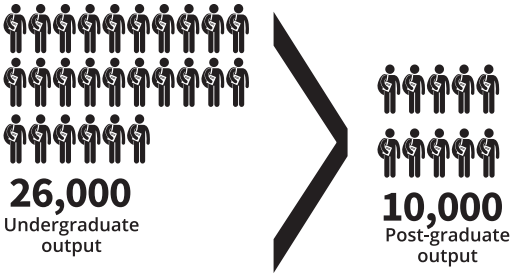
Ready access to a highly trained workforce is essential for promoting technology-based development. Although Sri Lanka boasts of near universal primary completion, the share of workers with tertiary level education (a degree or tertiary level vocational training qualification) is low. Only around 26,000 students pass as undergraduate from university annually and 10,000 with post-graduate qualifications. Out of these, only a limited percent is following science (12.1 per cent), computer science (4.4 per cent), engineering (6.6 per cent) and other technology related subjects.[16] The migration of highly talented individuals is aso limiting the number of skilled individuals available for technology driven jobs. According to the LFS data, only 5.3 per cent of employed has a degree or higher level of education qualification in 2016.[17] Further, the available talent in Sri Lanka lacks a full range of

[14] Sri Lanka Association of Software and Service Companies. (2016). *Vision 2022: Sri Lanka IT/BPM sector.* Colombo, Sri Lanka: Sri Lanka Association of Software and Service Companies.

[15] Sri Lanka Association of Software and Service Companies. (2016). *Country overview of the startup ecosystem in Sri Lanka.* Colombo, Sri Lanka: Sri Lanka Association of Software and Service Companies.

[16] University Grants Commission. (2017). *Sri Lanka university statistics - 2017.* Retrieved from http://www.ugc.ac.lk/en/component/content/article/2029-sri-lanka-university-statistics-2017.html.

[17] Own calculations based on LFS Data 2016 of the DCS.



skills needed for promoting innovation.[18] Tertiary level qualifications together with other soft skills are needed to be successful in emerging technology enabled occupations. The LFS conducted by the Department of Census and Statistics (DCS) in 2017 shows that the first-time job seekers who have just a university degree are not as ready for the labour market, as those with a university degree plus a technical/ vocational education. The main reason for their lack of preparedness is the lack of job specific skills or competence (29.8 per cent) and poor attitude, personality and lack of motivation (17.1 per cent).

5.4 How Technology is Changing the Sri Lankan Labour Market

5.4.1 Trends in Technology Enabled Jobs

The extent to which technology is changing the Sri Lankan labour market is difficult to predict due to lack of data. Available information shows that access to digital technology is already making a mark in the economy. Policies by successive governments have helped to facilitate and expand the access to digitised data through better ICT infrastructure. There are three main types of technology related jobs, as discussed in section 5.2. The first type involves off-site workers who directly carry out tasks for overseas companies. These include business process managers and knowledge process managers. The second type involves platform workers who source work through digital platforms. There are several types of platform workers (see Figure 5.2). Thirdly, the startup entrepreneurs, are involved in developing new technologies and contributing to technological changes.

Off-Shore Workers

The SLASSCOM expects to promote the knowledge and innovation sector in Sri Lanka through various ways. In the earlier years, the sector benefitted mainly through the growth in the information technology (IT) services and BPM sectors. The first BPM industry was setup in Mahavilachchiya in 2007. From then on, the IT/BPM sector has grown to a USD 800 million export revenue earner, employing more than 75,000 workers by 2015.[19] The growth in the IT/BPM sector was helped by "agility, high value-to-cost, a niche talent base, strong ethics, cultural adaptability and superior quality of life as a destination for doing business".[20] The improvements to technology on one hand is facilitating growth in this sector as firms and countries get closer. But, automation and AI are threats, as more firms rely on machines to conduct some of these outsourced activities.

More recently, the knowledge process management (KPM) sector has been adding value to the ICT sector.[21] As explained by SLASSCOM

[18] Sri Lanka Association of Software and Service Companies. (2016). *Vision 2022: Sri Lanka IT/BPM sector.* Colombo, Sri Lanka: Sri Lanka Association of Software and Service Companies.

[19] *Ibid.*

[20] *Ibid.*

(2013), the finance and accounting outsource (FAO) businesses take a large share of the KPM industry in Sri Lanka. Sri Lanka is recognised as a Global Centre of Excellence for FAO. This is partly helped by the fact that Sri Lanka has the second largest number of United Kingdom (UK) qualified accountants in the world. According to the SLASSCOM, the FAO sector workforce consist of highly educated professionals who provide high-end services. More than 78 per cent of the workforce has full or part qualifications in accounting and finance. The FAO industry in Sri Lanka provides a variety of services ranging from low end routine tasks – such as book keeping, accounts and payroll processing and financial reporting -- to high-end decision support activities – such as investments and quantitative research and process re-engineering.

Platform Workers

With the development of the ICT infrastructure, the number of gig-workers are also increasing in the country. A large number of independent workers are benefitting from both locally and globally developed platforms (see examples in figure 5.2). The LFSs are unable to pick-up detailed information on gig-workers in Sri Lanka. Available information on gig-workers indicate that around 17,000-22,000 Sri Lankan workers are engaged in web-based digital labour on global platforms and 3,000 more workers in local platforms.[22]

Available data indicate that platforms serving different sectors are providing employment to many independent workers. For example, UBER has revolutionised the taxi market in the country. It now has a locally produced platform – Pick Me. In 2015, 3,000 tuk-tuk drivers and 4,000 cab drivers were registered with Pick Me.[23] E-commerce platforms selling both used and new products – such as Ikman.lk and Takas.lk -- are also becoming popular. Both local (e.g., eZ Cash) and international (Paypal) online payment systems have facilitated the growth of this sector. Another industry that has benefitted from the platform economy is the hotel industry. The ability to source clients through the web (through platforms such as Airbnb) has facilitated the growth of the informal hotel sector.

Technological Startups

The IT/BPM as well as the KPM sectors generate employment through provision of services. Recently, the government has paid attention to develop startups – i.e., as innovative businesses can introduce new production and service processes. Traditional LFSs are unable to obtain detail information on the startup industry. The SLASSCOM's startup survey of 225 entrepreneurs (115 aspiring entrepreneurs, and 110 exiting entrepreneurs) provides some information on the startup eco system in the country.[24] According to this survey, the startup sector is growing, but at a slower pace. The number of startups is increasing, from 171 in 2007 to 225 in 2015, where the existing startups are also expanding. About 41 per cent of the surveyed startups were growing, and 14 per cent were on the look out to expand into new markets.

According to the aforementioned SLASSCOM survey, the technology startups were founded mainly by young people between 20 to 35 years

[21] Sri Lanka Association of Software and Service Companies. (2013). *Financing and accounting outsourcing sector of Sri Lanka.* Colombo, Sri Lanka: Sri Lanka Association of Software and Service Companies.

[22] International Labour Organisation. (2019). *Future of work in Sri lanka - Shaping technological transitions for a brighter future.* Colombo, Sri Lanka: International Labour Organisation.

[23] *Ibid.*

[24] Sri Lanka Association of Software and Service Companies. (2016c). *Country overview of the startup ecosystem in Sri Lanka.* Colombo, Sri Lanka: Sri Lanka Association of Software and Service Companies.

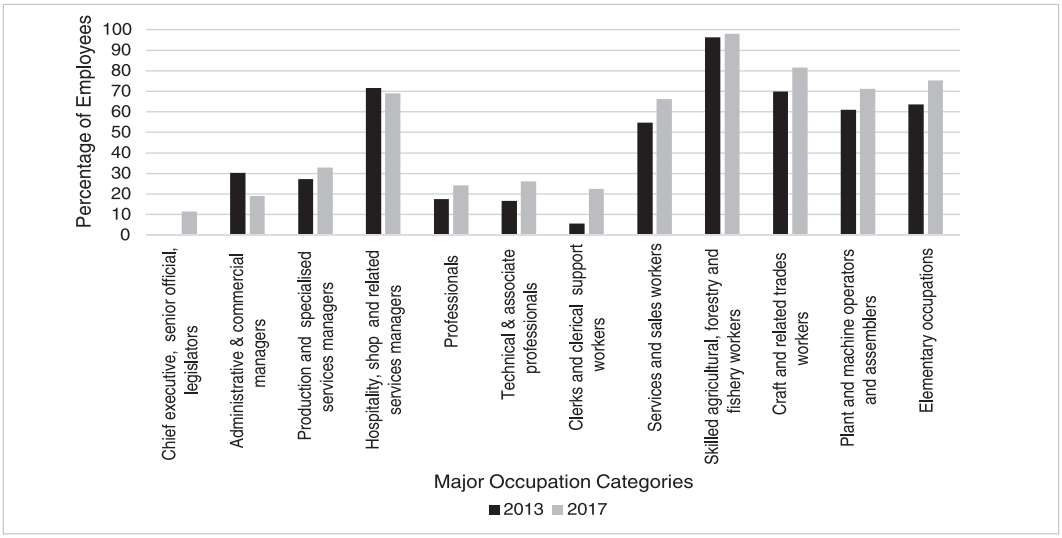
of age. A large share of them (77 per cent) have a degree or a higher educational qualification. Of these, more than 48 per cent have listed computer science as their core area of expertise followed by engineering (18 per cent) and business management (17 per cent). Most startups are carried out by a small group of three to five individuals. Only about 7 per cent of startups were sole entrepreneurs.

5.4.2 Trends in Organisation of Work and Self-employment

Due to several reasons, it is rather difficult to obtain systematic data on trends in self-employment activities enabled by technological platforms. First, as mentioned before, many individuals get involved in platform enabled self-employment activities only on a temporary basis while working in other types of employment. As such, these workers are not always captured in regular LFSs. Also, in Sri Lanka, the occupation classification of workers changed in 2013.[25] As such, trends can be explained only from 2013. Of those who claimed to be self-employed, the two-digit occupation categories for 'Information and Communications Technicians' and 'Information and Communication Technology Professionals' increased by 283 per cent and 41 per cent respectively, over the 2013 to 2016 period. This indicates an increase in ICT related activities amongst the self-employed. The available numbers on other types of self-employed captured in the survey are not significant for a detailed analysis.

Available data indicate that there is an increase in informal sector employment for high skilled occupations (Figure 5.3). Informal sector employment increased by 9.2 per cent from 2013 to 2017 (Table 5.1). What is noteworthy is that other than for 'Administrative and Commercial

Figure 5.3
Share of Informal Sector Employment, by Occupation (%)



Source: Compiled based on data from DCS, *Labour force survey- Annual report* 2013 and 2017.

[25] Sri Lanka Standard Classification of Occupation -2008 based on International Standard Classification of Occupation-2008 (ISCO 2008) is used in LFSs since 2013 by the DCS.

Managers', for most of the occupations requiring high levels of skills, there is an increase in the share of informal sector employment. All types of informal employment have increased over the period for both males and females, indicating that the organisation of work arrangements as well as informal employment are also undergoing change in Sri Lanka.

Table 5.1
Distribution of Informal Employees, by Job Characteristics

All Employees	2017			Growth from 2013 to 2017 (%)		
	Male	Female	Total	Male	Female	Total
Permanent	73,845	30,609	104,454	104.5	533.2	155.1
Temporary	888,171	360,131	1,248,302	76.1	119.1	86.7
Casual	250,710	129,070	379,780	43.0	132.9	64.6
No Permanent Employer	572,159	110,038	682,197	2.2	-3.6	1.2
Total	1,784,885	629,848	2,414,733	39.9	85.9	49.6

Source: Compiled based on data from, LFS- 2013 and 2017, DCS.

5.4.3 How Technology is Changing Occupation Skill Profiles in Sri Lanka

Technological developments and the rate at which occupation profiles are changing raise concerns on policy makers. One of the reasons is that lack of awareness and without proper knowledge of future job markets, it will be difficult to train future workers. Frey and Osborne (2013) in their research on the 'Future of Employment' developed a model to assess job disruptions due to computerisation.[26] Based on their estimates, about 47 per cent of total jobs in the US are at the risk of becoming obsolete.

Frey and Osborne (2017) constructed their estimates by developing a method to assign a probability of computerisation, to 702 detailed occupations in the US in 2013.[27] Assuming that the probability of susceptibility to computerisation for detailed jobs in Sri Lanka is the same as those for US in 2013,[28] the likelihood of job desruptions due to automation in Sri Lanka can be examined. This is conducted by matching the detailed occupation codes in the US (International Classification of Occupations 2008 (ISCO 08)) to those in Sri Lanka (Sri Lanka Standard Classification of Occupations 2008 (SLSCO 08)), and assigning the susceptibility of computerisation probabilities (SCP) to

[26] Frey, C. B., & Osborne, M. A. (2013). The Future of Employment: How Susceptible are Jobs to Computerisation? Oxford Martin School, University of Oxford. Retrieved from https://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

[27] Frey, B., & Osborne, M. A. (2017). The future of employment: How susceptible are jobs to computerisation? Technological Forecasting and Social Change, pp. 254-280.

[28] Jobs were detailed at the 4-digit level of the International Classification of Occupations 2008 (ISCO 08).

[29] The probabilities of computerisation estimated by Frey and Osborne (2013) were matched to Sri Lanka Standard Classification of Occupations 2008 (SLSCO 08) in the LFS 2016. Out of 520 4-digit level occupation codes in the LFS 2016, 231 matched. According to the LFS 2016, there were 7,947,683 employed people. Of these we were able to assign probabilities of computerisation to 3,602,169 (45.3 per cent) of the workers who were engaged in the 231 matched occupations.

occupation catgories in Sri Lanka.[29] From the 3,602,169 workers for whom it was able to assign susceptibility to computerisation values, 70.3 per cent (or 2,530,581 workers) are involved in jobs that have more than a 70 per cent probability of becoming outdated. However, the time taken for a replacement of these jobs will depend on the speed of technological adoption in Sri Lanka.

On average, the job categories that are less likely to be computerised require high levels of skills such as major occupation category 1 (i.e. 'Managers, Senior Officials, and Legislators') and 2 (i.e. 'Professionals') (Figure 5.4). Further, for these two categories of major occupations, the susceptibility to computerisation does not vary much. This indicates that sub-occupations within these two categories also have a low probability of becoming obsolete due to computerisation. Approximately, 14 per cent of all employed are in these two categories of employment in 2017.[30] Major occupation category 4 (i.e. 'Clerks and Clerical Support Workers') is the most susceptible to computerisation, on average. However, only 4 per cent of all employed are in this occupation category. The major occupation category 3 (i.e. 'Technical and Associate Professionals') and 5 (i.e. 'Service and Sales Workers') have low probabilities of computerisation on average, but the susceptibility to computerisation of the sub-categories within these groups of occupations vary to a high extent. The biggest change in the occupation profile will happen amongst major occupation categories 6 and 7 (i.e. 'Skilled Agricultural, Foresty and Fishery Workers' and 'Craft and Related Trade Workers'). These occupation groups have a high susceptibility to computerisation, where a large share is employed (17.1 per cent and 16.7 per cent, respectively in 2017) at present.

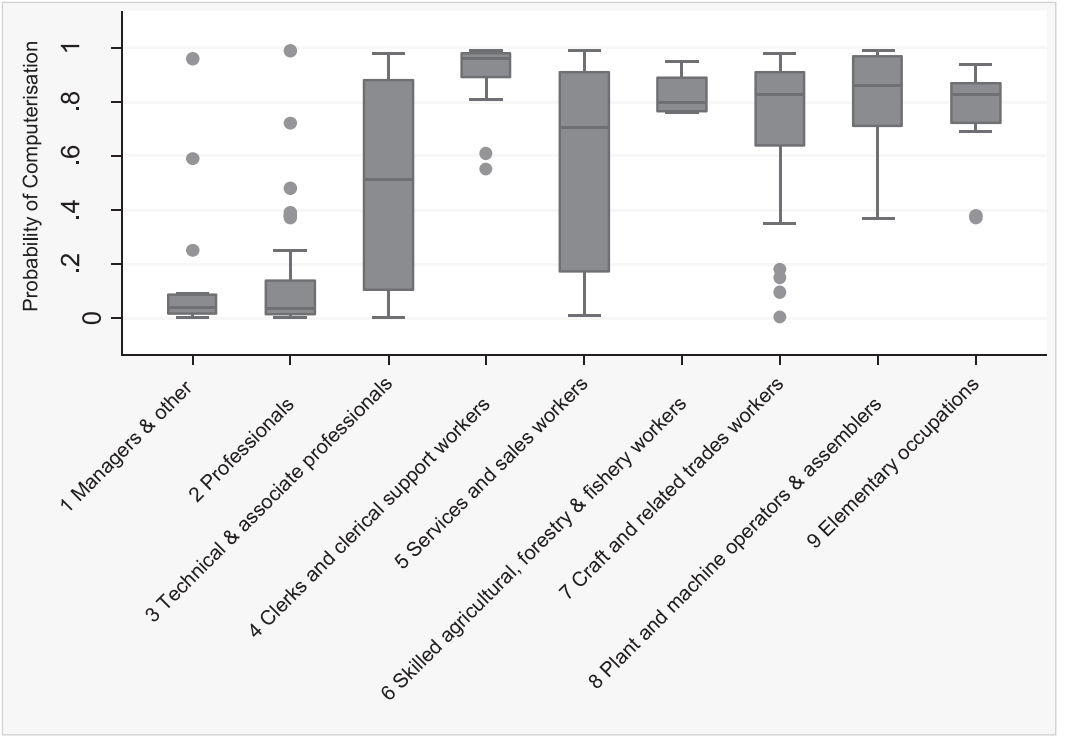
On average, the job categories that are less likely to be computerised require high levels of skills.

Table 5.2 shows the jobs that are most and least susceptible to computerisation at the 2-digit level.[31] The jobs that are least susceptible are those with skill levels 3 and 4. As seen in Table 5.3, skill levels 3 and 4 require high levels of factual knowledge, problem solving skills, decision making skills and creativity. Usually, a tertiary level education or equivalent experience is needed to carry out such jobs. The only occupation which is in the top 10 least susceptible to computerisation

[30] Department of Census and Statistics. (2017). *Labour force survey – Annual report 2017.* Colombo, Sri Lanka: Department of Census and Statistics.

[31] These jobs are limited to the 231 job categories that matched.

Figure 5.4
Susceptibility of Jobs to Computerisation in Sri Lanka, by Major Occupation Groups



Source: Compiled by authors based on (Frey & Osborne, 2017) probabilities of computerisation for detailed occupations mapped to labour force data 2016.

Note: Calculations are shown for 231 occupations that matched (at the 4-digit level of the International Classification of Occupations). The line in the middle of the boxes show the average probability of computerisation for the major occupation group. The boxes are framed by the probabilities at the 25th percentile and the 75th percentile.

with a lower skill level is 'Personal Care Workers'. At the other end of the spectrum, the occupations that are most susceptible to computerisation mostly require level 1 or level 2 skills, or the equivalent of primary or secondary level education. The only occupation with a level 4 skill which is likely to be replaced by computers is 'Business and Administration Professionals'.

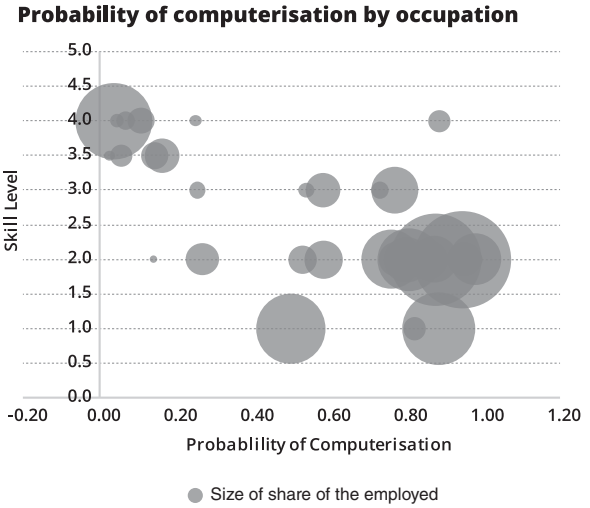


Table 5.2
Two-digit Level Top 10 Occupations that are Most and Least Susceptible to Computerisation

2-digit Level Occupation Code	Occupation	Probability of Computerisation (Average)	Skill Level	Share (% of Total Employed In 2016)
Least Susceptible to Computerisation				
11	Chief Executives, senior officials and legislators	0.02	3 + 4	0.07
23	Teaching professionals	0.03	4	3.71
22	Health professionals	0.04	4	0.13
14	Hospitality, retail and other services managers	0.05	3 + 4	0.37
21	Science and engineering professionals	0.07	4	0.24
26	Legal, social and cultural professionals	0.11	4	0.43
53	Personal care workers	0.14	2	0.03
12	Administrative and commercial managers	0.14	3 + 4	0.53
13	Production and specialised services managers	0.16	3 + 4	0.86
25	Information and communication technology professionals	0.25	4	0.10
Most Susceptible to Computerisation				
75	Food processing, woodworking, garment and other craft and related trades workers	0.87	2	5.59
93	Labourers in mining, construction, manufacturing and transport	0.88	1	3.16
24	Business and administration professionals	0.88	4	0.34
82	Assemblers	0.89	2	0.10
44	Other clerical support workers	0.94	2	0.27
52	Sales workers	0.94	2	6.10
61	Market-oriented skilled agricultural workers	0.95	2	0.71
42	Customer services clerks	0.96	2	0.37
43	Numerical and material recording clerks	0.97	2	0.22
41	General and keyboard clerks	0.98	2	1.88

Source: Authors' construction based on (Frey & Osborne, 2017) probabilities of computerisation for detailed occupations mapped to labour force data 2016.

Note: These occupations are chosen from the 231 occupations matched with the US occupation codes. The probability of computerisation was matched at the 4-digit level, reported values are averaged at the 2-digit level.

Table 5.3
Description of ISCO 08 Skill Levels

Skill Level	Description	Equivalent Level of Education[a]
1	Performance of simple and routine physical and manual tasks which include using of hand-held tools such as shovels, or simple electrical equipment such as vacuum cleaners	Primary level of education
2	Performance of tasks such as operating of machinery and electric equipment, driving vehicles, maintenance and repair of electrical equipment and mechanical equipment, and manipulation, ordering and storage of information, relatively advanced literacy and numeracy skills	Secondary level of education
3	Performance of complex technical and practical tasks that require an extensive body of factual, technical and procedural knowledge in a specialised field	First stage of tertiary level education (e.g., advance diploma)
4	Performance of tasks that require complex problem-solving, decision making and creativity based on an extensive body of theoretical knowledge, factual knowledge and generally requires high to very high level of literacy, numeracy and well-developed interpersonal communication skills	The equivalent to a degree or higher level of education

Note: a: Education may be aquired either through formal training or through experience.
Source: International Labour Organisation. (2008). *International standard classification of occupations.* Geneva, Switzerland: International Labour Organisation.

5.4.4 Equity in Access to Technology Enabled Jobs in Sri Lanka

According to the Telecommunications Regulatory Commission of Sri Lanka (TRCSL), access to telephone and Internet services has seen a several fold increase since the early 1990s.[32] The number of telephone subscribers increased exponentially from the early 1990s (fixed access telephone subscriptions increased from 121,388 in 1990 to 2,603,178 in 2017 and mobile subscriptions increased from 2,644 in 1992 to 28,199,083 in 2017.) Access to on-line data has also increased in the last decade. The fixed broadband and narrow brand (BB and NB) subscriptions have increased from 249,756 to 1,221,960, while the mobile broadband subscriptions have increased from 91,359 to 4,682,300 during 2009 to 2017.

In order to benefit from technology enabled jobs, computer and digital literacy are essential.[33] Despite the increase in access to mobile and data services in Sri Lanka, wide disparities are evident in the computer and digital literacy of the population, across urban, rural and estate sectors. In 2017, only 28.6 per cent of Sri Lankans were computer literate, and only 40.1 per cent

[32] Telecommunications Regulatory *Commission of Sri Lanka* (2019). Statistics. Retrieved from http://trc.gov.lk/2014-05-13-03-56-46/statistics.html.

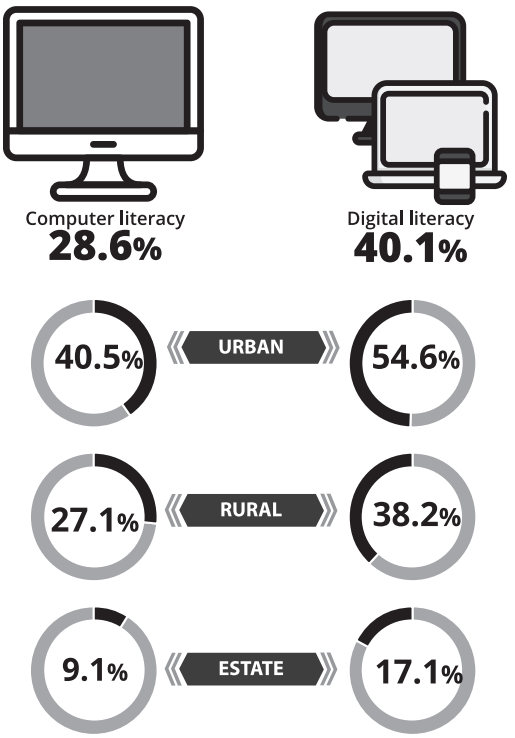
[33] A person who can use a computer on his own is considered to be computer literate, while a person who can use a computer, lap top, tablet or smartphone on his own is considered to be digital literate. The survey was limited to those aged 5 to 69.

were digital literate.[34] While 40.5 per cent of those in the urban sector are computer literate, the comparative statistics for rural (27.1 per cent) and estate (9.1 per cent) are much lower. Similar disparities are seen in the digital literacy of individuals. The digital literacy in the urban sector (54.6 per cent) is much higher than that in the rural (38.2 per cent) and estate (17.1 per cent) sectors.

The computer literacy rate is also highly correlated with the level of education. Those who have passed the General Certificate of Education Advance Level (A-Levels) or more had a 70.6 computer literacy rate, while this rate was only 42.7 per cent even for those with General Certificate of Education Ordinary Level (O-Levels). Further, males had a slightly higher computer literacy rate (31.1 per cent) compared to females (26.4 per cent).

In order to benefit from technology enabled jobs, computer and digital literacy are essential.

Sri Lanka's computer and digital literacy rate in 2017



The above differences in the computer and digital literacy rates are also reflected in the technology enabled entrepreneurs. For example, a survey by SLASSCOM shows that 96 per cent of startups are founded by males, and over 86 per cent of them have a bachelor's or higher degree.[35] Further, according to the LFS 2017, a large share

[34] Department of Census and Statistics. (2017). *Computer literacy statistics 2017* (Annual). Colombo, Sri Lanka: Department of Census and Statistics.

[35] Sri Lanka Association of Software and Service Companies. (2016c). *Country overview of the startup ecosystem in Sri Lanka.* Colombo, Sri Lanka: Sri Lanka Association of Software and Service Companies.

(54 per cent) of workers engaged in professional, scientific and technological activities are located in the Western Province.

The above data indicate that unless equity to improve English, computer literacy, and access to ICT infrastructure are enhanced, access to technology-based jobs might increase labour market inequalities

5.5 Conclusions and Policy Implications

The 4IR is transforming industries and changing the way firms and people work, influencing labour markets in many ways. First, the occupation skill profiles in countries are changing as existing jobs are becoming obsolete and new jobs are being created. Further, the skills required to perform these jobs that survive are also changing drastically, happening faster, and in more complex ways, than before.

The technological change is also transforming the organisation of labour markets. Fast and more affordable access to internet services, are connecting people from across the world. This has allowed companies to source different types of workers using different methods. Further, it is allowing firms to offer their usual workers more flexible work arrangements. Such changes improve the efficiency and flexibility of the labour market, but it has the potential to make workers more vulnerable, as more and more workers are preferring to be independent informal workers.

These changes mostly occur in the developed world. However, available data show that the labour market in Sri Lanka is also changing. The number of workers involved in innovations and startups in Sri Lanka is not very large, but the share of workers benefiting from ICT enabled jobs – such as gig workers – is growing. The IT/BPM industry as well as the KPM industry have grown quite substantially since their inception. Further, a large share of workers is engaged in providing services, selling goods or renting assets using internet platforms. The analysis in the chapter shows that the occupation profile of the country is likely to change with many low skilled jobs becoming obsolete.

Technology driven changes that are taking place can offer solutions to the issues faced by the labour market in many ways, but these are also creating challenges. The rest of this chapter will provide policy recommendations for making best use of technological changes that occur in the country.

5.5.1 Labour Market Information

Since early 1990, Sri Lanka has been gathering systematic information on the supply side of the labour market using the quarterly LFSs conducted by the DCS. More recently, the DCS also conducted a labour demand survey to obtain information on the demand side of the labour market. Nevertheless, none of these surveys capture the technology driven changes that occur in the labour market. Better methods need to be used to gather information on such changes, so that policies can be shaped to address issues arising from these changes.

5.5.2 Technological Change and Implications for Skills Training

Technological changes and the related structural changes that are taking place disturb the balance between the demand and supply of skills in the market place. Such imbalances are not new.

But, if mismatches persist over a long period, these can result in lowering the productivity and competitiveness of firms, and constrain its ability to adopt and innovate new technologies. Such mismatches also increase labour costs to firms, due to loss of production and underemployment. Given the fast-changing nature of the workplace, training workers for future work has become a major issue in many countries. At the rapid rate technologies are changing, countries are uncertain as to what jobs will be available for future workforces. The nature of skills required to perform some of the existing jobs will also change drastically.

The traditional methods of planning and reforming education and training in Sri Lanka will be unable to keep up with the changes that are taking place in the labour market. The organisation and governance of the education system will need to change in the long run, so that it is able to adapt with time. Further, given the rate at which skill demands are changing in the labour market, even the children who are best prepared for the labour market will have to upgrade their skills from time to time. The education system will need to take this into account and offer opportunities for lifelong learning. Also, as discussed earlier, as routine, rule-based tasks are being taken over by computers. Therefore, jobs that remain for human to perform will involve complex tasks such as problem solving, critical thinking, decision making and creativity. The education systems should also be revised to harness such skills.

5.5.3 Implications on Social Protection

Technology has not only replaced or complemented the work that people do, but has also changed the way people work. According to the 'Future of Jobs' survey, 44 per cent of the respondents identified "changing nature of work and flexible work" as a driver of change in the labour market.[36] Computerisation of routine tasks and the increased connectivity of people and firms through the internet allow firms to reach to a wider market in order to source workers, as well as offer more flexible work arrangements to their workers. It should also be highlighted that these short term work arrangements are making workers more vulnerable. The social protection schemes in Sri Lanka are mainly available to formal sector permanent workers. Sri Lanka will need to formulate social protection laws in a way that extend protection to independent workers as well .

5.5.4 Effect of Technological Change and Inequality

Not everyone can have access technology enabled jobs. To begin with, high speed computers and access to internet services are essential to benefit from the new developments that are taking place. Further, along with the necessary physical conditions, individuals will need the ability to handle computers and converse in international languages to benefit from emerging job opportunities. Unless policy makers improve access to internet services to all, and provide individuals with English language and computer skills, some will not be able to benefit from technology enabled new opportunities. Hence policies are needed to improve equity in access to the internet, as well as English language and computer skills.

Further, the analysis shows that generally, much more educated individuals benefit from jobs

[36] World Economic Forum. (2016). *The future of jobs - Employment, skills and workforce strategy for the fourth industrial revolution.* Geneva, Switzerland: World Economic Forum.

created by technology. These highlight the need to improve equitable access to tertiary education sector in the country. The analysis in this chapter shows that occupations which need an equivalent amount of tertiary level education are more likely to survive technological change than occupations carried out by low skilled workers.

6. Sri Lanka's Education Sector: Reskilling in the 4IR

6.1 Introduction

The profound impacts that an emerging fourth industrial revolution (4IR) will have on the future employment landscape underscore the crucial role of education and skills in preparing a workforce that can meet the needs of today's and tomorrow's labour markets. Indeed, education is at the heart of preparing present and future generations to succeed in a technology-driven future economy. A country's ability to take on new technologies and transform them into economic advantage will largely depend on the availability and readiness of its human capital to cater to these demands in sufficient quantity and quality.

The World Bank, in its *2019 World Development Report* speculates that future jobs will require a combination of wide-ranging skills including technological know-how, problem-solving, and critical thinking, as well as soft skills such as perseverance, collaboration, and empathy. Moreover, the rapidly changing nature and types of jobs, as well as the emergence of a gig economy where workers are likely to have many 'gigs' over the course of their careers, mean that education systems will need to focus on developing adaptable and transferable skills which can be applied to multiple jobs.

Most education systems today, however, are still based on models developed over a century ago, and fall significantly short of equipping individuals

A country's ability to take on new technologies and transform them into economic advantage will largely depend on the availability and readiness of its human capital to cater to these demands in sufficient quantity and quality.

to meet the demands of a 4IR era. Further, large disparities in the quality of and access to education, both within and between countries, mean that there is no unique path forward, with certain strategies and tools being more feasible and effective than others, depending on the specific setting.

In this context, this chapter examines the readiness of Sri Lanka's education system to prepare individuals to meet the demands of current and future labour markets. The chapter first outlines some overall implications for education systems in a 4IR context. It then examines current opportunities and challenges for Sri Lanka in transforming its education ecosystem into one that is more relevant and responsive to changing requirements. The final section discusses some potential policy measures that can be adopted to exploit existing opportunities while pushing through prevailing barriers.

6.2 Implications of the 4IR for Education

6.2.1 Changing Skills Requirements

There is a general consensus that, to ensure the success and very survival of students in the context of an upcoming 4IR, they will need to be adaptable, innovative, and responsive to changing times. In particular, an education system designed for an economy in the 4IR requires a shift in emphasis from the current focus on specialisation, to individuals developing broader skills sets, given the need to continue to invest and upgrade qualifications and skills in line with changing demands. It also requires a change from a system founded on facts and procedures, to one that applies knowledge to collaborative problem solving.[1] Indeed, the current large divide

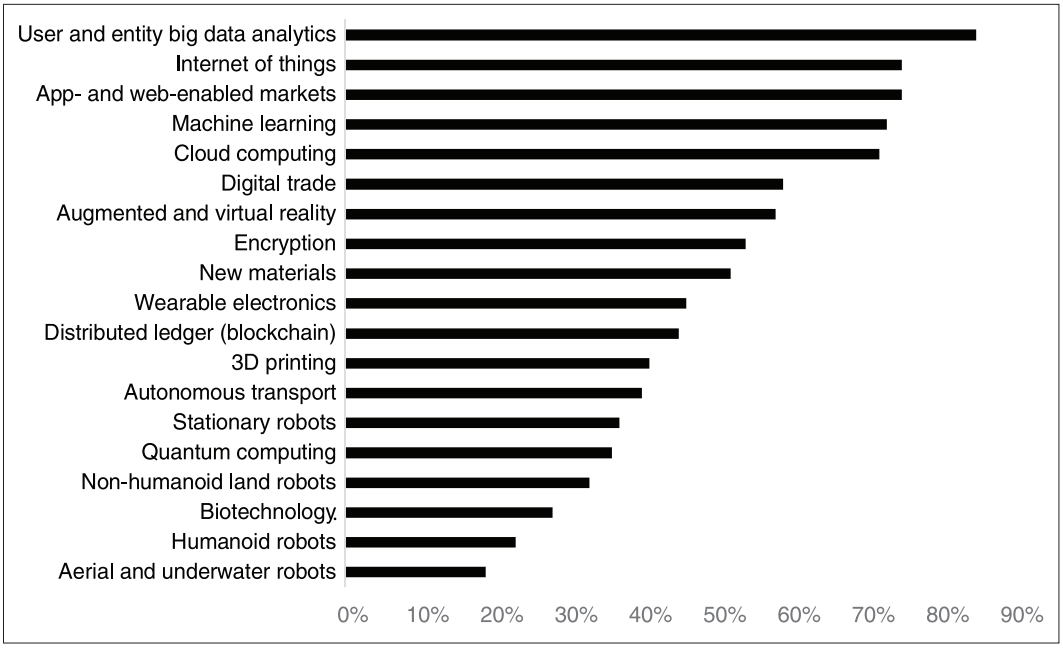
The current large divide – between the content-driven education model developed in the 19th century and today's skills-based world of work – is identified as one of the biggest concerns, especially in the context of preparing students for jobs that do not exist yet.

– between the content-driven education model developed in the 19th century and today's skills-based world of work – is identified as one of the biggest concerns, especially in the context of preparing students for jobs that do not exist yet.[2]

A survey of 300 chief human resource officers of operations in geographic locations covering 20 developed and emerging economies suggests that by 2022,[3] in terms of new technologies, 85 per cent of respondents are likely or very likely to have expanded their adoption of user and entity big data analytics (Figure 6.1). Other key technologies which are highly likely to be embraced by a majority of companies include the internet of things (IoT), app- and web-enabled markets, machine learning, and cloud computing.

In line with the expected adoption of such new technologies, analytical thinking, innovation, and active learning are identified as key skills for which demand is set to grow in the near future (Table 6.1). Apart from such technology-related skills, 'human' skills such as creativity, originality and initiative, critical thinking, and persuasion and negotiation will also become increasingly important, as well as attention to detail, resilience, flexibility and complex problem-solving – skills that are unique to each individual, and those that machines cannot necessarily do. On the other

Figure 6.1
Likely Adoptable Technologies by 2022 (Projected), Proportion of Companies



Source: World Economic Forum. (2018). *The future of jobs report.* Geneva, Switzerland: World Economic Forum.

1 Brown-Martin, G. (2018). *Education and the fourth industrial revolution.* Retrieved from https://www.linkedin.com/pulse/education-fourth-industrial-revolution-graham-brown-martin/.

2 Kamath, M., (n.d.). 21st century skills: Surviving the 4th industrial revolution, *ArcSkills.* Retrieved from https://www.arcskillsforwork.com/blog/21st-century-skills-surviving-the-fourth-industrial-revolution.

3 World Economic Forum. (2018). *The future of jobs report.* Geneva, Switzerland: World Economic Forum.

hand, the world is experiencing a gradual decline in the demand for routine cognitive skills such as memorising, which are easily automatable.

The analysis also shows that out of three main available options to deal with shifting skills demand – (1) hiring new workers already equipped with skills relevant to new technologies; (2) completely automating work tasks; and (3) retraining existing employees – the likelihood of hiring new workers with relevant skills is nearly twice the likelihood of the other options. This reiterates the need for developing education systems that are capable of equipping individuals with skills in high demand.

6.2.2 New Forms of Learning

Changing skills requirements call for new and effective ways of learning. Some of the most important technological developments in education have taken place since the launch of the internet in the early 2000s, and are being increasingly embraced in more recent years. Computer-aided learning – where computer programmes are used to assist students in learning subjects – as well as a wide variety of Information and Communication Technology (ICT) based learning applications, including mobile technologies embedded in devices such as e-toys, digital cameras, smart games, electronic tables, and smart mobile devices, have become progressively important as education resources for students.[4]

Table 6.1
Comparing Skills Demand, 2018 vs. 2022, Top Ten

Today, 2018	Trending, 2022	Declining, 2022
Analytical thinking and innovation	Analytical thinking and innovation	Manual dexterity, endurance and precision
Complex problem-solving	Active learning and learning strategies	Memory, verbal, auditory and spatial abilities
Critical thinking and analysis	Creativity, originality and initiative	Management of financial, material resources
Active learning and learning strategies	Technology design and programming	Technology installation and maintenance
Creativity, originality and initiative	Critical thinking and analysis	Reading, writing, math and active listening
Attention to detail, trustworthiness	Complex problem-solving	Management of personnel
Emotional intelligence	Leadership and social influence	Quality control and safety awareness
Leadership and social influence	Emotional intelligence	Coordination and time management
Reasoning, problem-solving and ideation	Reasoning, problem-solving and ideation	Visual, auditory and speech abilities
Coordination and time management	Systems analysis and evaluation	Technology use, monitoring and control

Source: World Economic Forum. (2018). *The future of jobs report.* Geneva, Switzerland: World Economic Forum.

[4] Zaranis, N., Kalogiannakis, M., & Papadakis, S. (2013). Using mobile devices for teaching realistic mathematics in kindergarten education. *Creative Education,* Vol. 4, pp. 1-10.

Various forms of online learning – referring to courses delivered via the internet to individuals outside the traditional classroom setting – have also risen in importance, and offer the ability for learning to occur from any location in the world. It allows for both live and real interaction between teachers, students, and peers via live online classes, whereas at other times it can be a lecture that is pre-recorded. Learning material can be shared in various formats including videos, slideshows, word documents, and PDFs. Other means of online communication made available via smartphones and tablets allow learners to keep in touch with teachers and each other, and discuss course-related matters, while also providing a sense of community.

The demand sources for online forms of learning include schools, universities, corporates, governments, or direct-to-student, whereas supply channels include content providers (authors, institutions), service providers (content creation, publishing, marketing), and technology providers (authoring tools, platforms, learning management systems (LMSs)).[5] Different tools within the LMSs enable various processes to be automated, such as a course with set materials and automatically graded tests.

There are several types of online forms of learning – all interconnected to each other – which can be broadly categorised into four main groupings, as detailed in Table 6.2.

Table 6.2
Online Forms of Learning

Type	Description
E-learning	Interaction between students and teachers happens online, without a student being present in a physical classroom with a teacher. While they can both be present in the same building, learning and communication takes place online. While offline components can exist (writing a response to a paper), the connection to the teacher is always online, through an internet connection (emailing a picture of their response to the teacher).
Blended learning	A combination of the traditional face-to-face learning in a classroom and distant learning via online instructions. Instructions therefore come from two sources: students generally follow a fixed learning schedule by attending classes at an educational institute, while courses are still online, allowing coursework and assignments to be completed online.
Online learning	Refers to using online tools for learning. Encompasses elements of both e-learning and blended learning, where the key element is the use of the internet. Lectures, assignments, and tests are all enabled via various virtual platforms.
Digital learning	A combination of online learning, e-learning and blended learning along with offline digital learning, using local software, such as video conferencing software, and digital cameras.

Source: Studyportals. (2018). *What's the difference between blended learning, e-learning and online learning?*. Retrieved from https://www.distancelearningportal.com/articles/269/whats-the-difference-between-blended-learning-e-learning-and-online-learning.html.

[5] Wijesiri, L. (2018, January 26). E-learning, way forward for next generation, *Daily News* (online edition). Retrieved from http://dailynews.lk/2018/01/26/features/141050/e-learning-way-forward-next-generation.

Massive Open Online Courses (MOOCs) – free online courses openly available for anyone to enroll – have gained prominence as an important e-learning platform in the last decade or so. First introduced in 2006, MOOCs provide an affordable and flexible way to learn new skills and deliver quality educational experiences at scale. In addition to traditional course materials such as recorded lectures, readings, and problem sets, many MOOCs provide interactive courses with user forums to support community interactions among students and teachers, as well as immediate feedback to quizzes and assignments. Despite high drop-out rates, numbers registering for MOOCs have expanded rapidly at comparatively low costs.

The Khan Academy (KA) is a well-known MOOC, a US based not-for-profit repository of pre-recorded instructional video tutorials, practice exercises, and a personalised learning dashboard, that enables learners to study at their own pace both in and outside the classroom.[6] It covers subjects including mathematics, science, computer programming, history, and economics, using state-of-the-art adaptive technology that identifies and strengthens learning gaps. A math lesson, for example, involves an instructor presenting mathematical concepts in seven-14 minutes on an electronic blackboard. The popularity of KA is apparent from its current user population of around 14-15 million from over 200 countries.[7] A key identified advantaged of KA is its ability to blend well with any teaching method, enabling teachers to use it without the need to change their current teaching models.[8]

6.3 Current Opportunities for Sri Lanka

Online forms of learning are largely limited to developed countries, with ICT infrastructure investments in developing countries often being hardware-oriented, focused on physical facilities such as computer laboratories.[9] In many countries, the institutional mechanisms to integrate and adapt technologies required for online learning are weak.[10] In this context, it is encouraging to note that Sri Lanka has recently ventured into the arena of online forms of learning, thereby opening up opportunities to modernise its education system in line with rapidly changing requirements. Most of these initiatives discussed below, take place in blended learning environments, with face-to-face learning in a classroom combined with online instructions.

6.3.1 My Personal Data Analysis

In recognition of the importance of high-quality mathematics education and in the context of poor performance levels of students,[11] a pilot project termed 'My Personal Data Analysis' was introduced in 2011 with the objective of

[6] Khan Academy. (2019). Retrieved from https://www.khanacademy.org/about.

[7] The Economist. (2017). *Learning and earning. Special report: Lifelong education.* Retrieved from https://www.economist.com/sites/default/files/learning_and_earning.pdf

[8] Weeraratne, B., & Chin, B. (2018). Can Khan Academy E-learning video tutorials improve mathematics achievement in Sri Lanka?. *International Journal of Education and Development using Information and Communication Technology, 14*(3), pp. 93-112.

[9] Asian Development Bank. (2018). *Learning from e-learning: Testing intelligent learning systems in South Asian Countries.* Project completion report.

[10] *Ibid.*

[11] From 2005 to 2010, the average mathematics failure rate at the G.C.E. Ordinary Level Examination (O-Levels) was 50.3 per cent, although somewhat lower at 37.0 per cent in 2018 (Department of Examinations of Sri Lanka). Further, 87.0 per cent of eighth graders scored below the pass mark of 40 in a national assessment of a paper comprising of Trends in International Mathematics and Science Study (TIMSS) test items, representative of the Sri Lankan grade eight mathematics curriculum

It is encouraging to note that Sri Lanka has recently ventured into the arena of online forms of learning, thereby opening up opportunities to modernise its education system in line with rapidly changing requirements.

improving mathematics learning outcomes. It involves a computer software in mathematics tailored for individual students, implemented by the government in collaboration with the Asian Development Bank (ADB), providing a series of mathematics problems at various levels of content knowledge targeting individual student needs.[12] An impact evaluation of the programme comprising a sample of 224 eighth grade English medium students of which 114 were in the treatment group, underwent 12 weeks of project implementation.[13] The impact evaluation showed the programme to be effective at a statistically significant level, with the standardised test scores of students in the treatment group improving by approximately 6.9 per cent of the possible score range compared to the control group. The positive outcomes of this programme, along with higher expected benefits of expanding it to non-English speaking students,[14] led to the implementation of a KA-type e-learning programme in 2014.

6.3.2 Khan-Academy Video Tutorials

The KA e-learning programme involves supplementing regular mathematics teaching, for a sample of ninth grade students in Sinhala medium public schools, with audio-visual tutorials in the form of YouTube videos from KA, covering 115 sub-topics related to the Sri Lankan ninth grade syllabus. For this initiative, 55 existing KA videos were translated into Sinhala, while another 80 new videos were developed for specific sections of the syllabus that are

[12] Asian Development Bank. (2018). *Learning from e-learning: Testing intelligent learning systems in South Asian Countries*. Project completion report.

[13] Kim, J. (2012). *Results from Item Response Theory (IRT) analysis of the MPDA mathematics program in Sri Lanka (First term 2012).* Manila, Philippines: Asian Development Bank.

[14] English proficient students in Sri Lanka are, generally, more economically advantaged and more likely to receive high-quality private tutoring, which could have limited the observed effects of this project. The relatively small sample size also challenged the impact evaluation estimates.

unavailable in the original KA programme. A total of 632 students were subjected to treatment who followed KA during two or three out of five class periods allocated for mathematics per week, while students in the control group followed regular classes for all five time slots. An impact evaluation of KA using propensity score matching revealed that, on average, KA contributed to increasing students' raw and scaled test scores by 3.77 and 3.15 percentage points, respectively, and standardised test scores by 0.20 standard deviations above the average test score.[15] These evaluations provide preliminary evidence that KA-type learning platforms can help Sri Lankan students in improving learning outcomes in mathematics, and potentially in other subjects as well.

6.3.3 Smart Classrooms

Another project in the sphere of online learning involves developing smart classrooms (SCs) in several schools across Sri Lanka. SCs consist of educational technology related components that facilitate an interactive and stimulating learning environment, including smart interactive whiteboards – a combined Digital Screen and Open Pluggable Specification, combining features of a computer and smart television – a classroom and multimedia control centre, computers and tablet personal computers (PCs), audio/video elements such as data show, projectors and recording systems, and classroom management systems – software that allows teachers to have full control of SC components and student equipment.

The construction of SCs in Sri Lanka is being undertaken by the government under the Ministry of Education (MOE), via collaborations between the government and private sector, primarily in the form of corporate social responsibility (CSR) projects, and by Past Pupils' Associations (PPAs). The MOE-led programme is within the purview of the government's '13 Years Guaranteed Education Programme', aimed at directing students who do not perform well at the O-Levels to higher education, vocational education, or direct employment – via an emphasis on vocational and skills training – offered within the school system itself.[16] The project involves the provision of five desktop computers, five laptops, and one interactive smart board in each school, to be used among 12th grade students, as part of their vocational and skills training. In 2017, information technology (IT) equipment was provided to 43 schools, which was extended to a further 154 schools in 2018.[17] As Figure 6.2 indicates, schools from all provinces – at broadly similar shares out of total school numbers – have been recipients of such facilities. An additional 661 schools will be targeted over the 2019-2021 time period.

The provisions in these schools, however, are limited to a few computers and smart boards and do not provide the full experience of a SC. Government and private sector collaborations have seen the construction of more comprehensive SCs – including tab PCs, classroom and multimedia control centres, projectors and recording systems, and online content systems – in a few public schools,

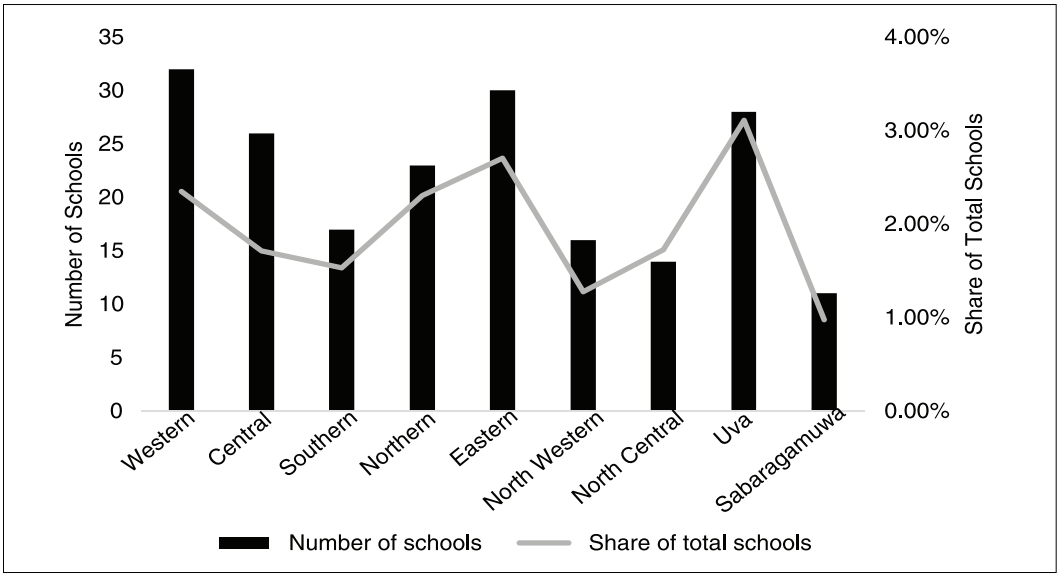
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[15] Weeraratne, B., & Chin, B. (2018). Can Khan Academy E-learning video tutorials improve mathematics achievement in Sri Lanka?. *International Journal of Education and Development using Information and Communication Technology, 14*(3), pp. 93-112.

[16] Government of Sri Lanka. (2017). *Vision 2025: A country enriched.* Colombo, Sri Lanka: Ministry of National Policies and Economic Affairs.

[17] Interview with official at the *Education for All* Branch, Ministry of Education of Sri Lanka.

Figure 6.2
Number and Share of Schools Provided with IT Facilities under the '13 Years Guaranteed Education Programme' as of end 2018, by Province



Source: Ministry of Education of Sri Lanka. (2019). *Education for All Branch*. Colombo, Sri Lanka: Ministry of Education of Sri Lanka.

primarily of privileged status, across several provinces (Table 6.3). At present, each school is equipped with one SC, with the exception of Sri Jayawardenepura Maha Vidyalaya Kotte where the entire grade seven has SCs, and students are able to make use of these facilities on a scheduled basis. Additionally, PPA-funded SCs have also been constructed in a few private and international schools in the Colombo and Kandy districts.

Table 6.3
Current Fully-Developed Smart Classroom in Sri Lankan Public Schools

School	Province	School Status
Sri Jayawardenepura Maha Vidyalaya, Kotte	Western	Highly privileged
Mahinda Rajapaksa Vidyalaya, Homagama	Western	Highly privileged
Vidyaloka Vidyalaya, Galle	Southern	Highly privileged
Sangamitta Balika Vidyalaya, Galle	Southern	Highly privileged
Buonavista Vidyalaya, Galle	Southern	Not privileged
Uadayarkatti Tamil Vidyalaya, Mullativu	Northern	NA
Kuliyapitiya Central College, Kuliyapitiya	North Western	Highly privileged
Saranath College, Kuliyapitiya	North Western	Privileged
Vishaka Girls' High School, Badulla	Uva	Highly privileged

Note: Sri Lankan public schools are categorised into five status groupings—highly privileged, privileged, not privileged, underprivileged, and highly underprivileged—based on a list of school resources, amenities, and ease of access to a school.

NA = Information not available.

Source: Ministry of Education of Sri Lanka. (2019). *Information and Communication Technology Branch.* Colombo, Sri Lanka: Ministry of Education of Sri Lanka.

Furthermore, a multistakeholder initiative involving the collaboration of several private sector stakeholders – Headstart (Pvt) Ltd, Commercial Bank, Microsoft Sri Lanka, and Dialog Axiata – under the supervision of the Department of Education of the Western Province, has embarked on a project to convert 65 schools in the Western Province into 'Smart Schools' capable of deploying digital learning protocols.[18] Operated by guru.lk – Sri Lanka's leading e-learning portal – the project involves providing schools with content to use on computers, a LMS, Microsoft Office 365 licenses, and technical support and training via trained 'ambassador teachers'. The following provisions have already been dispersed under this project:

- 175 IT labs, housed with computers, printers, furniture, and other equipment, benefitting over 160,000 students
- An innovative online education programme for an initial population of 20,000 students from 20 schools, where students can freely access web content in line with the local curricula of the G.C.E. Advanced Level (A-Level) mathematics and bio science streams and of grade 10 mathematics, science, and English
- A free-of-charge LMS for 25 schools, with compulsory projects such as monthly online quizzes and digital assignments being required to be uploaded to the system

Investments are also underway to create an online mathematics lab, mathematics revision lessons, and a section dedicated to vocational training. Currently, there are 6,500 trained teachers in guiding digitised learning, spread across the 65 schools.

These SCs are powered by several technology providers, including CodeGen International, Haier, the EWIS group, and Akura, operated via XOLO and other SC platforms.[19] Teaching and learning processes are carried out using tab computers or laptops – connected to a wireless access point that serves as the classroom cloud – where the need for printed textbooks and other material is redundant. The wireless access point and classroom management software enable teachers to monitor student progress on given tasks and aid them in the learning process, while also facilitating student-to-student collaboration.

The smart interactive displays provide both students and teachers opportunities to engage in different learning techniques, moving away from the traditional rote method of teaching. For instance, the technology allows for the installing of interactive tools or applications, uploading homegrown content, downloading interactive content online, and using interesting features such as automatically plotting graphs through a simple mechanism of clicking and dragging an equation on to a graph.[20] Lessons generated via the interactive whiteboard are automatically uploaded on student laptops. Some applications

[18] Daily FT. (2017, April 28). *From blackboards to smart schools: 65 WP govt. schools transformed.* Retrieved from http://www.ft.lk/article/611874/From-blackboards-to-Smart-Schools--65-WP-Govt--schools-transformed.

[19] XOLO is a unique education platform that goes beyond an LMS; it is the world's first unified application where electronic and personal content are both integrated in real-time on one screen with smart content delivery, where students are able to read, learn and write simultaneously.

[20] Daily FT. (2017, December 21). *EWIS powers Sri Lanka's very first smart classroom solution.* Retrieved from http://www.ft.lk/it-telecom-tech/EWIS-powers-Sri-Lanka-s-very-first-Smart-Classroom-solution/50-645663.

have additional facilities including a web interface which allows parents to log-in and monitor children's progress, a short message service (SMS) feature through which teachers can send messages to parents, and a mobile component where parents can view their child's progress via smartphones.[21]

Encouragingly, learning experiences in SCs have been positive so far, with identified improvements in student learning outcomes, attendance, motivation, engagement, and concentration.[22] Teachers are of the view that the new interactive technology of the system is attractive to students, as they can download lessons at any time, and participate in a class room session even if they miss school.[23] Teachers also view these new mechanisms as simpler and rewarding, facilitating lesson preparation through presentations, and the flexibility of grading assessments on their own tabs even from home.

Moreover, under the 'Smart Schools' project, a coding device named 'Microbit' has been used to engage students in innovative activities with coding and IoT in two schools in rural settings, following student training received at the University of Moratuwa on IT and Computer Science.[24] One example is the creation of a new software including an identity card for teachers where the name and details of the staff is registered and monitored in the software system, to be used in place of the traditional method of signing the attendance register.

6.3.4 E-thaksalawa

'E-thaksalawa' is a project initiated by the ICT branch of the MOE, as a strategy to incorporate e-learning methods into general education. It is an online LMS and consists of resources developed aligned to all grades of the school curricula including creative lessons, past papers, model papers with answers, text books, supplementary reading material, interactive learning sessions, and teacher instructional manuals. Its key objective is to promote equity in school education provision, and accordingly focuses on assisting students from rural backgrounds in establishing communication mechanisms to share knowledge and ideas. Further, it has the added advantage of being created by teachers serving in government schools who are familiar with the government school curriculum. Content is targeted to be available in all three languages. This e-platform has won several awards including the 'Manthon Award' in 2014 for the best e-learning content management system in the Asia-Pacific region, the 'E-Swabhimani National Best E-Content Award' under the e-learning and education category, and a merit award for the best Sri Lankan website in 2018.[25]

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[21] Aspitio. (2019). *Aspitio - Àkura school management system.* Retrieved from https://www.aspitio.com/akura/

[22] According to the school principal of the Sri Jayawardenepura Maha Vidyalaya Kotte, student attendance has increased up to 92.5 per cent, and average performance in subjects has increased by 24.0 per cent, with the highest individual average of 87.0 per cent at the term examination being recorded from a SC.

[23] Inayathullah, H. (2017, October 8). Cloud smart classroom in Sri Lanka: Revolutionising classroom teaching, *Sunday Observer* (online edition). Retrieved from http://www.sundayobserver.lk/2017/10/08/features/cloud-smart-classroom-sri-lanka-revolutionising-classroom-teaching

[24] Inayathullah, H. (2018, February 25). Digital-learning in rural schools push forward, *Sunday Observer* (online edition), Retrieved from http://www.sundayobserver.lk/2018/02/25/features/digital-learning-rural-schools-push-forward.

[25] Ministry of Education of Sri Lanka. (2016). *E-thaksalawa: The national e-learning portal for general education.* Retrieved from http://www.e-thaksalawa.moe.gov.lk/web/en/e-thaksalawa/about-e-thaksalawa.html

6.3.5 Digital Learning Experience Centre

The MOE has also established a Digital Learning Experience Centre (DLEC) to generate awareness and demonstrate new tools and learning methods, and keep in line with ICT and e-learning initiatives. The DLEC is akin to a SC environment, housed with all SC equipment, where demonstrations of lessons are conducted for school students. It is most frequently in use during school holidays, as well as on Wednesdays – which is Public Day at the MOE – when parents come to visit MOE officials. Encouragingly, students across the country, including those from distant locations, visit the MOE to make use of this facility.[26]

6.4 Current Challenges for Sri Lanka

While the above online learning initiatives are encouraging steps in the right direction, these are but a few examples; Sri Lanka's e-learning industry is still in its infancy, with fundamental changes in the education sector, as well as a robust infrastructure for digital access being needed to develop the industry and for it to eventually play a key role in shaping the skills and education needs of the country. Several challenges can be identified in this regard:

6.4.1 Resource and Skill Constraints

The technologies and equipment required to install and maintain SCs and other online learning platforms are costly. In the past, educational reforms aimed at modernising the education

Sri Lanka's e-learning industry is still in its infancy, with fundamental changes in the education sector, as well as a robust infrastructure for digital access being needed to develop the industry and for it to eventually play a key role in shaping the skills and education needs of the country.

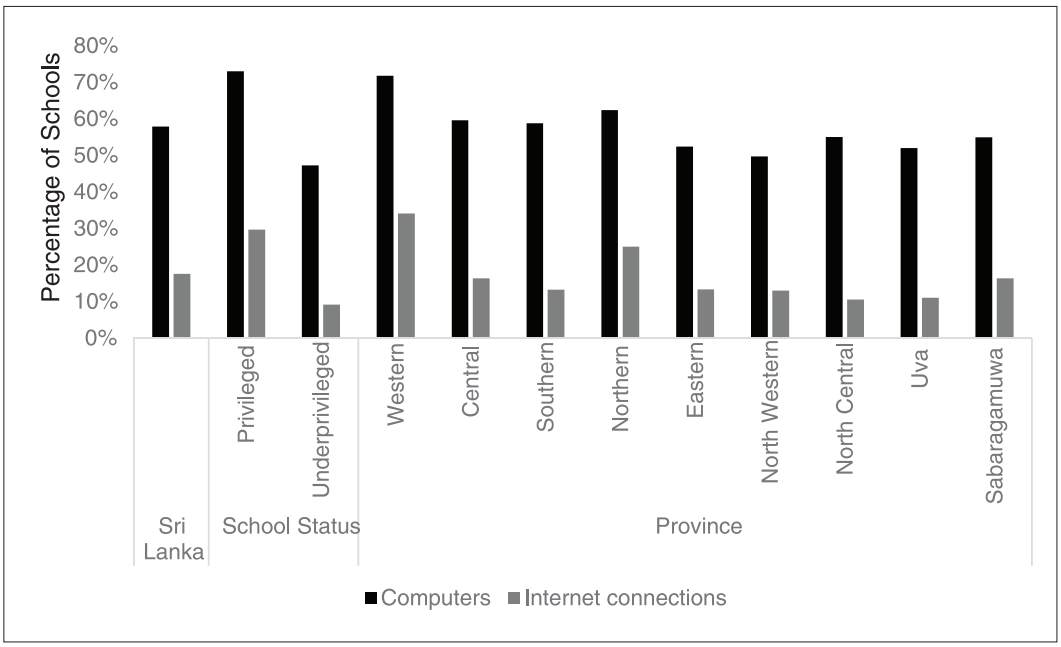
[26] Interview with official at the I*nformation and Communication Technology Branch,* Ministry of Education of Sri Lanka.

system – such as the introduction of a more practical-oriented curriculum and use of IT as a tool for learning-teaching processes – have failed due to lack of available resources.[27] Given the tight budget constraints under which Sri Lankan public schools operate, and limited private sector participation, allocating funds for smart technology will be a formidable challenge.

School Census data for 2017 indicate that only 58 per cent of schools have desktop computer facilities at the primary and/or secondary level. Not surprisingly, these facilities are also concentrated in privileged schools and in the more affluent Western Province (Figure 6.3). More worryingly, the share of schools with access to internet connections is substantially lower, across school status and provinces, signaling problems in expanding online forms of learning throughout the country.

Moreover, the current availability of other SC-related equipment in schools is notably low, and considerably below that of desktop computers. Figure 6.4 shows the average ratios of the number of different types of equipment to the number of schools, by school status. As can be seen, the ratios are below one for all equipment in both privileged and underprivileged schools, and are particularly low among underprivileged schools,

Figure 6.3
Share of Schools with Computer and Internet Connection Facilities, by School Status and Province, 2017



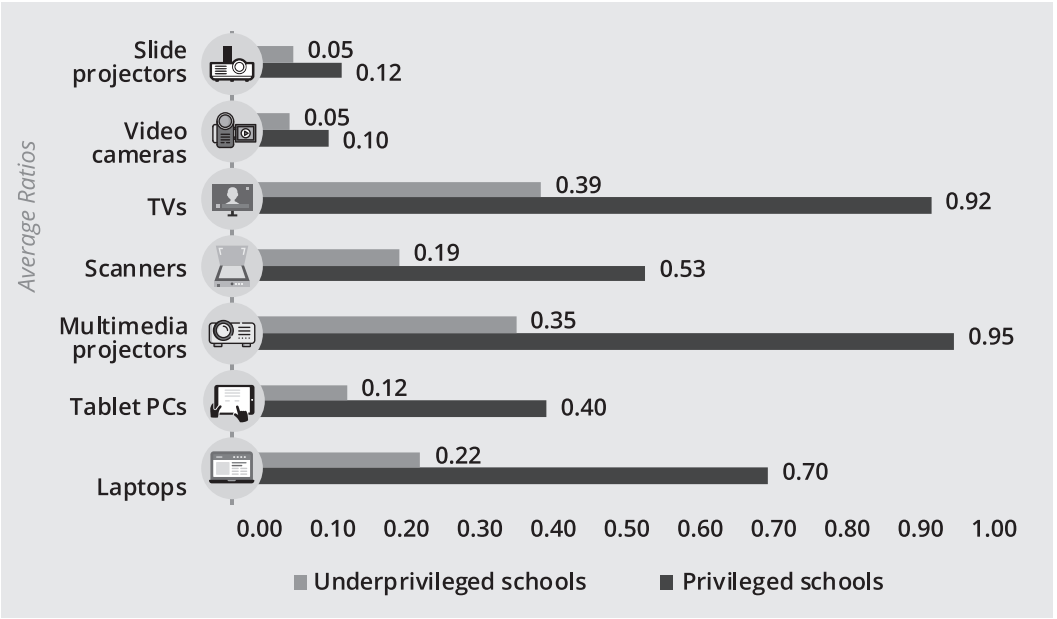
Source: Own calculations using 2017 school census data.

[27] Institute of Policy Studies of Sri Lanka. (2016). *Sri Lanka state of the economy 2016,* Colombo, Sri Lanka: Institute of Policy Studies of Sri Lanka.

indicating that there are fewer than one respective equipment per school. The chances of individual students benefitting from smart technologies are therefore negligible.

education level.[28] These gaps are also reflected in the relatively low enrollments in STEM subjects at the tertiary level: engineering, medicine, IT, and science undergraduate university enrollments

Figure 6.4
Average Ratios of Smart Classrooms Equipment to Number of Schools, by School Status, 2017



Source: Own calculations using 2017 school census data.

Apart from technological equipment, resource constraints in terms of providing education in the science, technology, engineering, and mathematics (STEM) fields will also hinder the skilling of students in fields such as big data analytics and machine learning. For instance, only 10 per cent of schools offer STEM subjects at the A-Levels, while there also exist national-level shortages in qualified and experienced science and mathematics teachers at the secondary

account for only 28 per cent of total enrollments, compared to over 50 per cent in the arts, law, and management streams.[29] The relatively low number of skilled IT graduates has in fact been identified as a major constraint facing Sri Lanka's rapidly growing ICT industry, according to a recent survey undertaken by Sri Lanka's Information and Communication Technology Agency (ICTA) (Box 6.1).

[28] Arunatilake, N., & Abayasekara, A. (2017). *Are there good quality teachers for all classrooms in Sri Lanka?* Colombo, Sri Lanka: Institute of Policy Studies of Sri Lanka.

[29] Dundar, H., Millot, B., Riboud, M., Shojo, M., Aturupane, H., Goyal, S., & Raju, D. (2017). *Sri Lanka education sector assessment: Achievements, challenges, and policy options,* Washington D.C.: World Bank.

Box 6.1
Shortage of Skilled ICT Graduates in Sri Lanka

The fifth consecutive National ICT Workforce Survey conducted by the ICTA in 2018, aimed at providing comprehensive information on the ICT sector in Sri Lanka, notes that Sri Lanka's rapidly expanding ICT industry now requires a bachelor's degree as a minimum entry-level qualification. This requirement has led to a widening of the demand-supply gap for the country's ICT workforce, from a shortfall of 500 workers in 2013 to as much as 12,000 in 2019. The problem is not to do with numbers per se, but relates more to the demand for good quality workers – raising the minimum entry-level qualifications comes amidst several quality concerns raised by employers with regard to workers produced by various training institutes. In particular, this survey notes that tertiary and vocational education institutes in both the state and private sector should take measures to raise the skills of trainees at national vocational qualification (NVQ) levels 5 and 6 (diplomas and higher diplomas) as well as upgrade them to level 7, equivalent to the graduate level, in close consultation with potential employers. Apart from deficiencies in core and technical skills, gaps in soft skills have also been identified, particularly pertaining to communication, team work, creative thinking skills, and professional ethics, skills which are increasingly important in a 4IR context.

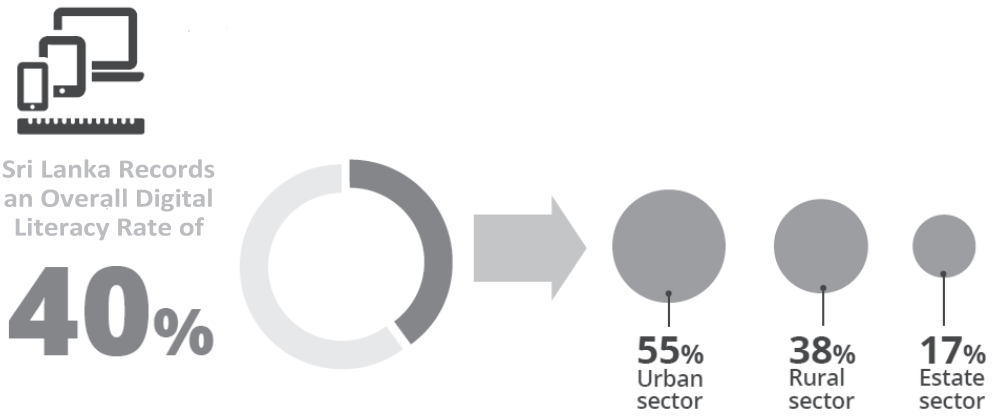
Source: Economy Next. (2018). *High quality ICT graduates severely short in Sri Lanka, soft-skills gap: Survey.* Retrieved from https://economynext.com/High_quality_ICT_graduates_severely_short_in_Sri_Lanka,_soft_skills_gap__survey-3-15417-7.html

6.4.2 Equity Concerns

A related concern is the risk that smart technologies will widen existing disparities in access to quality education. As seen, current SC initiatives – particularly those that involve fully developed SCs – are largely limited to schools in the Western Province, owing both to resource availability as well as sources of private funding such as well-established PPAs, mainly prevalent in large urban schools.[30] In addition to the concentration of physical resources in more affluent areas, disparities in the distribution of human resources also pose challenges in this regard; while Sri Lanka records an overall digital literacy rate of 40 per cent – defined as the share of 5-69 year-olds who can use a computer, laptop, tablet, or smartphone on his/her own – this rate varies significantly from 55 per cent in the urban sector to 38 per cent in the rural sector, and to only 17 per cent in the estate sector.[31] Even if smart technologies were made available, ensuring that students in rural and marginalised areas are able to benefit from these, and that there are sufficiently skilled teachers who can learn and adopt new teaching methods, will thus be a challenge.

[30] Arunatilake, N., & Jayawardena, P. (2013). School funding formulas in Sri Lanka. Paper commissioned for the EFA Global Monitoring Report 2013/4, *Teaching and learning: Achieving quality for all.* Geneva, Switzerland: United Nations Educational, Scientific and Cultural Organisation.

[31] Department of Census and Statistics of Sri Lanka. (2017). *Computer literacy statistics – 2017 (Annual).* Battaramulla, Sri Lanka: Department of Census and Statistics of Sri Lanka.



The risks of further widening already existing gaps between privileged and underprivileged schools and urban and rural areas, in terms of equipping students for a 4IR environment, are thus high. A case in point is the KA programme, where adoption of random sampling methods to select schools was not possible due to ICT infrastructure gaps in schools, thus limiting the sample to three (more urbanised and affluent) provinces – Western, Southern, and Central.[32] Further, the requirement of 20 computers for concurrent student use necessitated the 20 schools to be purposively selected, given that only 20 schools had such facilities in each province.[33] As a result, students attending less privileged schools in more rural locations were unable to benefit from this programme.

6.4.3 Slow and Unsystematic Reform and Implementation Processes

Barriers to reform education in line with 4IR developments, for instance due to archaic and inflexible governance structures or poor implementation, can also pose challenges in embracing modern education-related technologies. In Sri Lanka, education policy reforms, spearheaded by the National Education Commission (NEC) take place once in 10 years, while changes and revisions to school curricula undertaken by the National Institute of Education (NIE), are also made only once in every eight years.[34] This pace of reform implementation is woefully inadequate, given the rapid speed of technological advancements. Adopting new learning techniques, for instance, will have limited effectiveness unless school curricula are also revised in a manner that encourages traits such as critical thinking and problem-solving.

Moreover, past curriculum reform efforts of the NIE to make learning more practical-oriented have led to limited change in the quality of education due to a host of problems. These include failure to base reforms on identified weaknesses in preceding curriculums, lack of proper pre-testing carried out with regard to suitability, deficiencies in content, teaching methodology, and curricular

[32] Weeraratne, B., & Chin, B. (2018). Can Khan Academy e-learning video tutorials improve mathematics achievement in Sri Lanka? *International Journal of Education and Development using Information and Communication Technology, 14*(3), pp. 93-112.

[33] *Ibid.*

[34] Institute of Policy Studies of Sri Lanka. (2016). S*ri Lanka state of the economy 2016.* Colombo, Sri Lanka: Institute of Policy Studies of Sri Lanka

material, poor knowledge of teachers about new curricula, and lack of a proper monitoring and evaluation system.[35] A recent proposal to provide tablet PCs to A-Level students and teachers in government schools free of charge has also come under criticism,[36] given the large costs involved and the absence of a concrete policy document with an explicit indication of how the provision of tabs will translate into good learning outcomes. Information is also lacking on support systems needed, and how the impact of the intervention is to be assessed.

6.5 Policy Implications

Restructuring Sri Lanka's education system to meet the demands of a 4IR labour market is a multifaceted and long-term task; nevertheless, this section identifies some policy priorities that Sri Lanka can focus on, in moving towards a more relevant and responsive education ecosystem, by capitalising on available opportunities to push through existing barriers.

6.5.1 Designing a 'Future-ready' Curricula

There is an urgent need to design education curricula which impart knowledge and skills that have relevance in the modern workplace. Existing research points to two key focus areas in accomplishing this task;[37] (1) what to teach; and (2) how to teach it. There is a growing consensus that content should focus on linguistic, mathematical, and technological competencies all jobs will need in the future, ensuring in-depth subject knowledge and the ability to make inter-disciplinary connections, and developing global citizenship values, including noncognitive employability skills. With regard to the second point, there is general agreement that curricula must be: 1) updated and adapted periodically, based on insights and projections regarding the development of local and global labour markets and trends in skill demands; 2) developed and revised collaboratively, with input from all relevant stakeholders including employers, unions, parents, teachers, and students; and 3) subject to systematic review, in order to avoid implementation delays associated with curricular revisions.

As discussed previously, Sri Lanka has a poor track record with regard to updating curricula that is timely and relevant, a gap that needs to be addressed to remain competitive in a rapidly evolving technological landscape. In this context, Sri Lanka can take advantage of the recent uptake of e-learning systems such as SCs – and identified positive learning outcomes and other benefits – to make timely and significant changes to its education curricula. Smart technologies, for instance, allow for more holistic teaching approaches, making a strong case for incorporating more critical thinking, problem-solving, and interpersonal skills approaches into syllabi – as opposed to traditional memorisation-intensive content – to support these new forms of learning.

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[35] National Institute of Education. (2008). *An evaluation of the process of development and implementation of the new curriculum in grades 6 and 10.* Maharagama, Sri Lanka: National Institute of Education.

[36] The project envisions including contents of text books and course materials into the tabs, thereby removing the need to refer to physical textbooks and syllabi redundant. The targeted sample is 175,000 students and 28,000 teachers, at an estimated cost of Rs 4-5 billion.

[37] World Economic Forum. (2017). *Realising human potential in the fourth industrial revolution: An agenda for leaders to shape the future of education, gender and work,* White Paper. Geneva, Switzerland: World Economic Forum.

Sri Lanka can take advantage of the recent uptake of e-learning systems such as Smart Classrooms – and identified positive learning outcomes and other benefits – to make timely and significant changes to its education curricula.

6.5.2 Multistakeholder Involvement

Addressing issues such as resource constraints and equity concerns in digitising Sri Lanka's education sector requires the involvement and contribution of multiple stakeholders, given the enormity of the task at hand. Capitalising on positive experiences such as the 'Smart Schools' project, similar collaborations between the government and private sector partners can be initiated in expanding e-learning initiatives across the country, especially in more rural underprivileged schools that are unlikely to have alternate sources of funding.

It is also prudent to look into collaborations with international organisations: recent initiatives such as 'IT Yahamaga' by Sarvodaya Fusion – a Sri Lankan technology-inclusion non-governmental organisation (NGO) – with CISCO324 and Microsoft325 can serve as good examples, which aims at creating awareness among school children, teachers, and parents on using modern day ICT tools to create a positive social impact.[38] Apart from such collaborations, the continuous improvement of public sector effectiveness through greater inter-ministerial coordination on education issues and strengthened governance, management, and financing of education is also key, particularly in ensuring that planned initiatives are implemented effectively, with clearly identified objectives and specified means of achieving them.

[38] *Sarvodaya-Fusion. (2018). Sarvodaya-Fusion and LK domain registry partnership continues*. Retrieved from https://fusion.lk/tag/sarvodaya/ https://fusion.lk/tag/sarvodaya/

6.5.3 Enhancing Digital Fluency

Moving forward in developing a responsive and relevant education ecosystem calls for improving digital fluency across the country. Increasing the STEM-literacy of the population is an important element of improving digital fluency, and is considered important for emerging advanced IT jobs. However, as research indicates,[39] this alone is not sufficient: STEM subjects are typically taught in a way that reinforces a divide between sciences and humanities, and focuses on theory over application. Further, even within STEM-specific fields, employability will partly depend on creative, critical thinking, and non-cognitive skills, emphasising the importance of generalised digital fluency, over and above subject-specific competencies.[40] Thus, there is a need to embed technology across the educational experience to reflect its bearing in all sectors and occupations.

In this regard, Sri Lanka would do well to consider: (1) modernising the A-Level arts stream and making it more technology-intensive; and (2) creating more flexibility in integrating the humanities and arts with STEM subjects. Modernisation of the arts stream is important both because improving STEM education in Sri Lanka is a challenging and long-term process, and because the current employability levels of arts graduates are low despite high enrollment rates.[41] A-Level subjects such as arts, music, and the languages, which at present hold limited scope in the job market, can be transformed into those of increasing relevance and importance – particularly given their creative nature – by integrating technological components into

Sri Lanka would do well to consider: (1) modernising the A-Level arts stream and making it more technology-intensive; and (2) creating more flexibility in integrating the humanities and arts with STEM subjects.

[39] World Economic Forum. (2017). Realising human potential in the fourth industrial revolution: An agenda for leaders to shape the future of education, gender and work, White Paper. Geneva, Switzerland: World Economic Forum.

[40] *Ibid.*

[41] Dundar, H., Millot, B., Riboud, M., Shojo, M., Aturupane, H., Goyal, S., & Raju, D. (2017). *Sri Lanka education sector assessment: Achievements, challenges, and policy options.* Washington D.C.: World Bank.

these subjects. Many undergraduate and graduate courses in areas such as digital image manipulation, podcasting, internet art, 3D modeling, holography, moving image art, new media art, computer animation, and video art are examples of such endeavours.[42] Allowing more flexibility in selecting subject combinations at the A-Levels across arts and STEM subjects, while encouraging more students to pursue technical subjects, is also important in moving away from an emphasis on specialisation to one that equips individuals with broader skills sets and flexibility demanded by a 4IR economy.

[42] Upul, Kumara, (2018). *Modernisation of arts stream to enhance employability in Sri Lanka,* Draft Report. Battaramulla, Sri Lanka: Ministry of Education.

7. Migration and International Travel in the 4IR

7.1 Introduction

The fourth industrial revolution (4IR) is changing today's world. The combination of digitalisation (catalysts from the third industrial revolution) with features such as robotisation, automation of tasks, big data, artificial intelligence (AI), blockchain, and the internet of things (IoT), to name a few, have evolved into the 4IR – a state where machines can consume and translate a large volume of data developed at rapid speeds to achieve tasks beyond the capacity of humans.[1] It is being variously described as an "unprecedented advancement in technology, the explosion of data, and our ability to consume and convert it into intelligence, is causing our physical and digital worlds to converge at rate like never before."[2]

Travel, in general, has taken a new shape in the context of the 4IR. Shared economy and platform business models have eliminated the middlemen and made air travel and accommodation bookings more lean and cost effective; biometric data authenticating the validity of digital and physical information in travel documents such as e-passports makes traveller's identity less susceptible to tampering; automation at borders can make travel less stressful with faster clearance of low risk travellers at e-Gates, while IoT censors capture information about a traveller's body temperature and hydration etc., allowing service providers to customise and personalise traveller experiences.

While some travel for the pleasure of travelling, a vast number travel for employment in a foreign country. Globally, 64 per cent of all migrant travellers has migrated for employment.[3] However, traditional models of employment are increasingly replaced by new developments associated with 4IR technologies.[4] Employment platforms are increasingly making work piecemeal, where workers are engaged for 'gigs' instead of employment with an employer, and a disconnected team of workers carry out work in isolation via a *platform* on a single project, without reflecting any traditional characteristics of a 'team'. At the same time, the new world of work is increasingly polarised across low-skilled, low paying jobs and high skilled, high paying jobs. As a result, the 4IR is challenging the validity

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1 McKenzie, F. (2017). *The fourth industrial revolution and international migration.* Working Paper. LOWY Institute for International Policy.

2 Fletcher, I. (2018). *IBM: Fourth industrial revolution – Positioning for change.* Retrieved from https://cfi.co/northamerica/2018/08/ian-fletcher-fourth-industrial-revolution-positioning-for-change/.

3 International Labour Organisation. (2018). *ILO global estimates on international migrant workers : Results and estimates.* Geneva: International Labour Organisation.

4 See Chapter 5 of this book on '4IR and the Future of Work in Sri Lanka'.

of a bulk of workers in the middle of the skills distribution set. These developments of the 4IR in terms of employment, coupled with associated elevated levels of connectivity, its speed and flexibility, herald a new era for the global labour force and related labour migration.

Often, labour migration is motivated by wage differentials across countries and the capacity to earn a higher income, and possibility to remit such incomes to the country of origin. Similar to the many opportunities opening up via the 4IR for labour migration and world of work, the greater connectivity and speed expand the horizons for remitting the benefits of migration. Such remittances include both financial and social remittances, where blockchain technology shows the potential to revolutionise financial remittances, while the socially connected and integrated world in the 4IR complements transfer of social remittances.

Nevertheless, this height of technological advancements in some aspects are creating inadvertent challenges. For instance, international remittances are now routed via many countries in efforts to make transactions efficient and cheaper. As a result, for instance, it remains tedious to discern the country of origin of remittances, and leads to a gray area often exploited for money laundering and for financing terrorism. At the same time, the normally unsearched corners of the internet is facilitating global workers to provide their labour anonymously via online platforms and marketplaces for illegal activities.

In this context, this chapter examines the implications for international travel, tourism, migration, and remittances in the Sri Lankan economy from the point of view of the 4IR. The discussion starts with an introduction to the 4IR and an overview of the influence of 4IR in aspects related to tourism, migration, and remittances. Thereafter, these aspects are examined in relation to Sri Lanka along with an analysis of the current trends in tourism, migration and remittances through the lens of the 4IR. The final section concludes by identifying challenges, future potential and way forward for Sri Lanka in terms of the 4IR for travel, migration and remittances.

7.2 4IR for Travel

The 4IR has influenced travel for pleasure and tourism in many ways. Developments in crowdsourcing, automation of tasks, big data, platform economy, AI, and IoT have contributed to extensive analysis and understanding of travellers to improve the services offered to them. This section discusses how these changes have impacted booking to travel, preparation of travel documents and border control.

7.2.1 Platforms, Market Places and Shared Economy for Booking

Travel involves at least three clearly demarcated phases – pre-travel, travel, and destination. An important component of the pre-travel phase is about searching out where to travel to and the available options to get there, where to stay, what to do and how to navigate at the destination.

Traditionally, information required to make these decisions would involve months of research and the services of a travel agent, mediating between the traveller and travel service provider. The 4IR technologies have made travel planning efficient, replacing physical travel agents with online travel agents, where the potential traveller can access a plethora of related information by a few key strokes on a computer connected to the internet. The service providers for travel are increasingly adapting to a platform, or a sharing economy

for their numerous benefits. This new wave of economic models is based on the building blocks of internet technologies associated with Web 2.0 also known as 'participatory', or 'social web'. In contrast to the first generation of internet (Web 1.0) where users were limited to passive viewing of web content, internet technologies associated with Web 2.0 facilitate user interaction and collaboration in virtual communities, creates user generated content, promotes ease of use, and facilitate inter-operability (compatible with other products, systems, and devices). These serve as the building blocks of many innovative business models in the era of 4IR.

Platform and shared economies of diverse shapes and sizes commonly offer an "open digital infrastructure to an ecosystem of distinct but mutually dependent groups of users".[5] Contingent upon its type, these platforms have built-in mechanisms that allow groups of users to seek, intermingle, cooperate and transact with each other on the platform. These mechanisms are leveraging on data and associated algorithms developed to match across different groups of users.

For travel, there are platforms that provide crowdsourced reviews to assist potential travellers to make plans, as well as booking platforms/marketplaces to lock in reservations for air travel and accommodation. For instance, TripAdvisor, among other features, is a version of a crowdsourcing website with a collection of over 760 million reviews and opinions covering approximately 8.3 million traveller services, and on average has 490 million unique visitors a month.[6] The ability of potential customers to access such a large pool of customer reviews makes 'travellers rely on other travellers' reviews to plan their trips, or at least can be satisfactorily helped in their decisions by others'.[7] Though not representative of all travellers, the voluntary reviews provided in these sites generate a mixed bag of positive and negative feedbacks, which enables potential travellers to make better-informed decision than solely relying on self-advertisements by the service provider.

Subsequent to obtaining information and making a travel decision, the next task (once challenging but now effortless) is booking for travel in the country of destination. The increased level of connectivity and new models of economic operation in the 4IR is making travel agents increasingly obsolete. For instance, the Bureau of Labour Statistics (BLS) of the US predicts a 12 per cent decline in employment of travel agents from 2016 to 2026.[8] In addition to simply replacing services of a physical travel agent, the market places or platforms that host accommodation, air travel or tourist experiences are also bringing together large cross sections of travel and tourist service providers on a single platform or market place. This enables easy comparison of dimensions such as services or facilities available, pricing, and demand and supply trends, and influences supplies and travellers differently.

For suppliers, the competition can now be gauged more easily in real time. As such, pricing is a crucial aspect of modern travel and tourism

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5 Dustch Transformation Forum. (2018). *Unlocking the value of platform economy : Mastering the good, the bad and the ugly.* Dustch Transformation Forum. (p.7).

6 TripAdvisor. (2019). *TripAdvisor reports first quarter 2019 financial results.* Retrieved from http://ir.tripadvisor.com/events-and-presentations

7 Miguéns, J., Baggio, R., & Costa, C. (2008). *Social media and tourism destinations: TripAdvisor case study.*

8 BLS. (2019, May 29). *Occupational outlook handbook, travel agents.* Retrieved from https://www.bls.gov/ooh/sales/travel-agents.

services, where dynamic pricing is critical. Such tedious and time-consuming calculations are supported by automation of tasks and high levels of analysis fostered by the 4IR. For instance, the airline industry groups airfares into multiple classes and manages seat inventory dynamically, and 'constantly recompute protection levels and bid prices by taking into account the current number of available seats and latest demand forecasts. As such, these results in constant opening, closing, and reopening of fare classes and volatility in prices according to Li, Granados and Netessine (2014, p. 2).[9] From the point of view of the traveller, he or she needs to sift through a large amount of information about features and prices to decide on a service provider, and lock in a reservation at the right time to obtain the best possible price. While suppliers may rely on big data and related analytics for their pricing decisions, individual consumers do not have such capacities. The solution to remedy this imbalance has also emerged from platform/market ecosystems, where most market places or platforms for travel and tourist services provide a comparison across a large number of service providers within seconds, and use AI, big data, and machine learning to provide suggestions to consumers about 'wait' or 'buy.'[10]

Another major development in the travel and tourism sector in the 4IR, is the disruption of the traditional tourism accommodation model of renting space. Challenging this model, Airbnb became operational from 2009, as a trusted community marketplace for people to list, discover, and book unique accommodations around the world. In its peer-to-peer accommodation model hosted via an online marketplace facilitating large-scale rental of spaces from one ordinary person to another, Airbnb is free to access for hosts, which allows them to 'effortlessly enter the tourism accommodation sector as hosts, and compete with traditional accommodation enterprises for guests from around the world'.[11]

Another major development in the travel and tourism sector in the 4IR, is the disruption of the traditional tourism accommodation model of renting space.

[9] Li, J., Granados, N., & Netessine., S. (2014). Are consumers strategic? Structural estimation from the air-travel industry. *Management Science,* 60(9), 2114-2137.

[10] *Ibid*.; Proffit, C. (2019, May 28). Top 10 big data companies disrupting the travel industry. *Disruptor Daily.* Retrieved from https://www.disruptordaily.com/big-data-disrupting-travel-industry/

[11] Guttentag, D. (2015). Airbnb: Disruptive innovation and the rise of an informal tourism accommodation sector. *Current Issues in Tourism, 18*(12), 1192-1217.

As noted, 'the real novelty and added value of digital platforms is not about a specific technology, but about how platforms combine technologies to organise the interactions more effectively between individuals on a very large scale'.[12] In linking hosts to travellers, Airbnb hosts create a listing with property details, price and pictures, which are checked out by potential travellers. As such, technologies of Web 2.0 and the shared economy allow small players in the industry to determine their own prices and effectively market their products and services to a large and geographically scattered audience. In this peer-to-peer market, travellers and hosts both have the ability to review the profile of the other party and accept/reject a booking. Currently, Airbnb lists over 1.2 million accommodations spanning over 34,000 cities across 190 countries or more.

At the macro level, Airbnb is seen to grow the overall pie and allow a wide variety of businesses to obtain a larger slice in the tourism/accommodations industry.[13] Nevertheless, a drawback of such platforms is their capacity to undermine competitiveness of other players/operators. Specifically, these platforms generate and analyse extremely large volumes of data using highly powerful processing engines. This gives such platforms an undue advantage when competing on data in this modern digitalised world in the 4IR. This advantage often means an ability to dictate to the market and make other stakeholders dependent on them.[14] Many studies on the impact of Airbnb on the hotel industry show that the increase in hotel rooms due to Airbnb has resulted in a decline in hotel revenues.[15]

Additionally, such platform economies operate in a gray area in terms of regulations in the context of laws created for businesses and people. What the sharing economy does is to create a third category – i.e. people as businesses.[16] A main regulatory concern against platform economies, such as Airbnb, is not being covered by the same laws as that of their traditional competitors. To remedy this, many new laws are being passed, such as the ones restricting those eligible to offer their homes on Airbnb and making Airbnb responsible to pay the 14 per cent hotel tax in San Francisco, and a law that requires online platforms (such as Airbnb) to transmit user data (such as gross income and number of transactions) to the French tax authorities on an annual basis.

7.2.2 Biometrics and Blockchain for Border Control

While the pre-travel stage is highly influenced by developments such as platforms and market places for researching and booking, the experience in the travel stage is closely intertwined to border control. The 4IR can add length and breadth to increase efficiency in border control by overhauling individual privacy and identity management related to border control, and address issues such as queues, wait time, airline efficiency, and customer experience.

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[12] Dustch Transformation Forum. (2018). *Unlocking the value of platform economy : Mastering the good, the bad and the ugly.* Dustch Transformation Forum. (p. 6)

[13] Kaplan, R. A., & Nadler, M. L. (2015). Airbnb: A case study in occupancy regulation and taxation. *U. Chi. L. Rev. Dialogue, 82*, 103-115.

[14] *Ibid*.

[15] Gyódi, K. (2017). *Airbnb and Booking.com: Sharing economy competing against traditional firms?* Working Paper, DELab UW | NO. 3(September, 2017).

[16] Kaplan, R. A., & Nadler, M. L. (2015). Airbnb: A case study in occupancy regulation and taxation. *U. Chi. L. Rev. Dialogue, 82,* 103-115.

The 4IR can add length and breadth to increase efficiency in border control by overhauling individual privacy and identity management related to border control, and address issues such as queues, wait time, airline efficiency, and customer experience.

The most critical aspect of border control is validating the identity of travellers. Traditionally, identity verification is based on matching text/photographic information in the travel document against the holder of the document. The 4IR technologies make this process sophisticated by combing biometric, digital and physical data in the verification process. As such, current passports issued by all countries are standardised and machine readable, while many countries are also issuing e-passports. E-passports provide additional security to traditional non electronic passports by embedding an electronic chip with biographical information, and a country specific 'digital signature', which can be verified via respective certificates.[17] This biometric data stored in the passport establishes the link between the digital data stored in the passport and the physical information carried by the owner of the passport (face, fingerprint, etc.) to verify that the passenger carrying the passport is the authentic owner of same. Currently, the most commonly used biometric features for identity are fingerprint and iris, while other advanced biometrics that can become common with emerging technologies include trait, 3D face, DNA, gait and electrocardiogram.

E-passports also enable border officials to electronically authenticate the integrity and authenticity of a given travel document, and confirm if it has been altered or issued by the appropriate competent authority. The technology adopted with such e-passports is contactless smart card technology, where a built-in microprocessor chip and antenna communicate and authenticate information to a reader antenna at close proximity. Additionally, these e-passports have public key infrastructure (PKI), which uses cryptographic techniques to facilitate secure

[17] International Civil Aviation Organisation. (2019). *ePassport basics.* Retrieved from https://www.icao.int/Security/FAL/PKD/Pages/ePassportBasics.aspx

communication via insecure public networks, to verify the information stored. The use of PKI has made forging e-passports expensive and difficult.

In addition to e-passports, there are various other latest developments aiming to make travel and border control more efficient. One such development is virtual passports, in which information from the passports and biometrics are stored in the cloud and travellers pass border control document free. Virtual passports were pilot tested in Australia in 2015. Similarly, a 'single token' was launched in Aruba in 2015, where a passenger's identity is verified and authenticated by matching their passport and biometric information only a single time throughout a travel journey. Subsequently, a token containing a picture of the passenger stored in a personal data envelop within a secure platform virtually travels with the passenger throughout the journey to facilitate identification. Another novelty in passports is the use of mobile apps, which enable passengers departing from specific airports to use their smart phones in place of their physical passports. Other upcoming developments for border control include smart tunnels and e-cars.[18] In the smart tunnel, the passenger would pass through a tunnel in the airport where facial and iris recognition technology for identification and scanners for security checks, allow travel without a passport. With e-cars, the traveller would ride an e-car equipped with a camera, scanners as well as a weighing scale (in the boot), from home to the airport; during the ride, the passenger would clear border control and immigration via facial recognition technology. Further any baggage would be weighed and security scanned, and all information would be transmitted to relevant points in the airport. Finally, the passenger would be directly transported to the boarding gate or lounge, and cargo to the cargo area of the plane.

In all the above discussed sophisticated border control measure in the 4IR, highly sensitive unique personal information including biometric data is shared across parties. From the traveller's point of view, providing personal identity information permanently to a third-party government is risky if their security measures (of the information receiving party) to protect such information is not satisfactory. Moreover, just as biometric data can rapidly and accurately determine individual admissibility, it comes with the demand for extreme high levels of security features. For, unlike a password, if compromised, biometric data cannot be changed.[19]

A technology that is increasingly used to maintain information in a secure manner is blockchain. Blockchain is a public database or chain that stores cryptographically linked digital information, which is called a 'block'. The security feature of blockchain is the unique identifier called 'hash', which stores cryptographic hash of the previous block, linking all blocks into a chain.[20]

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[18] Tesorero, A. (2017, October 10). *Your smartphone is now your passport at Dubai airport.* Retrieved from https://www.khaleejtimes.com/nation/dubai/your-phone-is-now-your-passport-at-dubai-airport-

[19] World Economic Forum. (2018). *Future of jobs report.* Geneva, Switzerland: Centre for the New Economy and Society, World Economic Forum.

[20] Blockchain is inspired by the method of exchange used nearly 1,500 years ago on the island of Yap in Micronesia. The modern technology thrives under the influence of 4IR. A 'block' stores information about transactions, participants in the transaction, and a unique identifier called a 'hash', which also includes a cryptographic hash of the previous block. A new block is added to the chain only after the transaction has occurred, verified by the network of computers in this public database. A verified transaction is stored in a block, and a hash is associated with the block (Flore, M. (2018). *How blockchain-based technology is disrupting migrants' remittances: A preliminary assessment.* EUR 29492 EN, Publications Office of the European Union, Luxembourg, Retrieved from https://www.investopedia.com/terms/b/blockchain.asp, ISBN 978-92-79-98177-7, doi:10.2760/23991, JRC113484.).

Due to its design, tampering with data in a block is nearly impossible. Specifically, retroactive alteration of data in any block cannot take place without the alteration of all subsequent blocks. Moreover, given that data for blockchains are stored in a distributed network, an alteration or tampering of data in one computer is insufficient to make a change, as all computers in the blockchain network store copies of each blockchain. Thus, any tampering with data require that all computers be manipulated, as well as all subsequent hashes be altered, calling for extremely large computing power and energy. These characteristics make a blockchain almost foolproof and permanent. Additionally, blockchains have a combination of private and public keys which are required to securely store, access and verify information. As such, the issue of securely storing identification information of travellers are addressed by adopting blockchain technology.

7.3 Worker Migration in the 4IR

Apart from travelling for pleasure, a large component of global cross-border travel is for migration. Such migrants include those crossing borders for employment, education and other purposes such as security, medical and family reunification. The global stock of migrants in 2018 is estimated at 266 million.[21] Going by 2017 figures, 64 per cent of global stock were identified as migrant workers.[22] In terms of contribution to GDP, cross-border migrants are estimated to have contributed 9.4 per cent of global GDP, or approximately USD 6.7 trillion in 2015.[23]

7.3.1 Reshaping Employment and Foreign Employment

Innovative developments of the 4IR have revolutionised the world of work in ways that impact migrant workers. On the one hand, automation of routine work is increasingly displacing workers, including migrant workers. The predictions for future of work hint that 'most routine occupations, regardless of whether they are low-skilled or high-skilled, can be automated and therefore will be replaced by robots in the foreseeable future'.[24] At the same time, when developments in the 4IR such as automation and robotics become embedded into manufacturing processes, sensor technologies and the IoT create large amounts of operational data, which need to be captured, analysed and stored. This means a requirement for a workforce with *higher-tech* skills or specialised training compared to the traditional 'blue collar' workers, whereby this new breed of worker is identified as the 'new collar' or 'digital collar' workers. These digital collar jobs do not necessarily require advanced education or traditional education, but relevant skills often obtained through non-conventional education.[25] A current global deficit of digital

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[21] The Global Knowledge Partnership on Migration and Development. (2019). *Migration and remittances: Recent developments and outlook*. Migration and Development Brief 31, The Global Knowledge Partnership on Migration and Development (KNOMAD). Washington D.C.: World Bank.

[22] International Labour Organisation. (2018). *ILO global estimates on international migrant workers : Results and estimates*. Geneva, Switzerland: International Labour Organisation.

[23] McKinsey & Company. (2017). *Jobs lost jobs gained workforce transition in a time for transition.* McKinsey & Company.

[24] As noted by Autor (2011) routine tasks are job activities that are sufficiently well defined to enable successful automation. [Autor, D. (2011). The polarisation of job opportunities in the U.S. labour market: Implications for employment and earnings. *Community Investments, 23*(2)].

[25] Crawford, M. (2018). *"New Collar" workers are the future of manufacturing.* Retrieved from https://www.gray.com/news/blog/2018/03/21/%E2%80%9Cnew-collar%E2%80%9D-workers-are-the-future-of-manufacturing.

collar workers is reflected by the hiring challenges faced in developed economies (Table 7.1). Nearly four in 10 US tech firms have job openings and are actively recruiting candidates for technical positions.[26] The inadequacy of talent locally provides an opportunity for migrant workers, and many countries would need to rethink their immigration policies in terms of migrant work, to ensure an adequacy of workers.

There is a growing requirement for a workforce with higher-tech skills or specialised training compared to the traditional 'blue collar' workers, whereby this new breed of worker is identified as the 'new collar' or 'digital collar' workers. These digital collar jobs do not necessarily require advanced education or traditional education, but relevant skills often obtained through non-conventional education.

[26] CompTIA. (2019). *IT industry outlook for 2019.* Retrieved from https://www.comptia.org/resources/it-industry-trends-analysis.

Table 7.1
Top Five Challenges in Hiring for Tech Jobs

Rank	Challenge
1	Finding workers with skills/experience in the emerging areas (e.g. IoT, AI, etc.)
2	Finding workers with desired skills
3	Intense competition for tech talent
4	Rising salary expectations
5	Limited pool of available workers in local regions

Source: CompTIA. (2019). *IT industry outlook for 2019.* Retrieved from https://www.comptia.org/resources/it-industry-trends-analysis

Yet, proficiency in new technologies is only one element of the future skills equation. While developments such as AI, cognitive computing, and robotics will lead to new jobs and increased productivity, these developments will also allow workers to focus on the human aspects of work. Despite the emergence of these 'new collar' or 'digital collar' workers, some 'human-only' characteristics such as emotion, intellect, wisdom, and ethics cannot be automated. Thus, it creates a niche or a comparative advantage for humans in employment opportunities. Such non-routine tasks fall into two broad groups – abstract tasks and manual tasks – which lie at opposite ends of the occupational-skill distribution. In order to be competitive in the world of work in the 4IR, migrant workers need to reskill themselves to become competitive for the types of jobs available (mainly digital collar and human only jobs), rather than seek jobs that match their existing skills set.

7.3.2 From Migrant Worker to Gig Economy Worker

The novelties associated with the 4IR have introduced alternatives to labour migration. Hyper connectivity and cloud technology, etc., have enabled a global workforce in a supply chain to be connected via a platform. This digital or virtual connectivity of a workforce is increasingly replacing the need for labour migration. These developments have been referred to as a 'labour-like global flows of capital', where 'rather than move the body across enormous distances, new mechanism allow it to stay put while moving vast quantities of data at the speed of light' as indicated by Aneesh (2006, p. 2).[27]

The 4IR has enabled and reinforced a shift towards a world of working where skilled occupations have become more globally accessible, flexible, and compartmentalised in nature, and performed via virtual labour migration. McKenzie (2017)[28] defines 'virtual labour migration' as work that crosses national boundaries through online capital, labour, information flows, and blends local, national and global contexts, where workers can take part in the digital economy regardless of geographical barriers. As such, it is observed that some employers are already reluctant to hire permanent and on-site skilled migrants, instead preferring to combine temporary on-site employment and offshore outsourcing of skilled labour with lower wages.[29] In future, employers

[27] Aneesh, A. (2006). *Virtual migration: The programming of globalisation.* Durham, United Kingdom: Duke University Press.

[28] McKenzie, F. (2017). *The fourth industrial revolution and international migration.* Working Paper. LOWY Institute for International Policy.

[29] *Ibid.*

In future, employers will progressively look for task-specialised work, engage workers in a more flexible manner, and utilise remote staff. These trends will increase job creation in project-based, temporary and freelancing roles, heading towards a structural transformation in the labour market in terms of contractual arrangements, employment relations and occupational profiles.

will progressively look for task-specialised work, engage workers in a more flexible manner, and utilise remote staff. These trends will increase job creation in project-based, temporary and freelancing roles, heading towards a structural transformation in the labour market in terms of contractual arrangements, employment relations and occupational profiles.[30]

At the same time, this new world of work leaves protection and welfare of such gig workers and taxation of their income in no man's land. For instance, many online platforms purposely do not identify themselves as employers of those who are employed via their platforms. This has led to a situation where corporations pretend not to be employers, making state-based controls and labour protection mechanism redundant and irrelevant. There is also a lack of clarity about what should be done to protect the rights of online workers. Similarly, when a worker is not a full-time employee of the employer, is located in another country, and works on a platform, where salaries are paid online via payment methods/platforms such as Paypal etc., taxing their wages becomes complicated. It raises questions as to whether the location is defined as the place where the online platforms' server is found, or whether it is based on the IP address of the online worker. Answers to these questions also do not guarantee that all issues concerning taxing modern migrants are solved, as IP addresses can be rerouted or hidden.[31]

As such, there is an emerging need to reconsider rules and regulations governing the new breed of gig workers. In an attempt to rectify this, new legislations are being introduced in the

[30] World Economic Forum. (2018). *Future of jobs report.* Geneva, Switzerland: Centre for the New Economy and Society, World Economic Forum.

[31] McKenzie, F. (2017). *The fourth industrial revolution and international migration*. Working Paper. LOWY Institute for International Policy. (p. 15).

European Union (EU) for instance, to protect gig worker rights within a country. These include new laws that are expected to ensure firms will provide a 'statement of rights' on the first day of a person's employment, and be explicit about paid leave entitlements and more predictable working hours, even for zero-hour contracts, where an employer does not have to offer work and an employee has no obligation to work when asked.[32] Nevertheless, introducing such restrictions challenges the flexibility involved in a gig economy.

Box 7.1
Platforms for Illegal Activities

In addition to heralding new positive development, the platform economy is also contributing to pool cross-border labour towards unwholesome activities such as human smuggling, human trafficking, drug trafficking, illegal arms trade, terrorism, global economic crimes and high-tech crimes via dark corners of the internet. For instance, the area known as the 'Deep Web' in the internet enables people to anonymously and secretly share information via 'peer-to-peer' connections rather than moving through a centralised computer server. The 'Darknet' in the meantime is viewed to be 'completely lawless', keeps users anonymous and makes it virtually impossible to trace activity to its origin.

Sources: Bo, T. D., & Tung, D. T. (2019). Non-traditional security challenges from 4IR. *National Defence Journal*. Retrieved from http://tapchiqptd.vn/en/research-and-discussion/nontraditional-security-challenges-from-4ir/11775.html; Greenemeier, L. (2015). Human traffickers caught on hidden internet. *Scientific American.* Retrieved from https://www.scientificamerican.com/article/human-traffickers-caught-on-hidden-internet/; Wakefield, J. (2019). *GozNym cyber-crime gang which stole millions busted*. British Broadcasting Service (BBC); Stop the Traffik. (2018). *Human trafficking and the darknet : Insights on supply and demand*. London, United Kingdom: Centre for Intelligence Led Prevention.

[32] European Parliament. (2019). *Transparent and predictable working conditions in the European Union.* (P8_TA-PROV(2019)0379, Ed.). Retrieved from http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+TA+P8-TA-2019-0379+0+DOC+PDF+V0//EN

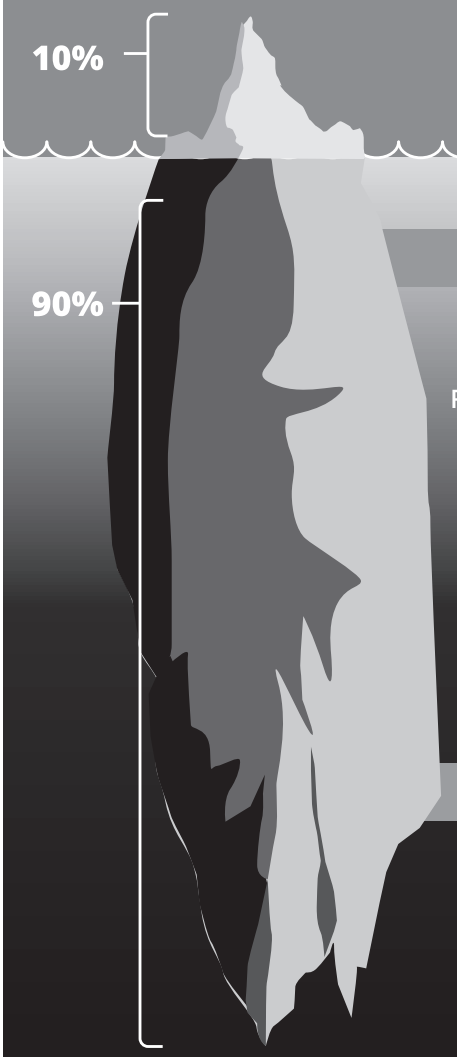
The Dark Side of the Internet

Surface Web

The part most of use are familiar with. This comprises only 10% of hte total size of the internet. All sites are indexed by search enginers and are easily accessible.

Examples: Facebook,Twitter,ect
Size: 19 TB / -980,000,000 websites
Largely unfiltered and cluttered

10%



90%

Special access only after this point

Deep web

Refers to the content on the internet that is not indexed by standard search enginers. The Deep Web contains *mostly* innocuous things

Examples:

Academic information, medical records, legal documents, government resources
Size: -7,500 TB / Unknown number of sites
Extremely well organiesed and filtered

100% anonymous after this point

Dark Web

The Dark Web forms the deepest layer of the Deep Web. it is believed most of the content here is of a criminal nature.

Source: *Based on The dark side of the internet.* (2017, July 8). Retrieved from - https://www.visualcapitalist.com/dark-web/

7.3.3 Remittances and Blockchain

Similar to travel and migration being heavily influenced by the 4IR, remittances by migrant workers are also equally modernised by 4IR technologies. Traditionally, the remitter and the beneficiary are required to physically visit the remittance service provider to send and collect remittances, respectively, and the transaction is processed via the Society for Worldwide Interbank Financial Telecommunications (SWIFT). The centralised feature of SWIFT requires a long time span to process a transaction and 'money seemingly disappears for few days after it has been sent'.[33] To protect against possible losses, remittances are insured, leading to increasing the cost of remittances. At the same time, to keep costs down, remittances are channelled via various routes, hindering the transparency of the link between origin, path and destination of remittances, providing opportunities for money laundering and financing for illegal activities such as terrorism.

By contrast, blockchain technology can revolutionise international remittances due to its capacity to reduce the transfer time and costs, by expanding - money distribution methods, brand options, and ways - to deal with money.[34] With blockchain technology, the system of verification of transaction is carried out by a network of computers that function 24x7, and the time taken for a verification is simply at the speed of verifying a new block. This speed and continuous operation cut down transaction costs and time, and offers many advantages. Specifically, "blockchain-based cross-border money transfer would simply rearrange the same parties so they instantly receive the same information simultaneously".[35] The chance of tampering with transactions is reduced because, if there are any anomalies, the transaction will not be processed. Moreover, blockchain backed transactions are fully traceable, enabling remitters, receivers, and regulators to track remittances, and keep a tab on money laundering and financing for terrorism.

7.4 Implications for Sri Lanka

The 4IR is increasingly catching up in many aspects in Sri Lanka and this section highlights its inroads to the economy in terms of travel, tourism, migration and remittances.

7.4.1 Travel, Tourism and Border Control in the 4IR

Though to a smaller extent, the 4IR developments influencing the global travel and tourism sector are also impacting Sri Lanka's tourism industry, which attracted over 2.3 million tourist arrivals and USD 4.4 billion in earnings in 2018.[36] A majority of tourists arriving in Sri Lanka are in the cohorts most influenced by the 4IR. For instance, in 2017, close to a fifth of travellers to Sri Lanka were in their 20s and a quarter were in their 30s. Of all tourists to Sri Lanka, approximately 40 per cent had made their own travel arrangements,

[33] Flore, M. (2018). *How blockchain-based technology is disrupting migrants' remittances: A preliminary assessment.* EUR 29492 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-98177-7, doi:10.2760/23991, JRC113484.

[34] *Ibid.*

[35] Flore, M. (2018). *How blockchain-based technology is disrupting migrants' remittances: A preliminary assessment.* EUR 29492 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-98177-7, doi:10.2760/23991, JRC113484. (p. 20)

[36] Central Bank of Sri Lanka. (2018). *Annual report 2018*. Colombo, Sri Lanka: Central Bank of Sri Lanka.

37 per cent made their payments online, and over 78 per cent used credit cards for online transactions.[37] Similarly, more than one in four of the 2 million plus tourists who visited Sri Lanka stayed in homestays and other informal modes of accommodation.[38]

In addition to tourists to Sri Lanka being 4IR technology savvy, service providers in Sri Lanka are also adopting some 4IR technologies. For instance, the growth in informal accommodation spaces and the entry of small timers, mainly facilitated by online travel agents (OTAs) and platforms such as Airbnb is evident in recent years. Notwithstanding this, traditional service providers are somewhat threatened by the 4IR influenced new entrants. For instance, the organised hotels in Sri Lanka complain that homestays operate without a license, do not pay any taxes and lack any standardisation.[39] As such, Sri Lanka too is grappling to regulate the influence of the 4IR on tourism without over-burdening and halting its growth. Specifically, the Strategic Plan for Tourism for 2017-2020 recognises that traditional homestays and the informal sector, where homeowners lease spare capacity through platforms such as Airbnb, would provide additional income as well as cater to the modern segment of travellers. As such, it suggests that Sri Lanka should adapt according to global reforms that are being introduced to regulate Airbnb.[40] At the same time, a common technology platform for the country's lodging businesses is proposed by the government to ensure uniform application of lodging related policies to both formal and informal sectors.[41]

Global projections indicate that over the 2018-2022 period, world travel and tourism will heavily adopt IoT, app and web enabled markets, big data analytics, machine learning, cloud computing, digital trade, augmented and virtual reality, autonomous transport, and encryption as part of a growth strategy (Figure 7.1). Echoing these, Sri Lanka's 'Strategic Plan for Tourism for 2017-2020' indicates future strategies such as tracking websites, use of social media and online reviews and other platforms using online tools such as Google Analytics; and forging commercial arrangements with online platforms (e.g. Google, TripAdvisor) to analyse their search data and provide traveller search trends such as rankings of Sri Lanka relative to other destinations in terms of holiday search data. It also recommends to use Beacon technology, which is a tool to provide information, recommendations and on-the-spot marketing offers to visitors at specific locations, while collating data for visitor profiling, development of travel apps, and online platforms. The strategic plan also underscores the importance and potential of smartphones and tablets that are commonly carried by travellers, which can be harnessed to communicate and connect with travellers throughout their stay in Sri

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[37] Sri Lanka Tourism Development Authority. (2017). *Annual statistical report 2017.* Colombo, Sri Lanka: Sri Lanka Tourism Development Authority.

[38] Daily Mirror. (2018). *Combank joins Ripple Net for blockchain powered remittances.* Retrieved from http://www.ft.lk/financial-services/ComBank-joins-RippleNet-for-blockchain-powered-remittances/42-665286; Daily Mirror. (2018). *Sri Lanka mostly visited by young tourists: SLTDA survey.* Retrieved from http://www.dailymirror.lk/article/Sri-Lanka-mostly-visited-by-young-tourists-SLTDA-survey-157530.html

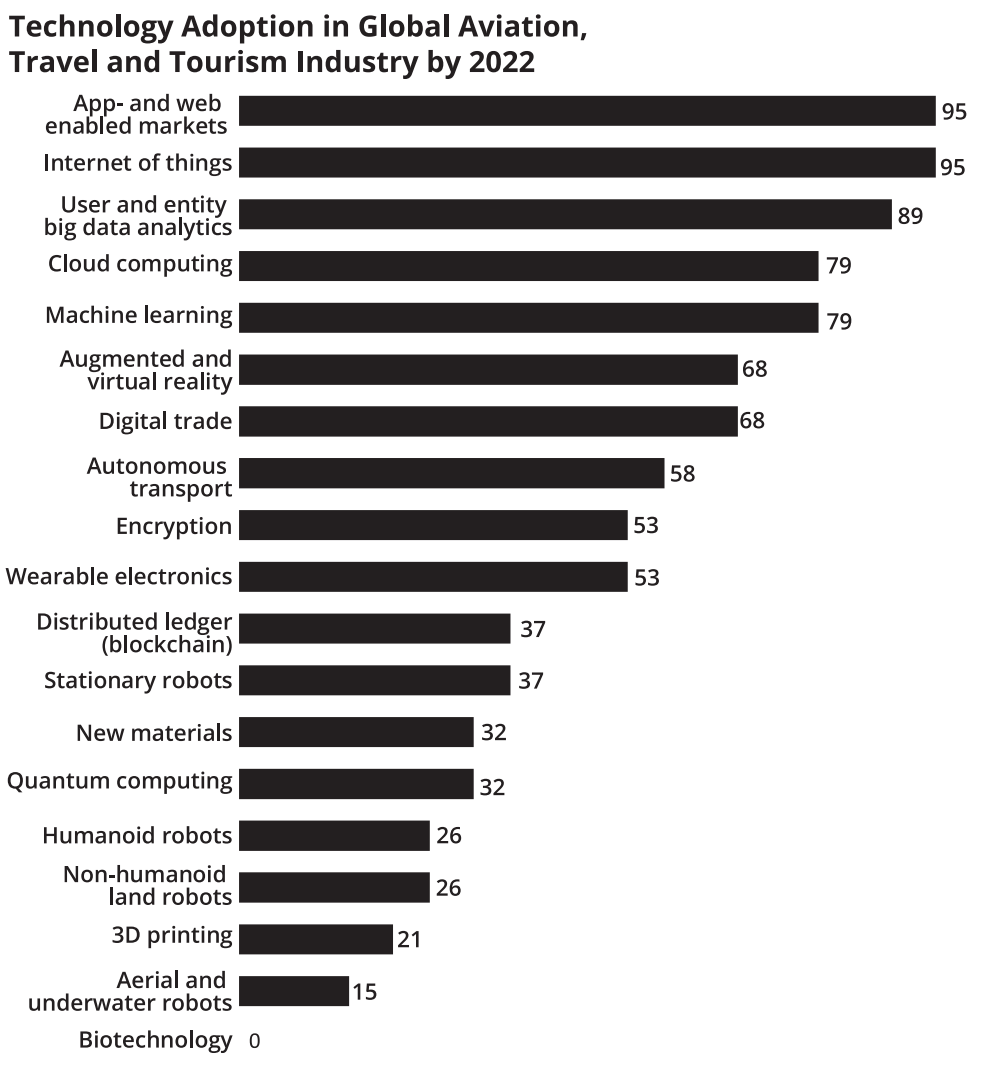
[39] Wijesekara, M. (2017). *As tourism booms in Sri Lanka, officials grapple with regulating homestay businesses.* Retrieved from https://globalpressjournal.com/asia/sri_lanka/tourism-booms-sri-lanka-officials-grapple-regulating-homestay-businesses/.

[40] Ministry of Tourism Development and Christian Religious Affairs. (n.d.). *Sri Lanka tourism strategic plan 2017-2020.* Colombo, Sri Lanka: Ministry of Tourism Development and Christian Religious Affairs.

[41] Ministry of Finance of Sri Lanka. (2016). *Budget speech 2017.* Colombo, Sri Lanka: Ministry of Finance of Sri Lanka.

Lanka. Encompassing all these, a comprehensive digital marketing roadmap that includes website design and development, content creation, management of social media channels, search engine marketing, search engine optimisation, etc., must also be developed.

Figure 7.1
Technology Adoption in Global Aviation, Travel and Tourism Industry by 2022



Source: World Economic Forum. (2018). *Future of jobs report.* Geneva, Switzerland: Centre for the New Economy and Society, World Economic Forum.

Beyond marketing, 4IR technologies can also be deployed in other areas such as outreach, research, crisis management, community mobilisation and recruitment. The lack of such broad based 4IR mainstreaming into travel and tourism industry in the 'Strategic Plan for Tourism for 2017-2020' is a noticeable limitation. This limitation leads to the absence of comprehensive visitor research and data; continued research into alternative attractions, niche and emerging market segments; and market intelligence, contributing towards inhibiting the 'effectiveness of product development decisions and marketing strategies'."[42] As such, in order to be competitive, the travel and tourism industry in Sri Lanka need to speedily adopt modern technologies in all aspects of travel and tourism and integrate these into services provided to travellers, and into the growth strategy of the sector.

In contrast, competitors such as Thailand are ahead of Sri Lanka in terms of adopting 4IR technologies to upgrade tourism. For instance, beacon devices are earmarked in Thailand to accurately inform tourists about product deals and tourist attractions; Digital signage is aimed to assist tourists to locate restaurants, accommodation, hospitals and key governmental offices, etc. Similarly, the Phuket speed-boat businesses are integrating digital trackers on boats and tracking wristbands for travellers to ensure their safety.[43]

In terms of border control, Sri Lanka has made much progress in terms of adopting 4IR technologies. The Sri Lankan passport now

The lack of such broad based 4IR mainstreaming into travel and tourism industry in the 'Strategic Plan for Tourism for 2017-2020' is a noticeable limitation. This limitation inhibits the 'effectiveness of product development decisions and marketing strategies'.

[42] Ministry of Tourism Development and Christian Religious Affairs. (n.d.). *Sri Lanka tourism strategic plan 2017-2020*. Colombo, Sri Lanka: Ministry of Tourism Development and Christian Religious Affairs.

[43] SmartCitiesWorld. (2018, July 24). *Thailand to roll-out national IoT network.* Retrieved from https://www.smartcitiesworld.net/news/news/thailand-to-roll-out-national-iot-network-3154

includes biometrics (fingerprints and face images) for identity verification in compliance with the International Civil Aviation Organisation (ICAO) requirements, and for checking biometrics against the existing database to avoid duplication of identities during issuance of travel documents.[44] Additionally, due to the adoption of appropriate modern technologies, Sri Lanka is among a limited number of countries where a passport is issued within hours. Currently, Sri Lanka also has an Integrated Enquiry Management System (IEMS) which "facilitates the verification of migration operational data related to border controls, and passport issuance information between the Department of Immigration and Emigration (DIE) and multiple national and foreign agencies for better decision making".[45] The IEMS in Sri Lanka is an online platform linked with multiple local and international databases. For instance, in 2012, the DIE linked with INTERPOL database systems enabled border control officials to check all arriving and departing passengers against INTERPOL stolen and lost travel document database and details of international criminals in real time.[46]

Despite some improvement, there are some glaring deficits in Sri Lanka in terms of 4IR technology for border control. For instance, the need for an advanced 'facial recognition system' at the Bandaranaike International Airport had been identified for years, before the United Nations Office on Drugs and Crime (UNODC) guaranteed support for it in the aftermath of terrorist attacks in April 2019. Similarly, inadequacies in data and data sharing among agencies, inter-agency cooperation in border management, and data security are important concerns in Sri Lanka's border control efforts and national security. Currently, the multiple agencies involved in managing borders are "largely working independently, with little to no information sharing".[47] In addition to risks in border security and blurring the lines of responsibility among agencies, this deficit in information sharing is inhibiting the possibility of a single point of view for border management effectiveness, and formulation of strategies to enhance border security. As highlighted by the National Border Management Committee, this has "left border management practices falling behind international standards" and "limits the risk assessment and facilitation power that could be leveraged through shared data and enhanced technologies to access the data".[48]

The inter-agency data linkage deficit was highlighted during investigations in Sri Lanka's terrorist attacks of April 2019, where despite a Cabinet decision to link the DIE and the Customs Department with the Criminal Investigation Department (CID) through a shared computer network, these agencies were not linked to facilitate cross checks on international movements and links.[49] Preferably, the DIE should provide the shared technological infrastructure required

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[44] Weeraratne, B. (2017). *Sri Lanka global compact of safe, orderly and regular migration : National consultation outcome report.* Colombo, Sri Lanka: International Organisation for Migration.

[45] International Organisation for Migration. (2019). *Immigration and border management.* Retrieved from http://srilanka.iom.int/iom/?q=CBR#_ftn1

[46] Department of Immigration and Emigration. (2012, June 11). *Sri Lanka immigraion border control system links up with INTERPOL.* Retrieved fromhttp://www.immigration.gov.lk/web/index.php?option=com_content&view=article&id=218:sri-lanka-immigraion-border-control-system-links-up-with-interpol&catid=1:latest-news&lang=en

[47] National Border Management Commitee. (2018). *Sri Lanka integrated border management strategy - 2018.* Colombo, Sri Lanka: National Border Management Commitee, Sri Lanka.

[48] *Ibid*. (p. 25)

[49] Daily News. (2019, May 3). *Failure to implement Cabinet decision: PM calls for explanation from relevant authorities.* Retrieved from http://www.dailynews.lk/2019/05/03/local/184545/pm-calls-explanation-relevant-authorities

to all involved agencies to assist in making informed decisions about people and goods entering/departing Sri Lanka. Such shared infrastructure would enable a single record for each individual entering/departing Sri Lanka, access to important information about travellers about their movement, visas, passport and compliance history, and the ability to determine who is in the country at a given point in time, among others.[50]

This data sharing deficit is not limited to agencies related to border control alone, but is a systemic issue in Sri Lanka in this 4IR era of increased connectivity. The data sharing deficit is exacerbated by many factors including cultural and attitudinal issues in Sri Lanka related to ownership of administrative data, as well as inadequacies in use of and skills in modern technologies and an appropriate institutional/legislative framework to facilitate administrative data sharing. Indeed, it is noted that "Sri Lanka lacks substantive laws for the protection of individual privacy and data".[51] Such inter-agency cooperation and data sharing for border management and other functions can be addressed by appropriate reskilling and capacity development, as well as adopting appropriate technologies associated with big data analytics, cloud computing and blockchain to name a few. Such adoption of appropriate modern technology and equipment can contribute to greater efficiency of border control, baggage security clearance, passenger security clearance, and passenger experience, all of which can contribute to Sri Lanka's attractiveness and competitiveness as a travel and tourist destination.

7.4.2 Sending Labour and Receiving Remittances in the 4IR

Labour migration in Sri Lanka has experienced many changes in recent years, and careful examination suggests that some changes can be attributed to the influence of 4IR. In recent years, the total registered departures for foreign employment has experienced a downward trend, and the composition of migrants has also undergone many changes. In 2018, a total of 211,459 migrants departed for foreign employment – a marginal decline compared to the 211,992 departures reported in 2017. This declining trend in departures began around 2014, and was largely triggered by a decline in the number of females and female domestic workers among labour (Figure 7.2).

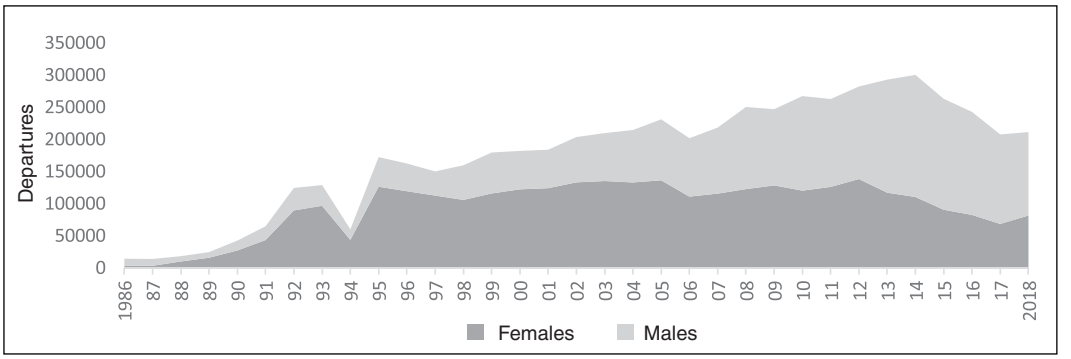
In terms of gender, the significance of female migrant workers has continued to decline to a point where the share of male departures is almost double that of females at present. Among female migrant workers from Sri Lanka, over 90 per cent are low-skilled (including housemaids). As such, in addition to policies in Sri Lanka that discourage female migration such as the Family Background Report (FBR) requirement, the likelihood of females being engaged in low-skilled routine jobs that can be easily automated in the 4IR, may also have contributed to this decline. On the contrary, among male departures, unskilled workers account for only about 37 per cent, while the bulk are skilled workers (47 per cent) who are less likely to be displaced due to automation.

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[50] National Border Management Commitee. (2018). *Sri Lanka integrated border management strategy - 2018.* Colombo, Sri Lanka: National Border Management Commitee, Sri Lanka.

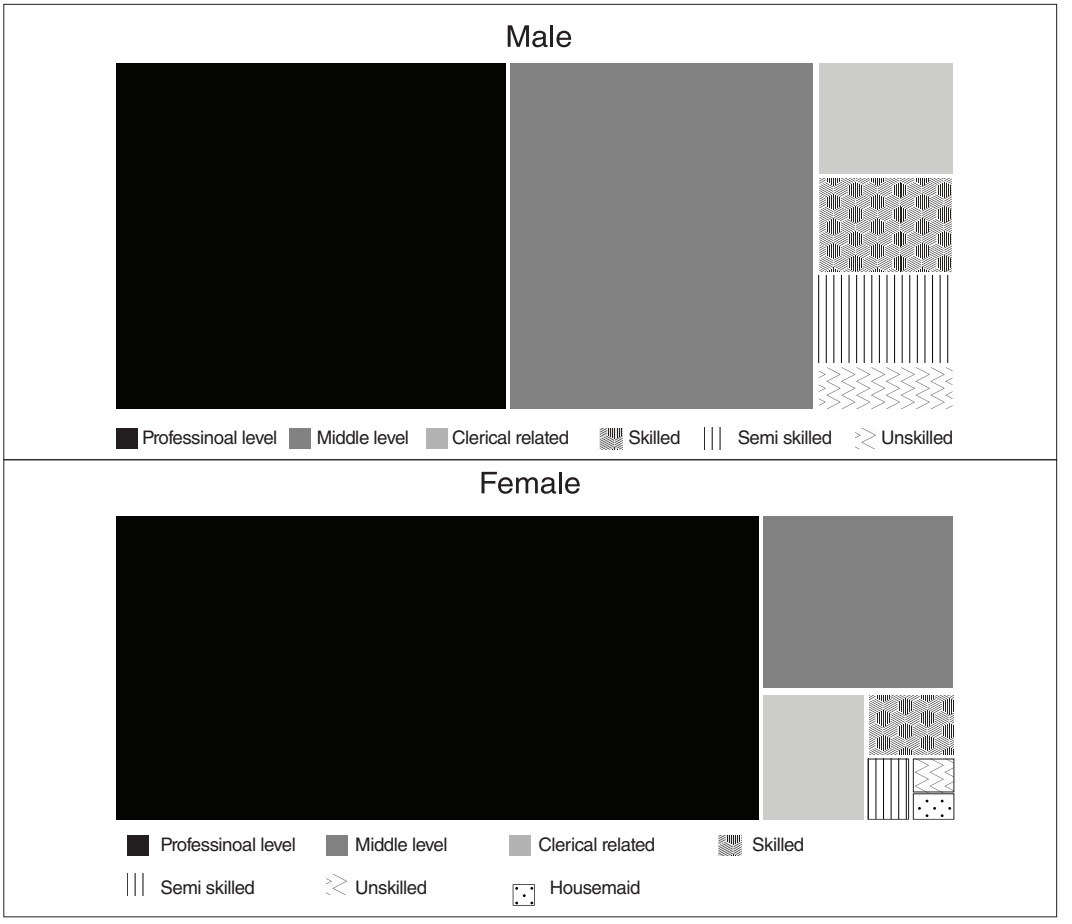
[51] Gunawardene, N. (2017). *Digital tranformation in Sri Lanka : Opportunities and challenges in pursuit of liberal policies.* Colombo, Sri Lanka: Friedrich Naumann Foundation.

Figure 7.2
Male and Female Departures for Foreign Employment, 1986-2018



Source: Central Bank of Sri Lanka. *Annual reports (Various years).*

Figure 7.3
Skills Distribution of Departures, by Gender, 2017



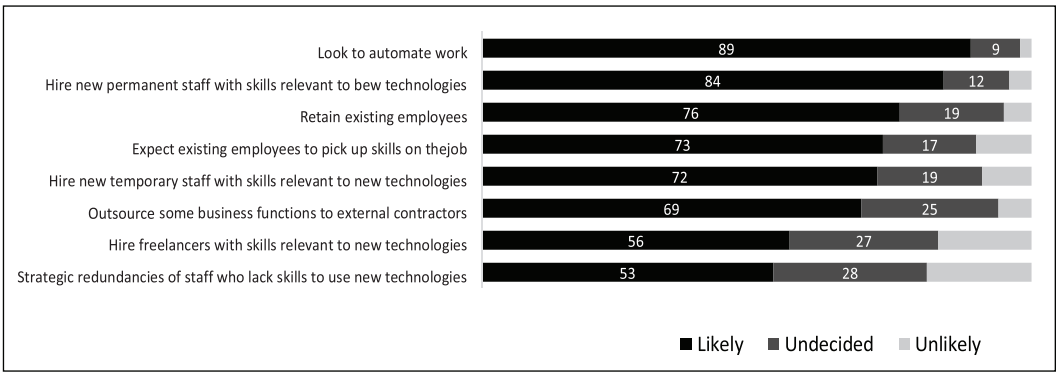
Source: Sri Lanka Bureau of Foreign Employment. (2017). *Annual statistical report.* Battaramulla, Sri Lanka: Sri Lanka Bureau of Foreign Employment.

The possibility of 4IR influencing the change in composition of migrant workers is further supported by the 4IR trends in Sri Lanka's main destination region, the Middle East. Despite various efforts over the years, the Middle East region still remains the main destination market, and changes in this destination market directly affect migrant worker departures from Sri Lanka. Specifically, since the inception of organised labour migration from Sri Lanka, the Middle East region has accounted for the bulk of total annual departures (Figures 7.2 and 7.3).

The projected trends for 2022 for the Middle East and North African regions in adapting to shift skills needs in the 4IR are depicted in Figure 7.4. This shows that nearly 90 per cent of employers sampled by the Word Economic Forum (WEF, 2018)) are likely to replace workers by automation, 70 per cent are likely to look for employees with 4IR skills, and 73 per cent expect existing employees to pick up 4IR skills. These adaptation strategies to shift skills needs by employers in the 4IR may have contributed to the decline in demand for workers from Sri Lanka. Additionally, the suggestion that employers in the Middle East are likely to hire new staff with skills in relevant new technologies, may also have contributed to the drop in departures.

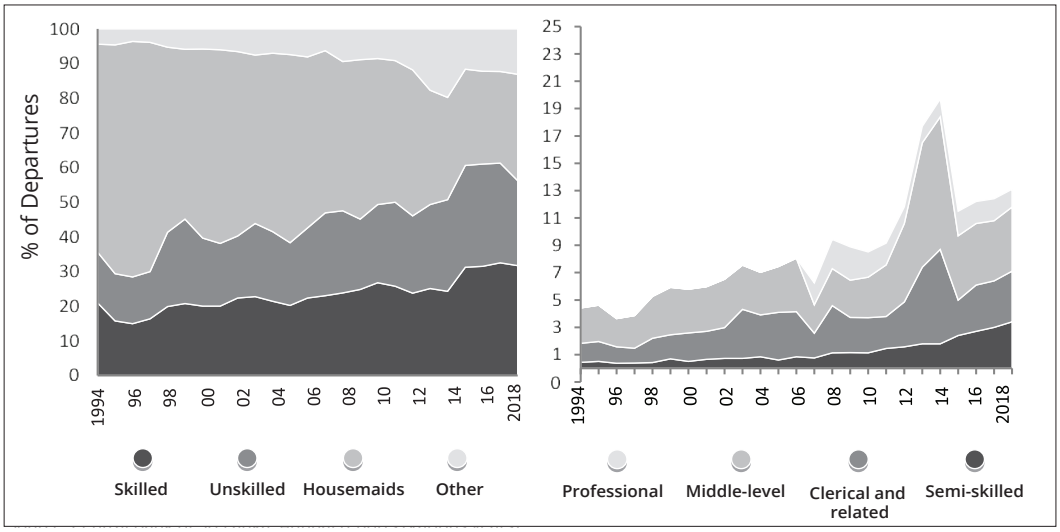
Despite numerous efforts over the years, the limited success in changing the skills composition to send more higher skilled migrant workers further reflects the traditional skills sets of Sri Lankan workers seeking foreign employment. As seen in Figure 7.5, the share of skilled, middle level, and professionals among worker departures is relatively small. This further reflects the high likelihood of Sri Lankan migrant workers facing challenges in the modern world of work in the 4IR.

Figure 7.4
Percentage of Responses to Shifting Skills Needs in Middle East and North Africa Region by 2022



Source: World Economic Forum. (2018). *Future of jobs report.* Geneva, Switzerland: Centre for the New Economy and Society, World Economic Forum.

Figure 7.5
Trends in Skills Among Departures for Foreign Employment from Sri Lanka



Source: Central Bank of Sri Lanka. *Annual reports (Various years).*

In this context, the existing programme at the National Apprentice and Industrial Training Authority (NAITA), and Sri Lanka Bureau of Foreign Employment (SLBFE) on Recognition of Prior Learning (RPL) is important. Specifically, RPL assesses a person's competencies acquired through informal, non-institutional learning, which are very much aligned with the assessments needed for the digital collar workers discussed in previous sections. Given that the assessment structure is already in place, Sri Lanka should capitalise on RPL to assess the tech related skills of potential migrant workers, to make them better employable in the 4IR. Moreover, as shown in Figure 7.4, in the Middle East and North Africa, many employees are likely to get on-the-job training in tech skills required for their jobs. As such, many returning Sri Lankan migrant workers are likely to have acquired some tech skills of the 4IR. The RPL should certify such skills of returning migrants, and harness their knowledge and skills to reskill other returnees, potential migrants, and workers in the domestic labour market.

At the same time, it is important to note the emerging structural changes to employment. Quantifying the global trend in the growth of platform and gig-based employment, the Middle East and North African region shows that nearly 70 per cent of employers would outsource work and over 50 per cent would hire freelance workers with relevant skills (see Figure 7.4). Such changes in employment structure would also have contributed to the drop in total departures from Sri Lanka.

Concurrently, the decrease in the importance of licensed recruitment agents for job placement reflects another dimension of foreign employment from Sri Lanka. In recent years, only a third of total employment were secured through licensed recruitment agents, while employment through other sources account for two-thirds. In the 4IR, the involvement of peer-to-peer platforms are increasingly making middlemen redundant, whereas licensed recruitment agents in Sri Lanka perform a middleman's role between the employer and the migrant worker. As evident in

recent data, most Sri Lankans are now securing employment via own means, probably benefitting from Web 2.0 applications for interaction on job placement websites, which enable potential employees and employers to signal, screen and select without the services of a recruitment agent.

Nevertheless, as discussed before, migrant workers from Sri Lanka will still have a niche in jobs that involve human-only tasks. In this respect, the significance of female domestic workers in the composition of migrant workers from Sri Lanka is important, because despite being routine and low-skilled, the tasks of female domestic workers such as childcare and household tidying and cleaning cannot be easily robotised. Similarly, caregiver is another niche position that Sri Lanka is focused on. In this respect, the restrictions imposed by the FBR on female migration is creating a dent in Sri Lanka's niche for such low-skilled yet human only jobs abroad. As such, in the 4IR, Sri Lanka ought to rethink its policy priorities, to facilitate employment in low-skilled jobs that have a high component of human-only tasks. At the same time, Sri Lanka should team up with other sending countries and work towards marketing this human only niche in low-skilled jobs in the foreign labour market, to increase wages and improve worker welfare and protection for related occupations. Such regional efforts should also focus on ensuring better protection for Sri Lankan gig and platform workers.

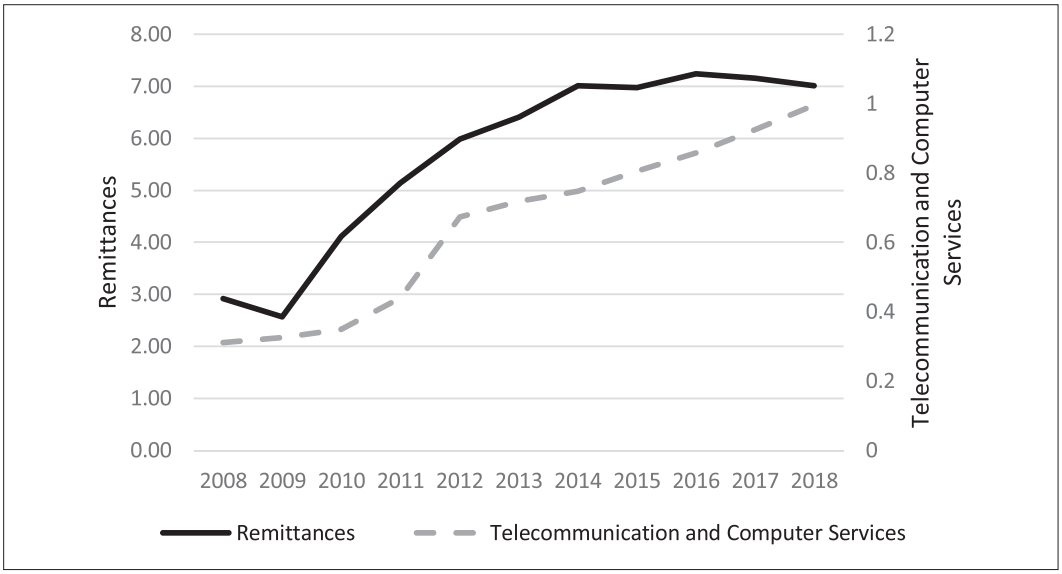
Migrant workers from Sri Lanka will still have a niche in jobs that involve human-only tasks.

Similarly, remittances, which play an important role in the Sri Lankan economy, is also influenced by developments of the 4IR. In recent years, remittances have stabilised with the country receiving USD 7 billion in 2018, accounting for to 7.9 per cent of GDP. Nevertheless, 2018 recorded the second consecutive year of negative growth in remittances. Traditional reasons for the decline in remittances include the prevailing geopolitical uncertainties of oil price fluctuations and the sluggish global economic growth in the Middle East, a decline in departures for foreign employment due to improvements in the domestic labour market opportunities, and government efforts to curb migration for specific occupations and skills categories. However, this slowdown in remittances could also be attributed to drop in migrant departures due to the influence of 4IR as discussed above, as well as due to transition from physical migration to virtual migration. Such transition of migration towards virtual migration leads to earnings from foreign employment now being recognised as payments for trade in services recorded in the service account in the balance of payment (BOP) accounts.

According to the International Labour Organisation (ILO) "between 17,000-22,000 Sri Lankan workers are engaged in web-based digital labour on global platforms".[52] This increasing trend in income earned from trade in services compared to remittances is seen in Figure 7.6. In 2018, the telecommunication and computer services earnings experienced a 7.5 per cent growth, which is largely attributed to increased usage of internet-based communication facilities, supported by broadband data services. Additionally, the enhanced high-speed connectivity for customers with a state-of-the-art tier 3 data centre that provides a secure and reliable data hosting facility and cloud computing services in Sri Lanka also contributed to this growth.[53]

Despite a slowdown of remittances in recent years, remittance infrastructure in Sri Lanka is increasingly relying on 4IR technologies, namely blockchain. For example, in 2018, the Commercial Bank of Ceylon PLC and Cargills Bank joined a global payment network (RippleNet) leveraging on blockchain technology to provide Sri Lankans the benefits of receiving remittances virtually and instantly, under extra secure measures such as transparent and tamper proof transactions with end-to-end tracing and tracking capacity. For the banks, using the underlying blockchain technology makes it possible to move money on a real time basis, leading to improved productivity. Moreover, blockchain removes the requirement for a middleman in remittances,

Figure 7.6
Remittances and Telecommunication and Computer Services Earnings, 2008-2018 (in USD Billion)



Notes: Left vertical axis corresponds to remittances. Right vertical axis corresponds to telecommunication and computer services.
Source: *Central Bank of Sri Lanka. Annual reports (Various years).*

[52] International Labour Office. (2019). *Future of work in Sri Lanka shaping technology transitions for a brighter future.* Colombo, Sri Lanka: Country Office for Sri Lanka and the Maldives, International Labour Office ; International Labour Office. (2019). *Work for a brighter future – Global commission on the future of work.* Geneva, Switzerland: International Labour Office.

[53] Central Bank of Sri Lanka. (2018). *Annual report 2018.* Colombo, Sri Lanka: Central Bank of Sri Lanka. (p. 166).

and the decentralised structure of blockchain contributes to the speed, while keeping costs low.

7.5 Way Forward for Sri Lanka

As evident in the abovementioned discussion, the 4IR is influencing travel, tourism, labour migration and remittances across the globe as well as in Sri Lanka. From a global scale, Sri Lanka's uptake of 4IR technologies is yet at a rudimentary stage, where the 'Digital Road Map' for the country was only launched as recently as June 2019. As such, the 4IR has immense potential to contribute towards making Sri Lanka more competitive against other global players in terms of travel, tourism, labour migration and remittances. The following are a few recommendations to guide Sri Lanka's efforts to strategically adopt 4IR technology and adapt to the same, in terms of travel, tourism, labour migration and remittances sectors.

- Speedily adopt modern technologies in all aspects of the travel and tourism industry in Sri Lanka (not limiting to marketing/ advertising) and integrate these technologies into services provided to travellers, and into the growth strategy of the sector.

- Border control efforts to adopt appropriate modern technology and equipment to enhance efficiency and national security, as well as improve passenger experience to maintain attractiveness and competitiveness as a travel and tourist destination.

- Understand the potential of low-skilled migrant workers in terms of human only jobs, and revisit restrictions such as the FBR to facilitate employment in this niche market segment.

- Team up with other labour sending countries and work towards marketing this human only niche in low-skilled jobs in foreign labour markets to increase wages and improve worker welfare and protection for related occupations.

- Focus on catering to the emerging digital collar jobs, by expanding RPL to harness the knowledge and skills of returning migrants to reskill other returnees, potential migrants and workers in the domestic labour market.

- Inculcate an institutional cultural for data sharing and inter-agency cooperation, providing soft skills for required related attitudinal changes, as well as relevant technology, skills and capacity.

- Develop an appropriate institutional/ legislative framework to facilitate administrative data sharing and inter-agency cooperation.

- Develop a data security policy and adopt appropriate technology such as blockchain for data protection to facilitate data sharing.

- Finally, speedily and regularly analyse the large amount of administrative and big data routinely collected by public and private entities using modern technology, to facilitate evidence-based policy planning in travel, tourism, labour migration and remittances that is relevant in the 4IR.

8. 4IR: A Challenge or an Opportunity for Gender Equality?

8.1 Introduction

The fourth industrial revolution (4IR) is the 'advent of cyber-physical systems involving entirely new capabilities for people and machines.[1] It is interesting to note that these capabilities rely on the technologies and infrastructure of the third industrial revolution – the digital revolution which has been occurring since the middle of the 20th century. However, the 4IR represents entirely new ways in which technology is being embedded within societies and even human bodies. In fact, the combination of technologies is blurring the lines between the physical, digital, and biological spheres.[2] The possibility of connecting billions of people through mobile devices, processing power of machines, storage capacity, and access to knowledge have increased immensely with technologies related to artificial intelligence (AI), robotics, the internet of things (IoT), autonomous vehicles, 3D printing, nanotechnology, biotechnology, material science, energy storage, and quantum computing.

These technological advances also hold significant implications on existing gender structures and balances, especially in the labour market. While optimists point out to opportunities for strengthening women's position through greater gender equality through the 4IR, counterarguments that are put forward signal the 4IR would be 'gender blind'. Entrenched inequalities and discriminatory social norms that keep women restricted to low-paid, poor-quality jobs are likely to further deepen by the 4IR.

As 4IR advancements and their implications on human life are being discussed in an environment where many people around the world today are yet to experience, the major technological advancements of the second industrial revolution – namely access to electric power – 4IR and gender also face some basic issues. Sri Lanka, for instance, still struggles with key dimensions of gender empowerment and equality, namely, economic and political empowerment.

In this context, this chapter examines the implications of the 4IR on gender in three main areas: labour market, education and skills, and social inferences. Following a brief introduction to the 4IR, a discussion on the 'gendered' labour market implications of the 4IR takes into consideration the anticipated structural changes, changes to the nature and quality of jobs, dynamics of employment relationships

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[1] Davis, N. (2016). *What is the fourth industrial revolution?* Retrieved from https://www.weforum.org/agenda/2016/01/what-is-the-fourth-industrial-revolution/

[2] Schwab, K. (2016). *The fourth industrial revolution: What it means, how to respond*. Retrieved from https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond

and access to employment during child bearing and rearing. This is followed by an exploration of the education and skills needed for the 4IR, and women's position and prospects in these. The next section deals with social implications of the 4IR on women and girls, particularly in gender stereotypes, digital threats and gender digital divide. The final section of the chapter highlights the way forward with some policy recommendations.

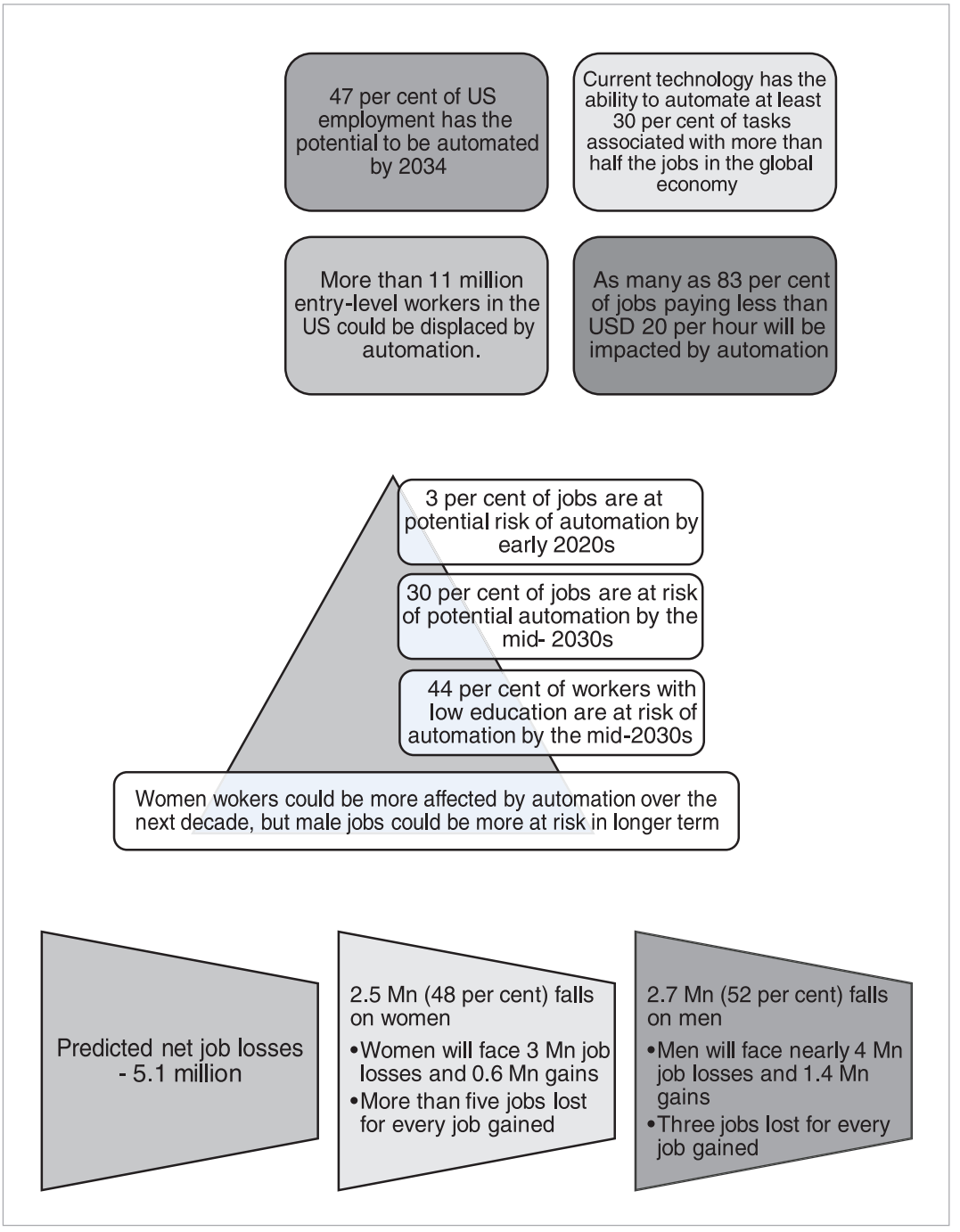
8.2 Women and Work in the 4IR

Labour markets will be the most affected by the 4IR (Figure 8.1). The prospects and challenges for gender equality arising from the 4IR depend on current differences in the position of women and men in the labour market, and their division of both paid and unpaid work. Currently, women are in a more disadvantageous position in the labour market than men. Globally, more women are employed in the informal sector and involved in unpaid care work than men. Women are paid less than men for the same job (gender pay gap). More women are also employed in low-paid and non-technological work. Further, more women tend to face burdens of the 'glass ceilings', 'sticky floors', and sexual harassments at work places than men. In this context, the gendered impact of the 4IR on the labour market can be discussed under four dimensions: structural changes (including occupational change and the task content), changes to the nature and quality of work (for women in particular), changes to the employment relationship, and changes in access to work over the period of child bearing and rearing.[3]

The prospects and challenges for gender equality arising from the 4IR depend on current differences in the position of women and men in the labour market, and their division of both paid and unpaid work.

[3] Howcroft, D., & Rubery, J. (2018). *Gender equality prospects and the fourth industrial revolution.* Retrieved from https://policynetwork.org/opinions/essays/gender-equality-prospects-fourth-industrial-revolution/

Figure 8.1
4IR Impact on the Labour Market



Source: Howcroft, D., & Rubery, J. (n.d.). *Bias in bias out: Gender equality and the fourth industrial revolution.* Retrieved from https://polsis.uq.edu.au/files/15541/Howcroft-Rubery-presentation-notes.pdf

8.2.1 Structural Change

The extent of structural change in the global labour market depends on many factors, such as the rate of technological advancement itself, ease of commercialisation, technical feasibility of automation, public acceptance and adoption of new technologies, and labour market dynamics (including quality and quantity of labour and associate wages, existing labour laws and benefits of automation beyond labour substitution).[4] It is predicted that in about 60 per cent of occupations, at least one-third of the constituent activities could be automated, implying substantial workplace transformations and changes for all workers.[5] The possible impact of automation on employment also differs by occupation and sectors. Some job roles will emerge and some will decline as a result of the 4IR (Table 8.1). Physical activities in predictable environments are the most susceptible to automation. It is apparent that collecting and processing data can be performed better and faster with machines displacing large amounts of labour.

Table 8.1
The Jobs Landscape in 2022

		Top 10 Emerging
Emerging Roles, Global Change by 2022	**133 million**	1. Data analysts and scientists
		2. AI and machine learning specialists
		3. General and operations managers
		4. Software and applications developers and analysts
		5. Sales and marketing professionals
		6. Big data specialists
		7. Digital transformation specialists
		8. New technology specialists
		9. Organisational development specialists
		10. Information technology services
		Top 10 Declining
Declining Roles, Global Change by 2022	**75 million**	1. Data entry clerk
		2. Accounting, bookkeeping and payroll clerks
		3. Administrative and executive secretaries
		4. Assembly and factory workers
		5. Client information and customer care workers
		6. Business services and administration managers
		7. Accounts and auditors
		8. Material-recording and stock-keeping clerks
		9. General and operational managers
		10. Postal services clerks

Source: World Economic Forum. (2018). *Future of jobs report 2018. Geneva,* Switzerland: World Economic Forum.

[4] World Economic Forum. (2018). *The future of jobs report 2018.* Geneva, Switzerland: World Economic Forum.

[5] Manyika, J., Lund, S., Chui, M., Bughin, J., Woetzel, J., Batra, P., Sanghvi, S. (2017). *Jobs lost, jobs gained: What the future of work will mean for jobs, skills, and wages.* Retrieved from https://www.mckinsey.com/featured-insights/future-of-work/jobs-lost-jobs-gained-what-the-future-of-work-will-mean-for-jobs-skills-and-wages

Studies on transformation of occupational structures due to the 4IR have seen job losses in both male-dominated occupations such as construction, and female-dominated occupations such as clerical work.[6] Also, evidence indicates major gains in some male-dominated occupations – e.g. information technology (IT) professionals, and some female-dominated occupations such as cleaners and helpers. This mixed pattern of growth means only a limited increase in the total share of female employment from 45 per cent in 2008 to 46 per cent in 2015. Job segregation has also been changing due to technological advancements, but in complex ways, and the overall effect in the most recent period (2011–2015) is to upgrade women's occupational position.[7] Yet, most of the job growth for men and women depends on what changes are happening in male-dominated and female-dominated jobs. Men are particularly vulnerable to changes in manufacturing and construction sectors, while women, to changes in the public sector and private services owing to the impact of recession and austerity.[8] Arguably, future structural changes will be determined not only by technology, but also by the level and distribution of investment, the impact of subsequent job loss on consumer demand (particularly for private services) and policies adopted towards the public sector, including consideration to use technologies to simply reduce labour input or to assist staff to provide better care.[9]

It is argued that the impact of structural change in the labour market on women due to the 4IR will be particularly appalling. Given that women are already underrepresented in tech jobs, they

Impact of structural change in the labour market on women due to the 4IR will be particularly appalling. Given that women are already underrepresented in tech jobs, they are more vulnerable to job losses due to the 4IR.

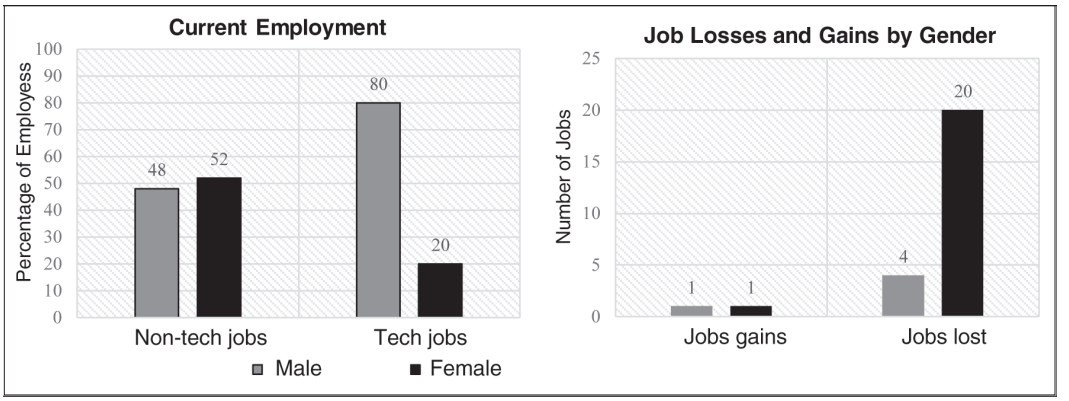
[6] Piasna, A., & Drahokoupil, J. (2017). Gender inequalities in the new world of work. *Transfer: European Review of Labour and Research, 23*(3). Retrieved from http://journals.sagepub.com/doi/abs/10.1177/1024258917713839

[7] Howcroft, D., & Rubery, J. (2018). *Bias in bias out: Gender equality and the fourth industrial revolution.* Retrieved from https://polsis.uq.edu.au/files/15541/Howcroft-Rubery-presentation-notes.pdf

[8] Rubery, J., & Rafferty, A. (2013). Women and recessions revisited. *Work Employment and Society, 27*(3), 414–432.

[9] Pritchard, G. W., & Brittain, K. (2015). Alarm pendants and the technological shaping of older people's care. *Technological Forecasting and Social Change, 93,* 124–132.

Figure 8.2
Predicted Job Disruption, by Gender



Source: Scott, L. (2018). *From Santiago: Gender equality and the fourth industrial revolution.* Retrieved from https://www.doublexeconomy.com/2018/02/26/santiago-gender-equality-fourth-industrial-revolution/

are more vulnerable to job losses due to the 4IR. According to predictions and estimations, some existing sectors as well as job categories will become obsolete due to automation. Job losses for women are predicted to be more than for men. As shown in Figure 8.2, women are expected to lose 20 jobs for every one gained in the coming era of the 4IR, while men will lose only four per job gained. At the same time, the few new jobs created will be in 'technology', which is generally described as business, engineering, digital tech, science/math, and health.[10]

Thus, benefits of the new technology such as robots and AI are expected to be distributed unevenly, and the chances of women enjoying these benefits is much less than for men.[11] Some Asian nations could lose more than 80 per cent of jobs in their garments, textile and apparel manufacturing sector which mostly employs women; fully automated sewing work by 'sewbots' could replace humans in factories. In Sri Lanka too, some major players in the apparel industry have already started to adopt automation of their production lines. Although the automation of the apparel industry in Sri Lanka is mainly due the labour shortages faced by the industry, it will bear major implications on women's employment given that the apparel industry is a key source of employment for Sri Lankan women.

8.2.2 Changes to the Nature and Quality of Work for Women

Three main factors important in determining changes to the nature and quality of work for women include the pattern of displacement, the current patterns of recruitment by gender into different types of jobs, and the overall pattern of work reorganisation.[12] Given that women

[10] Scott, L. (2018). *From Santiago: Gender equality and the fourth industrial revolution.* Retrieved from https://www.doublexeconomy.com/2018/02/26/santiago-gender-equality-fourth-industrial-revolution/

[11] Cliff., V. (2018). *The fourth industrial revolution could smash gender inequality – or deepen it.* Retrieved from https://www.weforum.org/agenda/2018/03/the-fourth-industrial-revolution-could-smash-gender-inequality-or-reinforce-it/

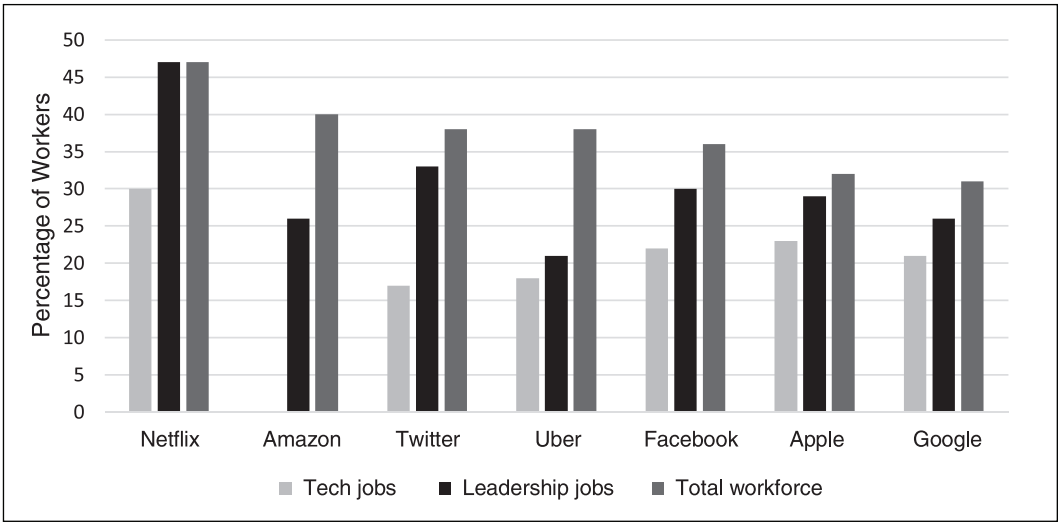
[12] Howcroft, D., & Rubery, J. (n.d.). *Bias in bias out: Gender equality and the fourth industrial revolution.* Retrieved from https://polsis.uq.edu.au/files/15541/Howcroft-Rubery-presentation-notes.pdf

are more likely to be involved in repetitive work throughout the labour market (with the exception of clerical support workers), an average improvement of the content of women's job might be expected if automation occurs mainly in relation to repetitive or routine tasks.[13] It is predicted that this could thus raise the quality of women's jobs, while reducing their number. However, repetitive jobs will not necessarily disappear initially, as it may still be cheaper to use labour than machines when more disadvantaged groups such as women are employed for low wages. Although historically women tend to be concentrated in repetitive work, the current patterns of recruitment by gender indicate women outperforming men in entering non-routine jobs requiring analytical or interpersonal skills. However, women still remain underrepresented in certain job categories, especially in jobs requiring science, technology, engineering and mathematics (STEM) knowledge and skills. Women's underrepresentation is particularly acute in the information and communication technology (ICT) sector (Figure 8.3).

Apart from low representation in the ICT sector, retention in the sector is challenging for women as many women leave within the first couple of years after entering the industry, with more leaving than are being recruited.[14] This implies that barriers to working in STEM are rooted beyond education and skills.

As mentioned above, the overall pattern of work reorganisation is an important factor in determining the nature and quality of work for

Figure 8.3
Percentage of Female Employees in the Workforce of Major Tech Companies



Notes: All data for 2017 or 2018 – latest available as of March 8, 2019.

Source: Richter, F. (2019). The tech world is still a man's world. *The statistics portal.* Retrieved from https://www.statista.com/chart/4467/female-employees-at-tech-companies/

[13] Piasna, A., & Drahokoupil, J. (2017). Gender inequalities in the new world of work. *Transfer: European Review of Labour and Research*, 23(3), Retrieved from http://journals.sagepub.com/doi/abs/10.1177/1024258917713839

[14] Moore, K., Griffiths, M., Richardson, H., & Adam, A. (2008). Gendered futures? Women, the ICT workplace and stories of the future. *Gender, Work and Organisation, 15*(5), 523–542.

women in particular. In other words, it is as to whether business organisations are in favour of designing human interventions, or using the human dimension to enhance competitiveness or the quality of the service provided. In response to changes anticipated due to the 4IR, three possible competitive strategies are proposed: squeezing out the cost base, automating to efficiency, and competing through connectivity.[15] Basically, these strategies are building on human skills as a basis for the survival of the businesses, especially in the retail sector. By adopting such strategies, automation can be combined with reskilling the workers rather than job displacements.

8.2.3 Employment Relationship

The traditional employer-employee work-relationship will be affected, and will change along with the 4IR. New forms of economies and markets such as the 'gig economy' are emerging,[16] and new employment types and options such as 'gig workers' and 'freelancers' are increasing, especially among females. Owing to new technology, including automation and digitalisation, new patterns and trends have emerged within labour markets, overriding traditional structures and practices and allowing for more flexibility at workplaces, connectivity, and opportunities to work from home offices (Box 8.1).

The new employment patterns and trends are particularly beneficial for women in accessing the labour market. These trends help to remove traditional barriers for women to enter and remain in the labour market, and pave new avenues and opportunities for women to be employed. For example, online job platforms with an international reach provide opportunities for women to work and earn in countries where

Box 8.1
New Reality of Work Patterns

- A wide variety of employment situations
- The rise of new forms of work
- Growing individual expectations and diverse working conditions
- The end of unified workplaces, times, and activities
- The emergence of multifaceted and discontinuous career paths
- Increasing interconnections between work and private life
- The end of static and predictable labour markets
- Fading boundaries between national labour markets

Source: World Employment Confederation- Europe. (2016). *The future of work.* Brussels, Belgium: World Employment Confederation- Europe.

[15] Tait, C. (2017). At the crossroads: The future of British retail.*The Fabian Society.* Retrieved from http://www.fabians.org.uk/wp-content/uploads/2017/01/FABJ4765_Retail_report_260117_WEB_.pdf

[16] The 'gig economy' is described as a free market system where an exchange of good and services take place through various on-line platforms including apps, smart phones or web applications. It has created new opportunities for job creation globally. These jobs can enable greater flexibility, access to a large market, and better earnings.

cultural barriers or rules make it difficult for them to work in the formal economy.[17] However, it should be noted that these new forms of employment options and relationships such as 'gig work' also have its downsides; on the whole, it represents continuation (and in some cases aggravating) of long-standing structural, and gendered inequalities.[18] Job insecurity, earning instability, limited or no access to social security benefits, limited assistance for career development, isolation, and lack of cultural solidarity are some major concerns associated with gig work.

8.2.4 Access to Work Over the Period of Child Bearing and Child Rearing

It can pose a risk if work becomes more fragmented with competition for each new task, much progress made by women in retaining access to employment through paid maternity leave may be obsolete.[19] At the same time, new technologies could potentially provide more flexibility and choice for women in deciding where, when, and how to work. This can perhaps reduce the proportion of women pushed into self-employment or the gig economy after childbirth. Flexible work arrangements are especially beneficial for women as it boost their employment rates.[20] Studies have found a positive relationship with 'working from home' options and employment rates, where countries with the highest shares of women working from home also have the highest maternal employment rates. For men, however, no such relationship emerges. Further, it is evident that gender pay gaps tend to be in industries where work arrangements are more flexible.

The International Labour Organisation (ILO) studying the technological advancement and future of work in Sri Lanka indicates that women in Sri Lanka are likely to benefit from new economic opportunities created by the 4IR.[21] However, the gendered division of labour will persist.

8.3 Education, Skills and Gender in the 4IR

Education plays an important role in facilitating and shaping the technological and societal transitions necessary to adapt to the 4IR. Given that the exact impact of 4IR technologies on society and human behaviour is still unknown and unquantified, the need for education, especially for a responsive higher education system, is urgent and essential.[22] Substantial changes to the science and technology curriculum are needed to enable students to develop capacity in the rapidly emerging areas of genomics, data science, AI, robotics and nanomaterials. Such a 4IR STEM curriculum would reconsider the traditional 'primary' sciences – biology, chemistry

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[17] An employment form in which organisations or individuals use an online platform to access other organisations or individuals to solve specific problems or to provide specific services in exchange for payment.

[18] Hunt, A., & Samman, E. (2019). *Gender and the gig economy. Critical steps for evidence-based policy.* ODI Working Paper 549. Retrieved from https://www.odi.org/sites/odi.org.uk/files/resource-documents/12586.pdf

[19] Howcroft, D., & Rubery, J. (n.d.). *Bias in bias out: Gender equality and the fourth industrial revolution.* Retrieved from https://polsis.uq.edu.au/files/15541/Howcroft-Rubery-presentation-notes.pdf

[20] Organisation for Economic Cooperation and Development. (2017). *Going digital: The future of work for women, policy brief on the future of work.* Retrieved from https://www.oecd.org/employment/Going-Digital-the-Future-of-Work-for-Women.pdf

[21] International Labour Organisation. (2019). *Future of work in Sri Lanka: Shaping technology transitions for a brighter future.* Colombo, Sri Lanka: International Labour Organisation.

[22] Penprase, B. E. (2018). The fourth industrial revolution and higher education. In N. Gleason (Ed.) *Higher education in the era of the fourth industrial revolution.* Singapore, Palgrave Macmillan.

and physics – and place a higher value for training in computer science subjects as a form of 4IR literacy.[23]

Despite the pressing need to equip students with STEM education to face challenges of the 4IR successfully, it is clearly evident that women are at a disadvantageous position to access STEM education and skills. This is reflected by low female representation in STEM-based jobs (see Figures 8.2 and 8.3). At present, gender differences exist in STEM education at all levels of education. In many parts of the world, the gender gap is to the disadvantage of girls, but in certain contexts and subjects, it is in their favour. The United Nations Educational, Scientific and Cultural Organisation (UNESCO) finds that gender differences in STEM education participation to be more apparent once/when subject selection becomes available usually in upper secondary education, and worsens as the level of education improves.[24] Globally, only 35 per cent of STEM students in higher education are women, and differences are observed within STEM disciplines (Figure 8.4).

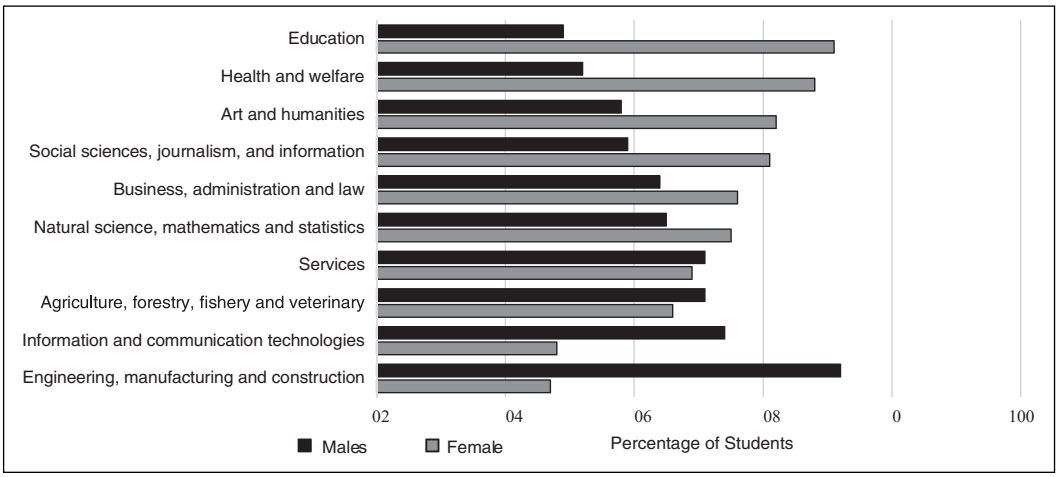
Not surprisingly, the same pattern of gender disparity can be observed in STEM education in Sri Lanka as well (Figure 8.5). While gender parity is significantly higher in admission for certain subject streams (e.g. law, arts, and indigenous medicine) at the university level, it is remarkably low for some (e.g. engineering, technology, and computer science).

Despite the pressing need to equip students with STEM education to face challenges of the 4IR successfully, it is clearly evident that women are at a disadvantageous position to access STEM education and skills.

[23] Penprase, B. E. (2018). The fourth industrial revolution and higher education. In N. Gleason (Ed.) *Higher education in the era of the fourth industrial revolution.* Singapore, Palgrave Macmillan.

[24] United Nations Educational, Scientific and Cultural Organisation. (2017). *Cracking the code: Girls' and women's education in science, technology, engineering and mathematics (STEM).* Paris, France: United Nations Educational, Scientific and Cultural Organisation.

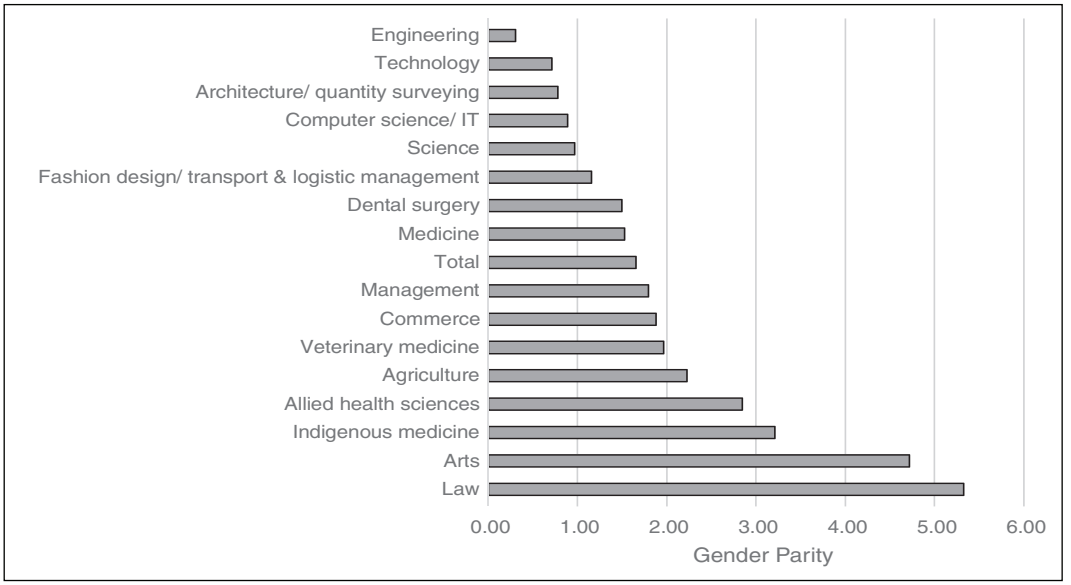
Figure 8.4
Share of Female and Male Students Enrolled in Higher Education, by Field of Study, Global Average



Source: United Nations Educational, Scientific and Cultural Organisation. (2017). *Cracking the code: Girls' and women's education in science, technology, engineering and mathematics (STEM)*. Paris, France: United Nations Educational, Scientific and Cultural Organisation.

In Sri Lanka, the low presence of female students in STEM fields is connected to education infrastructure facilities related (e.g. inadequacy of subject-qualified teachers and schools offering science and technology subjects) as well as gender-related (e.g. traditional social perception of engineering to be a masculine job, an absence

Figure 8.5
Gender Parity in Undergraduate Admissions by Academic Programmes in Sri Lanka, 2016/2017



Source: Author's calculations based on data by the University Grants Commission Sri Lanka http://www.ugc.ac.lk/en/publications/2029-sri-lanka-university-statistics-2017.html

of efforts to motivate women to take up jobs perceived as 'masculine' jobs, transport and safety issues faced by girls when travelling to schools in urban areas which offers science and mathematics subjects for advanced level, etc.).[25]

In addition to low female participation in STEM education and employment, the attrition rate is particularly high.[26] Women leave STEM disciplines in disproportionate numbers during their studies, during transition to the world-of-work and even during their career cycle. Even though biological explanations tend to rely on the fact that boys are better at spatial tasks while girls are better at verbal recall tasks, a number of scientific studies affirm that these differences are marginal and their link to STEM ability is insignificant.[27] Gender difference in STEM education is mostly a social construct, where countries with higher gender equality indicate a lower gender gap in STEM education.

Low female representation in STEM fields can be explained using some important theories such as 'gendered socialisation theory', 'peer group theory', and the 'theory of stereotypes of STEM professionals'.[28] Gendered socialisation' theory explains that low female participation in STEM fields as a direct response to stereotypes and socialisation practices, focused on male dominance and female submissiveness. These socialisation practices feed into the concept of stereotype threat, which can undermine girls' performance in STEM fields. Peer group theory identifies the gender gap in STEM as directly linked to the role peer groups play in the academic experiences of students. Students enjoy being part of a peer group and would rather engage in similar activities as their peer groups than in those activities which may not coincide with the 'in group' perception from their peers' point of view. Girls' motivation in math and science courses during the adolescent years is positively associated to peer support. The peer group influence can also turn girls away from STEM courses if their 'in group' does not academically succeed in the STEM related courses. The theory of stereotypes of STEM professionals emphasises the personality traits and characteristics that are stereotypical of technology professionals or engineers, which include social awkwardness or an introverted character. These professional stereotypes infiltrate society's views of STEM related professionals, which may directly oppose the desired personality traits for women who are more social and outgoing.

Apart from the weak educational progress in STEM by women, a clear gender disparity can also be observed in vital skills required by the 4IR. For example, there is a noticeable gender disparity in AI skills (Figure 8.6). AI is regarded as a prominent feature and skill within the transformations brought about by the 4IR. AI also serves as a key maker of the trajectory of innovation across industries. Globally, only 22 per cent of AI professionals are female, compared to 78 per cent who are male, accounting for a gender

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[25] Madurawala, S., Arunatilake, N., Madushani, C., & Karunaratne, N. (2017). *A desk review to assess the Sri Lankan girls and young women's economic and social empowerment for leadership.* Unpublished Research Report. Colombo, Sri Lanka: Institute of Policy Studies of Sri Lanka.

[26] United Nations Educational, Scientific and Cultural Organisation. (2017). *Cracking the code: Girls' and women's education in science, technology, engineering and mathematics (STEM)*. Paris, France: United Nations Educational, Scientific and Cultural Organisation.

[27] Gjersoe, N. (2018). *Bridging the gender gap: Why do so few girls study STEM subjects?.* Retrieved from https://www.theguardian.com/science/head-quarters/2018/mar/08/bridging-the-gender-gap-why-do-so-few-girls-study-stem-subjects

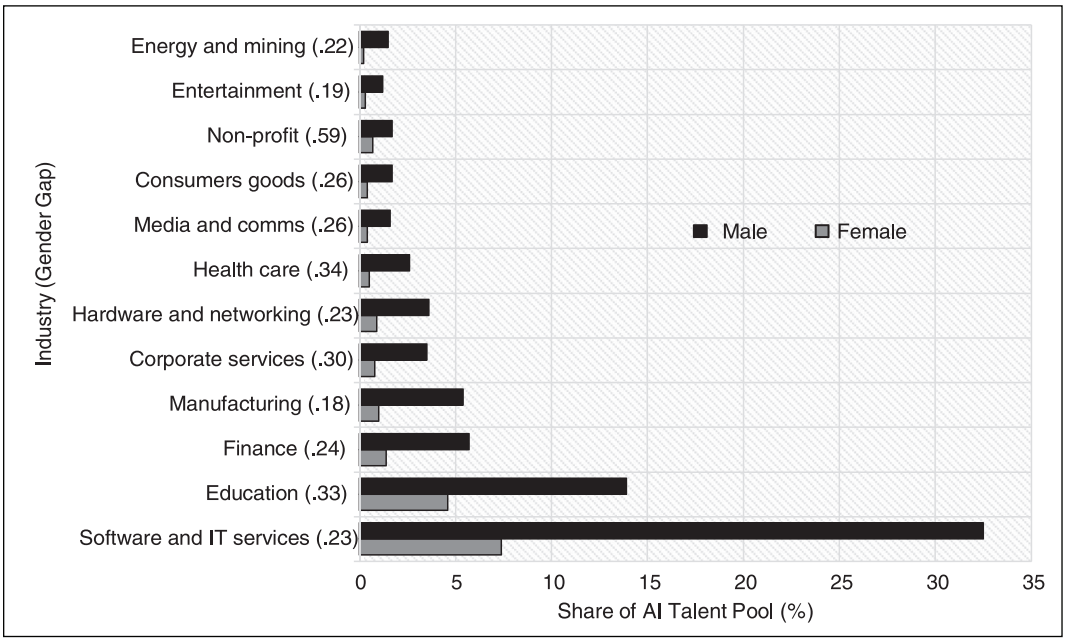
[28] Reinking, A., & Martin, B. (2018). The Gender gap in stem fields: Theories, movements, and ideas to engage girls in STEM. *Journal of New Approaches in Educational Research, 7*(2).

gap of 72 per cent. This gender gap has remained constant over recent years and at present, does not indicate a positive future trend.[29]

The implications of a large gender gap in AI skills are wide-ranging and require urgent action for three reasons.[30] Firstly, gender gaps in AI skills can aggravate present gender gaps in economic participation and opportunity in the future, as AI encompasses an increasingly in-demand skillset. Secondly, the gap implies that the use of this general-purpose technology across many fields is being developed without diverse talent,



Figure 8.6
AI Talent as Distributed Across Industries, by Gender



Source: World Economic Forum. (2018). *The global gender gap report 2018*. Geneva, Switzerland: World Economic Forum.
Note: Gender gaps range from 0 (no women) to 1 (parity).

[29] World Economic Forum. (2018). *Future of jobs report 2018.* Geneva, Switzerland: World Economic Forum.
[30] World Economic Forum. (2018). *The global gender gap report 2018.* Geneva, Switzerland: World Economic Forum.

limiting its innovative and inclusive capacity. Thirdly, low integration of women into AI talent pools is a significant and missed opportunity in a professional domain, where there is already an insufficient supply of adequately qualified labour.

8.4 Social Implications of 4IR on Gender

8.4.1 Gender Stereotypes and Social Justice

The 4IR, similar to its predecessors, is contributing to redefine the societal roles of men, women, and children in its wake. Previous industrial revolutions have contributed to shape the gendered societal roles. For example, the first and second industrial revolutions transformed an agrarian and handicraft economy to an industrial economy, leading to the development of workspaces such as factories and to the rise of working and middle classes. Due to poor working conditions such as overcrowded factories and safety issues, restrictions were put in place to protect women and children from these environments. Children were sent to schools and gradually, men became the 'breadwinners' and women being 'homemakers', were expected to focus on taking care of the house and family.[31]

Similarly, the 4IR is also expected to bring in some critical changes to existing gendered norms and roles. Some forecast that the 4IR will reverse the gender stereotypes created by the first, by placing an emphasis back on human talent such as ingenuity and creativity, and not on traditional masculine skillsets.[32] On-demand production of customised products and talent is becoming the most valuable asset in the 4IR.

In an economy which is based more on talent and less on capital, there is a higher prospect of women being treated more equally. Further, there will be fewer obstacles to talent acquisition and retention.

[31] Funna, R. (2018). *The fourth industrial revolution will eliminate the gender stereotypes created by the first*. Retrieved from https://qz.com/1177843/the-fourth-industrial-revolution-will-eliminate-the-gender-stereotypes-created-by-the-first/

[32] *Ibid*.

In an economy which is based more on talent and less on capital, there is a higher prospect of women being treated more equally. Further, there will be fewer obstacles to talent acquisition and retention. It is expected that the exponential nature of 4IR will rely more on the fluidity of roles, functions and industries and on human talent, regardless of gender. Business organisations will stop reinforcing gender roles in order to fuel an unprecedented race for the best talent. The most successful organisations and firms in the 4IR environment will be the ones that eliminate gender-stereotypes in favour of post-gender structures, allowing women to innovate and grow.

Considerable speculation on potential of the 4IR to consolidate power asymmetries, increase inequalities, and advance technologies fail to embody human-centred values.[33] It is of no doubt that emerging 4IR technologies such as AI and drones add value to human rights, basic service delivery, and other functions of civil society. Yet, there are instances where these technologies are being used against civic freedom and human rights. Various civil organisations including advocacy groups, trade unions, and other institutions increasingly face targeted digital threats and cyber-attacks. The use of digital and emerging technologies by firms, governments and civil society groups has created new challenges. Further, it has entrenched existing challenges associated with accountability, fairness, trust and transparency. Concerns about data protection, digital misinformation and ethical use of technologies are highlighted for greater participation and partnership in governing how these powerful, emerging technologies shape societies.[34]

8.4.2 Digital Threats and Online Violence Against Women and Girls

The occurrence of digital and cyber violence has increased in recent times, with women being disproportionately affected. The European Union (EU) estimates that one in 10 women have already experienced a form of cyber violence since the age of 15, and up to 90 per cent of non-consensual pornography victims are women.[35] In the case of Sri Lanka, a rapid increase is evident in the number of cybersecurity related incidents reported, especially those related to social media. According to the Sri Lanka Computer Emergency Readiness Team – the National Centre for Cybersecurity (SLCERT), 222 cybersecurity incidents were reported in 2017, compared to 77 incidents in 2010. Similarly, the number of reported social media incidents have increased from 80 in 2010 to 3,685 in 2017.[36] Although disaggregated data based on sex are not available in Sri Lanka, there is a high probability that women and girls account for a larger number of victims. Among 194 states, Sri Lanka was ranked at 83 globally, and 16 regionally (Asia-Pacific) on the global cybersecurity index in 2018.[37] The legal responses to online abuse, and threats are generally gender neutral. Current cybercrime

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[33] Sangokoya, D., & Ajoku, L. (2018). *Can we ensure a fair 'fourth industrial revolution'? 4 key challenges.* Retrieved from https://news.itu.int/a-fair-fourth-industrial-revolution-4-key-challenges/

[34] *Ibid.*

[35] European Institute for Gender Equality. (2017). *Cyber violence against women and girls.* Vilnius, Lithuania: European Institute for Gender Equality.

[36] Sri Lanka Computer Emergency Readiness Team.(2018). *National information and cyber security strategy of Sri Lanka 2019-2030.* Colombo, Sri Lanka: Sri Lanka Computer Emergency Readiness Team.

[37] International Telecommunication Union. (2018). *Global cybersecurity index (GCI) 2018*. Geneva, Switzerland: International Telecommunication Union. Singapore topped at the regional level with the UK ranked the world's best for 2018.

legislation and cybersecurity legislations are not robust to combat the digital and cyber intimidations that could further arise with the 4IR.

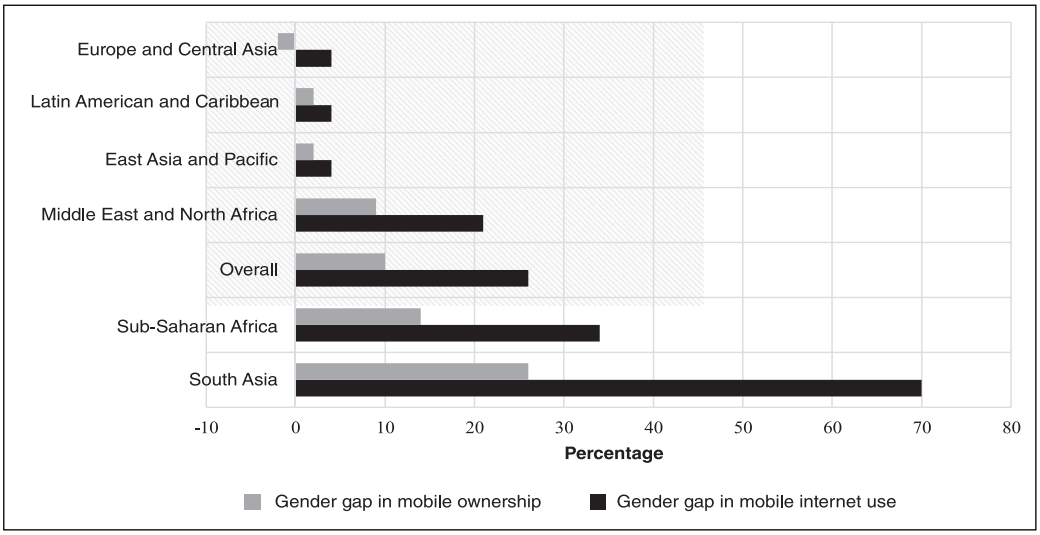
8.4.3 Gender Digital Divide

The existing gender digital divide prevent or limit women's access to, use of and benefits from ICT. Position of women who are already disadvantaged by such divisions further worsens with the emergence of the 4IR, which is built upon an ICT-based third industrial revolution.

Globally, as well as locally, the digital landscape as well as mobile internet connections have changed rapidly owing to many reasons. Wider mobile signal coverage, affordable mobile data services, increased usage of smartphones, increased computer literacy and progressive ICT policy reforms are some of the main contributory factors for this rapid expansion. However, a closer look reveals significant gaps, not only in terms of digital access, but also in the ability of specific social groups to leverage new technological applications for socio-economic development. Among these gaps in digital access, a gender gap is the most prominent, and can be observed in almost all communities.[38]

The digital gender divide becomes prominent furthermore across the world when it comes to women as creators of technology. Even in developed countries, this is a common phenomenon. For example, in the US, women account for 57 per cent of all professional occupations, but only 25 per cent of all computing occupations. Further, 88 per cent of all ICT patents are invented by male teams of inventors, whereas only 2 per cent by female teams of

Figure 8.7
Gender Gap in Mobile and Mobile Internet Use, by Region



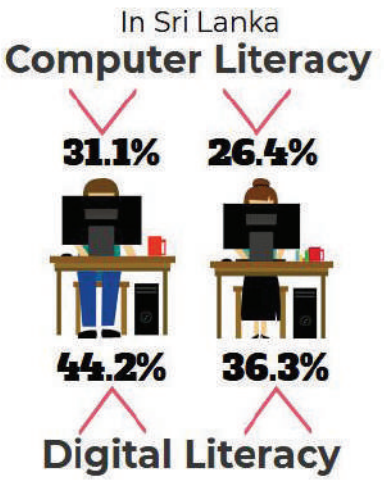
Source: Global System for Mobile Communications Association. (2019). *Connected women: The mobile gender report 2019*. London, United Kingdom: Global System for Mobile Communications Association.

[38] Mariscal, J., Mayne, G., Aneja, U., & Sorgner, A. (2018). *Bridging the gender digital gap G20 Argentina.* Retrieved from https://www.g20-insights.org/policy_briefs/bridging-the-gender-digital-gap/

[39] Ashcraft, C., McLain, B., & Eger, E. (2016). *Women in tech*: *The facts.* Retrieved from https://www.ncwit.org/sites/default/files/resourcesncwit_women-in-it_2016-full-report_final-web06012016.pdf

inventors.[39] Apart from common barriers that limit internet and digital devices access to both men and women – such as cost of devices and services, and poor infrastructure facilities –additionally, women face socio-cultural barriers in accessing internet and digital devices. Negative perceptions of women using digital devices, going out from home to community internet centres and erroneous beliefs that the internet does not contain relevant information for women and girls are some of the socio-cultural barriers faced by women.[40] As a result, women record a lower level of computer literacy and digital skills than their male counterparts.

Gender digital divide is apparent in Sri Lanka too. As of early 2017, 6 million active internet users and 25 million mobile connections were reported in Sri Lanka.[41] In numerical terms, computer literacy stood at 31.1 per cent and 26.4 per cent for men and women respectively, in Sri Lanka.[42] Similarly, digital literacy for men is 44.2 per cent and 36.3 per cent for women.[43] This existing gender digital divide will place extra pressure on Sri Lanka in meeting the challenges of the 4IR.



8.5 Way Forward and Policy Recommendations

As the waves of technological advancements of the 4IR are felt in Sri Lanka, affecting many aspects of the country's socio-economic landscape, a constructive discussion on the 4IR and its implications is needed. The gendered impact of the 4IR should be considered as vital, given the already poor performance of the country in ensuring gender equality in certain key areas.

As discussed above, the main impact of the 4IR will be on labour market. Sri Lanka has considerable potential to use the technological advancements to increase country's low female labour force participation – a problem that persists, and negatively affects country's economy.

Structural changes in the labour market due to the 4IR and its consequences can be detrimental, particularly for women. Employment categories which are presently dominated by women are expected to be replaced by machines and technology. Many traditional women-dominated job categories will decline, while new job categories which require new sets of skills will

[40] Mariscal, J., Mayne, G., Aneja, U., & Sorgner, A. (2018). *Bridging the gender digital gap G20 Argentina.* Retrieved from https://www.g20-insights.org/policy_briefs/bridging-the-gender-digital-gap/

[41] Colombo Digital Marketer. (n.d.). *Internet usage statistics in Sri Lanka – Updated for 2017.* Retrieved from http://www.digitalmarketer.lk/internet-usage-statistics-in-sri-lanka-2016-updated.html

[42] Department of Census and Statistics. (2017). *Computer literacy statistics –2017(Annual).* Colombo, Sri Lanka: Department of Census and Statistics.

[43] A person is considered as a computer literate person if he/she could use a computer on his/her own, where as a person is considered as a digital literate person if he/she could use a computer, laptop, tablet or smartphone on his/her own.

emerge. Given this structural transition in the labour market, the focus should be on those emerging sectors and jobs (e.g. tech-based jobs). A refocus is needed for those sectors which are traditionally considered as main job creators for women (e.g. apparel sector). The care economy which is less likely to be automated can be regarded as a good option for Sri Lanka to promote, and provide decent work opportunities especially for women, in the context of a large ageing population.

Opportunities that come with the 4IR should be explored to encourage greater economic participation of women. In this regard, the platform economy will allow women to work remotely, where flexibility allows them to access the labour market and remain in it. However, there is a risk where women working part-time or remotely through labour platforms can fall into the ambit of the informal economy. In a similar scenario, such women are less likely to have access to social security and labour protection guarantees, which are typically associated with regular and formal employment. Hence, it is important to undertake formation and reforms for necessary legislative and institutional frameworks to protect rights of platform workers.

A comprehensive restructuring of the education system will be needed to fulfill the requirements of the 4IR. STEM-based education can play an important role as a stepping stone to the era of the 4IR. New STEM-based subjects such as genomics, data science, AI, and robotics will be in demand that need to be taught. Existing gender imbalances in STEM education, where girls are at a more disadvantaged position, suggest that extra efforts are needed to enhance girls' participation in STEM education. Increasing the number of subject qualified teachers and schools offering such classes are key steps which should be taken in order to enhance STEM education in Sri Lanka. Other than these education infrastructure-related measures, gender barriers to increase women's participation in STEM education and STEM-based jobs should be addressed effectively. It is clear that socially constructed ideas and perceptions on certain jobs discourage women taking up such jobs and related education. Given the significant effect of gendered social conceptions on women's decisions on participating in STEM education, steps should be taken to mitigate them. Promoting female role models – those who have succeed in the STEM fields – is an important measure that can be taken in this regard.

The gendered impact of the 4IR should be considered as vital, given the already poor performance of Sri Lanka in ensuring gender equality in certain key areas.

It is predicted that the 4IR will influence the already existing gender stereotypes, and for women, this change could also be favourable. The 4IR will rely more on human talent regardless of gender. and the extent to which business organisations eliminate gender-stereotypes in favour of post-gender structures. In such an environment, women can be encouraged to develop their skills and competencies.

Digital threats and online violence against women and girls are on the rise with rapid digitalisation and increased access to the internet. Strong and enforceable legal frameworks are required to address existing loopholes in the legal system, while taking legal action in a more gender sensitive manner is to be encouraged.

The gender digital divide – the socio-economic obstacles which prevent women's access to, use of and benefit from ICT – constraints women from fully benefitting from the 4IR. Taking steps to eliminate the prevailing gender digital divide should be considered a priority, as these steps will enable many more women to benefit from the new technological advancements. The economy in turn will be positively impacted by increased women's economic and social contribution through digital access and participation.

9. Health Care in the 4IR

9.1 Introduction

Health care is considered a 'service' industry which involves labour intensive services. As such, the quality of service in the health care industry is highly dependent on access to qualified health professionals. In 1978, the 'Declaration of Alma-Ata at the International Conference' on Primary Health Care expressed the need for urgent action by all governments, health care and development workers along with the world community to protect and promote the health of all people, globally. The conference strongly reaffirmed that health is a "state of complete physical, mental and social wellbeing, and not merely the absence of disease or infirmity, is a fundamental human right and that the attainment of the highest possible level of health is a most important worldwide social goal."[1] However, the reality today is that the achievements have fallen short of 'health care for all' due to lack of access to health care services. According to a recent report from the World Bank and World Health Organisation (WHO), at least half of the world's population is unable to receive essential health care services.[2]

In developing economies, many countries are ill-equipped to provide quality health care services, as highly trained health care professionals are reluctant to serve in rural and remote surroundings. As such, many rural people struggle to have access to quality health care services. Also, countries need to be tactical in its healthcare developments as emerging health issues are evident, such as the growing prevalence of non-communicable diseases (NCDs) and long-term care for elders, with demographic changes as well as changing lifestyles of people. It can be expected that all these factors exert pressure to further increase the demand for health care services.

Such emerging issues in health care services are trending in Sri Lanka too. Population ageing is a universal phenomenon, but Sri Lanka is one of the fastest ageing countries in the world. According to the population census 2012 carried out by the Department of Census and Statistics (DCS), the share of Sri Lanka's senior citizens population (over 60 years) stands at 12.4 per cent, and is projected to increase to 28.8 per cent by 2050.[3] Given that NCDs are also more prevalent among the elderly population, battling the growing NCD epidemic and providing long-term care for elders will require fresh approaches to health care developments in the country.

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1 World Health Organisation. (n.d.). *Declaration of Alma-Ata.* Retrieved from https://www.who.int/publications/almaata_declaration_en.pdf

2 World Bank. (2017). *World Bank and WHO: Half the world lacks access to essential health services, 100 million still pushed into extreme poverty because of health expenses.* Retrieved from http://www.worldbank.org/en/news/press-release/2017/12/13/world-bank-who-half-world-lacks-access-to-essential-health-services-100-million-still-pushed-into-extreme-poverty-because-of-health-expenses

3 United Nations, Department of Economic and Social Affairs, Population Division. (2017). *World population prospects: The 2017 revision, custom data.* Retrieved from https://population.un.org/wpp/Graphs/DemographicProfiles/

The health care systems of many countries face considerable challenges in dealing with these demographic transformations, and to cater to the consequent emerging health care needs. To maintain the healthiness of populations and cure patients more effectively, solutions can be sought from those services beyond traditional health care services. The extent to which technology can make a difference in the context of a growing need for transformational change becomes a pertinent issue. To date, health is one of the core sectors which has been directly impacted by the radical technological shifts taking place in the contemporary world. In this context, the fourth industrial revolution (4IR) that promises an era of rapid technological transformation melding the physical, digital and biological systems extend much hope. These advanced technologies undoubtedly improve health outcomes and extend life spans in the digital era.

There are two major benefits that 4IR brings in to the health care sector through technologies. One is to prevent the disease itself (preventive care), and the other is to more efficiently manage the disease once it occurs (curative care). Both are directly related to cost savings and provide 'value-based' care. Health care is also expected to benefit considerably from this technological transformation through a progression towards more personalised and precise delivery of services. For example, in the fields of genomics testing and advanced radiological imaging, more precise diagnoses and treatments will be made available. Further, technology is a powerful enabler of new care models.

By embracing the potential of technologies offered by the 4IR, Sri Lanka can also transform the dream of 'health care for all' into a more promising reality. Against this backdrop, this chapter will discuss global experiences on how new technologies are transforming the health care landscape, and assess the impact and challenges in transforming health care in Sri Lanka, using new technologies available in the 4IR.

9.2 Transforming the Health Care Landscape with New Technologies

Today, the world finds itself in an era where technology can constantly change and challenge the role of human beings with the benefit of artificial intelligence (AI), robots, machines and various other tech devices. These technologies can be employed positively to improve health outcomes. Indeed, developed countries have already made several historical landmarks by accessing new technologies for early diagnosis of diseases, precision treatment plans, improved medicine and surgical facilities, rapid response, etc. Other more innovative achievements include successful 3D printing of organs and human head transplants. By contrast, health sectors in developing countries still struggle to address basic factors such as distance to reach a hospital facility, etc., when accomplishing surgeries that are urgent and delivering other health care related services. Given the diversity of factors involved, this section discusses the leading key drivers in health care in the 4IR such as the internet of things (IoT), AI, 3D printing and nanotechnology, genomics, etc.

9.2.1 Convergence of Biological, Social, and Digital Systems for Better Health Care

The 4IR provides a turning point in the transformation to digitalisation in an era of growing internet usage. In a computer dominated world, diagnosing and curing diseases have become easier, often at the touch of high-tech health devices and tools. Today, internal and external parts of the body can be 3D printed as necessary, while long-distance surgeries can be facilitated through well-equipped computers connected to the internet. Scientists have declared that 3D printing technology enables replicas of the human heart, which can save babies suffering from heart defects. These replicas are designed to match every tiny detail of a baby's heart, so that these can help surgeons to plan out treatment – as to where to make a cut in the tissue, reroute piping and patch holes in children with congenital heart defects.[4] The technology can be applied not only to construct tiny synthetic hearts, but also other organs, which make 3D printing a useful high-tech addition in health care services.

Further, in a computer dominated world, the next step forward with 4IR technologies is surgeries performed by advanced robots. In fact, the first ever robot-assisted laparoscopic surgery was carried out in 2000 under the approval of the food and drug administration (FDA) using the da Vinci surgical systems.[5] When performing a da Vinci surgery, a high-definition 3D camera is inserted, while surgeons control robotic arms that bend and rotate into positions where the human hand is incapable of penetrating, allowing for greater precision and control. The da Vinci robotic surgery system's 3D magnification screen allows the surgeon to view the operative area with the clarity of high resolution. This advancement enables for less contact between the exposed interior tissues and surgical device, reducing the risk of infection to a greater degree, while improving the accuracy in small operating spaces. Also, this system is a minimally invasive system that allows surgeons to operate through only a few small openings. In this context, the virtual presence of the surgeon or the doctor is enabled at the destination, and hence their physical presence is no longer a vital necessity. Developing countries such as India too has already facilitated carrying out a cardiovascular surgical procedure of 15 minutes duration on a patient who was approximately 20 miles away using modern technologies.[6] The successful adoption of such practices depends on access to high speed wi-fi connections and modern computer devices. It is noteworthy that robotic surgery has already been a successful option in neurological, urological, gynaecological, cardiothoracic, and numerous other general surgical procedures.

Further, with the advanced technological revolution in health care, the growing trend of detecting and treating difficult diseases is not as onerous as it used to be in earlier times. Nano-based drugs and drug delivery systems are some of the most novel forms of increasing efficacy in the field of science and medicine. Further, nanotechnology offers multiple benefits in treating chronic human diseases by specifying

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4 Ghose, T. (2014). *3D- printed hearts help surgeons save babies' lives.* Retrieved from https://www.livescience.com/48816-3d-printed-hearts-improve-surgery.html

5 The da Vinci surgical system is designed to translate a surgeon's hand movements into precise movements of the EndoWrist instruments, using advanced robotic technology.

6 Matthews, K. (2018). *Five surgical robots to look out for in 2019.* Retrieved from https://www.roboticsbusinessreview.com/health-medical/5-surgical-robots-2019/

and allowing a target-oriented delivery of precise medicines. For instance, advancements in nanomedicine have improved the approach to cancer treatment and allowed tumour sites to be directly targeted, making treatment faster and more effective.

Recently, a number of outstanding applications of nanomedicine in the treatment of various diseases have become evident. In the treatment of brain cancer, it is noted that "brain cancer is one of the most difficult malignancies to detect and treat mainly because of the difficulty in getting imaging and therapeutic agents past the blood-brain barrier and into the brain. Anti-cancer drugs such as loperamide and doxorubicin bound to nanomaterials have been shown to cross the intact blood-brain barrier and released at therapeutic concentrations in the brain. The use of nanomaterials including peptide-based nanotubes to target the vascular endothelial growth factor (VEGF) receptor and cell adhesion molecules like integrins, cadherins and selectins, is a novel approach to control disease progression".[7] In addition, nanomedicine can be used to develop more targeted medicines that treat, and in some cases, cure patients suffering from once life-threatening diseases such as human immunodeficiency viruses (HIV) and hepatitis C which were not even discovered until the 1980s.

The 4IR may also usher in a new wave of potentially life-changing innovations in areas like genomics. However, there are also important ethical dilemmas to be considered. The emerging field of gene editing may offer new hope for some largely untreatable genetic conditions or diseases. For instance, Novartis's application of CRISPR (clustered regularly interspaced short palindromic repeats) genome editing technology allows scientists to precisely delete, repair or replace the genes of selected cells that cause certain diseases.[8] Genome editing would repair the causes of diseases as opposed to reducing the effects of symptoms. For instance, cell regeneration science would help cancer patients enjoy cancer-free lives as they benefit from edit genes and create designer immune cells programmed to hunt out and kill drug resistant cells. In the fields of genomics testing, more precise diagnoses and treatments will also become available. Further, new technology has made it possible to sequence a person's genomic data which may pave the way for preventative measures, and to develop more personalised treatments. Further, these technologies will also prevent waste and spillage of scarce resources, and undoubtedly improve overall outcomes.

9.2.2 More Precise Diagnoses and Treatments

Doctors can use big data analysis which have a unique set of tools to reduce medical errors and benefit from the latest scientific knowledge. The large volume of clinical data analytics allows for faster, and better clinical decision-making. Patients whose condition is severe can be treated by reviewing their disease characteristics against large databases of previously known cases, which will reduce discrepancies of care as protocols. With this system, therapies can be optimised for each patient where only relevant treatments will be prescribed. Thus, transforming to value-based health care, eliminating waste and

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[7] Suri, SS., Fenniri, H., & Singh, B. (2007). *Nanotechnology-based drug delivery systems.* Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2222591/ Nanotechnology-based drug delivery systems

[8] Jimenez, J. (2016). *Three ways the fourth industrial revolution can transform healthcare.* Retrieved from https://www.weforum.org/agenda/2016/01/three-ways-the-fourth-industrial-revolution-could-transform-healthcare/

furthermore, at a lesser cost and improved pace of recovery. Furthermore, doctors will be able to recommend personalised medicine based on the patient's behaviour patterns (i.e. how often, how long, and when does the patient work on their rehabilitation), thus group and categorise patients to develop individualised therapies, unlike general treatment.

9.3 Sri Lanka's Health Care in the 4IR

Sri Lanka provides universal health services for all the citizens which encompasses the entire range of preventive, curative, and rehabilitative health care. Parallel to the public sector free health care facilities, the private sector also provides access to all types of care at a cost. The public sector provides the overwhelming majority (95 per cent) of inpatient care, while the private sector provides mainly curative care, which accounts for nearly 50 per cent of total outpatient (OPD) care. As of 2016, a total of 53 million OPD visits and more than 6 million hospitalisations occurred in the public sector health care services.[9]

9.3.1 The Health Care System

In the public sector, curative care services are d elivered through a network of health care institutions, ranging from sophisticated teaching hospitals with specialised consultative services to central dispensaries which provide only OPD services. As of 2016, 629 curative care hospitals in government health services provided inpatient facilities (Table 9.1). Further, specialised care is provided through teaching hospitals, provincial general hospitals, district general hospitals and base hospitals, while divisional hospitals and

Table 9.1
Type of Hospitals in Sri Lanka

Type of Institution	Total Number of Institutions	Average Number of Hospital Beds
Teaching hospitals	16	1,257
Provincial general hospitals	3	1,597
District general hospitals	19	627
Base hospital type A	24	369
Base hospital type B	47	166
Divisional hospital type A	50	108
Divisional hospital type B	135	68
Divisional hospital type C	298	29
Primary medical care unit and maternity homes	12	13
Other hospitals[a]	25	218
Central dispensaries	480	-

Notes: a: Teaching hospitals of cancer, mental and dental are categorised under other hospitals and military, police and prison hospitals are included under other hospitals.
Source: Ministry of Health, Nutrition and Indigenous Medicine. (2017). *Annual health bulletin 2016.* Retrieved from http://www.health.gov.lk/moh_final/english/public/elfinder/files/publications/AHB/2017/AHB%202016.pdf

[9] Ministry of Health, Nutrition and Indigenous Medicine. (2017). *Annual health bulletin 2016.* Retrieved from http://www.health.gov.lk/moh_final/english/public/elfinder/files/publications/AHB/2017/AHB%202016.pdf

primary medical care units are served by non-specialist medical officers. Most of the teaching and large hospitals are based in cities and urban suburbs, while secondary level hospitals are in the outskirts of cities or urban sector. In this context, rural people have less access to specialised treatments.

9.3.2 Importance of Transforming Health Care in Sri Lanka

According to Sri Lanka's health statistics, more than a half of medical specialists in the curative sector are to be found in the Colombo, Gampaha, Kandy and Galle districts.[10] As such, it is a common phenomenon to find patients who are in-need of medical assistance in remote areas being unable to reach particular professionals due to several reasons such as expenses that are unaffordable, unavailability of specialised doctors or surgeons, and difficulties in contacting medical specialists. This is one such area, where information and communication technology (ICT) can play a major role in country's health care services. Through advancements in e-health across the country, patient centric medical services can be facilitated to avoid or minimise such consequences.

At the same time, Sri Lanka faces emerging health issues with demographic changes as well as changing lifestyles of people – i.e. long-term care for elders, NCDs which need special attention in terms of providing better health care services.

More than a half of medical specialists in the curative sector are to be found in the Colombo, Gampaha, Kandy and Galle districts.

An Ageing Population and Rising Demand for Long-Term Care: As in the case of many other countries, Sri Lanka's demography has reached a turning point where its ageing population is on the rise. As per the population census 2012, Sri Lanka's share of the population over 60 years old was 12.4 per cent.[11] Similar estimates by the United Nations (UN) population projections show a rapid ageing of the population with the share of population over 60 years old forecast to reach 28.8 per cent in 2050 – which exceeds the average of that of many regions/countries in the

[10] Ministry of Health, Nutrition and Indigenous Medicine. (2017). *Annual health bulletin 2016.* Retrieved from http://www.health.gov.lk/moh_final/english/public/elfinder/files/publications/AHB/2017/AHB%202016.pdf

[11] Department of Census and Statistics. (2015). *Sri Lanka census of population and housing 2012.* Colombo, Sri Lanka: Department of Census and Statistics.

world.[12] Furthermore, the census 2012 reveals that 19 per cent of the aged 60 and above people have mobility difficulties, while 14 per cent of elders of the same cannot manage their day to day self-care by themselves.[13] These changes will result in a rapid increase in the number dependents who needs long term care.

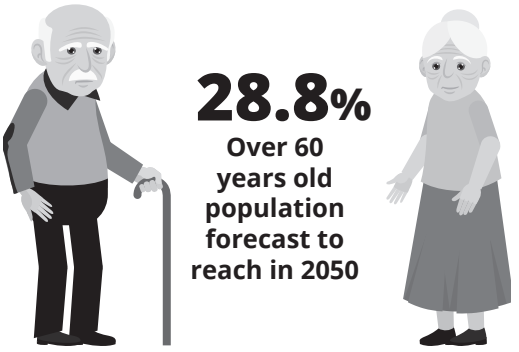
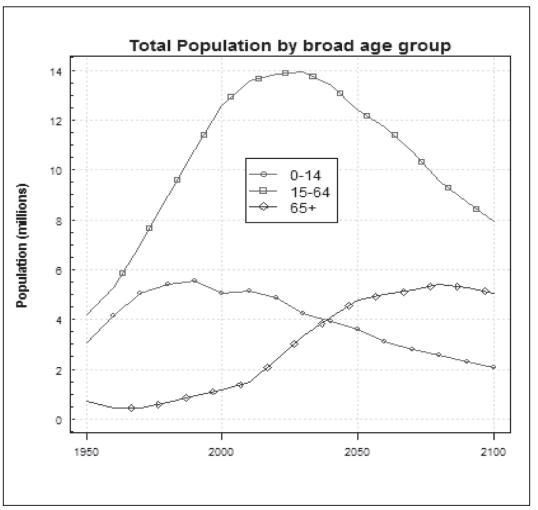


Figure 9.1
Population Projections, by Age Groups



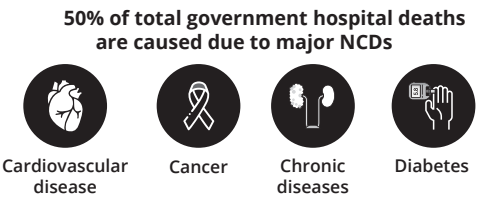
Source: United Nations, Department of Economic and Social Affairs, Population Division. (2017). *World population prospects: The 2017 revision, online demographic profiles.* Retrieved from https://population.un.org/wpp/Graphs/DemographicProfiles/

19 per cent of the aged 60 and above people have mobility difficulties, while 14 per cent of elders of the same cannot manage their day to day self-care by themselves.

[12] United Nations, Department of Economic and Social Affairs, Population Division. (2017). *World population prospects: The 2017 revision, custom data.* Retrieved from https://population.un.org/wpp/Graphs/DemographicProfiles/

[13] Department of Census and Statistics. (2015). *Sri Lanka census of population and housing 2012.* Colombo, Sri Lanka: Department of Census and Statistics.

Battling Growing NCDs: NCDs are widespread among elders. As such, rising patterns of elderly population will contribute to increase the proportion of elderly with NCDs. For instance, the demographic and health survey (DHS) 2016 carried out by the DCS reveals that heart disease, high blood pressure diabetes and wheezing/ asthma are mostly common among senior citizens (Table 9.2).[14] Further, Sri Lanka's health statistics reveal that nearly 50 per cent of total government hospital deaths are caused due to major NCDs such as cardiovascular disease, cancer, chronic respiratory diseases and diabetes mellitus.[15] According to the same source, heart disease has been the leading cause of hospital deaths for more than a decade. To overcome such situations, strengthening the health system for early detection and management of NCDs and its risk factors are very important. Thus, the promotion of an active healthy ageing concept, focusing more on the control of modifiable risk factors to prevent NCDs and early diagnosis through screening tests, is important. As such, a rapidly growing elderly population and the rising trend of NCDs demand newer health care initiatives such as e-health care. In order to achieve these, it is vital to enhance access to quality and viable health care, while promoting its availability and affordability.



9.4 A Digital Health Framework in Sri Lanka

Technical advancements in health care is currently underway globally and is also influencing developments in Sri Lanka too. To set the stage for digital health, strategic planning for e-health in the country began in 2010, with the establishment of the National e-Health Steering Committee in the Ministry of Health (MOH). A 'National E-health Technical Committee' has developed three national e-health policy enabling documents to facilitate a digital health framework: a national e-health policy, national e-health standards and guidelines, and national e-health strategy. The

Table 9.2
Prevalence of Selected NCDs, 2016

Non-Communicable Disease	Elderly People (60 and Above)	All Age Groups
Heart disease	7.7	2.2
High blood pressure	30.7	8.2
Wheezing/ asthma	9.7	5.0
Diabetes	17.3	5.7

Source: Department of Census and Statistics. (2017). *Demographic and health survey 2016*. Retrieved from http://www.statistics.gov.lk/social/SLDHS%202016%20Report%20Final%20Full%2010%20Oct%202017.pdf

[14] Department of Census and Statistics. (2017). *Demographic and health survey 2016*. Retrieved from http://www.statistics.gov.lk/social/SLDHS%202016%20Report%20Final%20Full%2010%20Oct%202017.pdf

[15] Ministry of Health, Nutrition and Indigenous Medicine. (2017). *Annual health bulletin 2016*. Retrieved from http://www.health.gov.lk/moh_final/english/public/elfinder/files/publications/AHB/2017/AHB%202016.pdf

national e-health policy articulates the guiding principles for e-health in Sri Lanka's health care sector. Its vision is to streamline the adoption and use of ICT in health care, while its mission is to facilitate the adoption of ICT solutions appropriately in the health care sector to improve the quality, efficiency, patient safety, and cost effectiveness of health care. The standards, guidelines and strategic plan are aimed at achieving this vision and mission of national e-health policy.

As an entry point to digital health, a uniform personal health number (PHN) has been officially endorsed across the health care services to identify patients. In 2018, a pilot project was initiated to issue an e-health card which contains important medical information of the card holder. With this system, patients are properly identified and channelled to relevant service stations of hospitals without keeping them waiting in long queues. For instance, in the emergency unit of the teaching hospital in Karapitiya where this PHN was tested, more critical patients were identified much more quickly using cutting edge technology. Thus, with the assistance of a nurse, priority treatment were given, saving time and people's lives.

As the next step, the MOH is in the process of implementing the health care recipient identification system (HRIS) which enables consolidation of entire health care interactions of a particular person to his or her PHN. The MOH has also taken steps to introduce a master patient index (MPI) to enhance the development and use of personal health records, which will be of great benefit to the health care recipient, with medical records fully captured in a single system.

Sri Lanka is also considering the development of electronic health solutions for preventive and curative health care services in the country.

As an entry point to digital health, a uniform personal health number (PHN) has been officially endorsed across the health care services to identify patients.

Many developed and developing countries around the world have already realised the advantages of incorporating ICT into their health care service delivery. Accordingly, Sri Lanka too initiated customisation of a hospital information management system (HIMS) for large-scale state hospitals in 2013. The HIMS solution focuses on enhancing service delivery, streamlining information management, ensuring sustainability and cost effectiveness (Box 9.1).

Box 9.1
Health Information Management System

A HIMS is a comprehensive electronic system to support functions within hospitals. The HIMS is being implemented in full scale, with the OPD module – as an admission, discharge and transfer module; pharmacy module; laboratory module and radiology modules being fully integrated, across all the interconnected health care departments of hospitals.

Delivering patient-centred care through e-health innovations is a major achievement of the HIMS; it has benefits for patients, while making life smoother for health care staff as well. For example, digital instantaneous x-rays, which show body structures 100 per cent accurately, allows doctors to commence treatment promptly. Also, the HIMS links commonly used laboratory analysers, and hence cuts down a significant proportion of hours that are otherwise spent on investigations and delivery of reports to wards. These are significant improvements on earlier systems in state hospitals which remained in a time-warp, with long queues and high volumes of paperwork.

Digitalisation also cuts down costs of image printing and reduces undue delays in urgent image requests. Consultants are able to get images sent electronically even when they are off-duty, and advise the team of doctors regarding treatment of patients. Meanwhile, an HIMS augmented hospital dashboard has also been developed, which is capable of indicating a summary of clinical and non-clinical information vital for managerial decisions, at the highest level.

The HIMS is being used successfully in several state sector key hospitals like the National Cancer Institute (Apeksha), Castle Street Hospital for Women, Lady Ridgeway Hospital (LRH) for Children, Colombo North Teaching Hospital, Kandy Teaching Hospital, Peradeniya Teaching Hospital, Kurunegala Teaching Hospital, Matale District General Hospital, and Gampola Base Hospital.

Source: Ministry of Health, Nutrition and Indigenous Medicine. (2017). *Annual health bulletin 2016.* Retrieved from http://www.health.gov.lk/moh_final/english/public/elfinder/files/publications/AHB/2017/AHB%202016.pdf

Another addition is the collection of nationwide real time data. Such data on indoor morbidity and mortality, for instance, is vital to estimate the actual disease burden of a country. An electronic indoor morbidity and mortality register (eIMMR) developed through local capacity building is now making HIMS possible in Sri Lanka. The HIMS is currently implanted in over 400 (63 per cent) of health care institutions (out of a total of 635 secondary and tertiary care institutions) in the country.[16] These institutions account for approximately 70 per cent of the total nationwide hospital admissions in Sri Lanka. This morbidity data can be leveraged to target sufficient resources to address various health issues across regions.



The HIMS is currently implanted in over 400 (63%) of health care institutions (out of a total of 635 secondary and tertiary care institutions) in the country.

[16] Health Informatics Society of Sri Lanka. (n.d.). *Digital health in Sri Lanka.* Retrieved from http://www.hissl.lk/Digital_Health_SL_1998-2017.pdf

9.4.1 Bridging Human Resources Gaps for E-health in Sri Lanka

The digital revolution is gathering pace and bringing about rapid changes in many spheres of people's lives. Nevertheless, nowhere this change is more obvious and significant than in the world of work. Organisations face radical shifts in the context of human resources, workplace, and the world of work. High quality human resource skills with IT, science and technology knowledge are vital to keep up with technical advancements. As such, a major challenge thrown up by the digital revolution is in the domain of human resource management. For Sri Lanka too, the importance of promoting technological innovations and generating a hi-tech workforce with IT skills is critical.

Sri Lanka's health care system is already following some strategies to develop human resources for e-health. As a first step, an MSc course in Biomedical Informatics has been ongoing since 2007 at the Postgraduate Institute of Medicine (PGIM) of the University of Colombo. This course aims produce ICT competent doctors who can function as the interface between the medical and ICT professions, while working hand in hand with administrators and policy makers at the highest level to spearhead the planning, development, implementation, monitoring and evaluation of ICT projects in Sri Lanka's health sector. Those armed with this qualification have been deployed across the public health sector, both at central and regional levels. The next step was the commencement of a MD in Health Informatics course at PGIM in 2017, for doctors to qualify as specialists in that field of study. Meanwhile, other measures to develop ICT awareness and literacy among health support staff through various workshops, seminars and conferences are also underway.

9.4.2 Reaping the Benefits of Technology in Health Care

Sri Lanka is a developing country where unequal distribution of health facilities is evident. As such, outreach of advanced medical facilities into remote areas is rather limited. For many elderly people in rural settings, visiting their local hospital on a regular basis and having access for specialised care remain difficult. Under such circumstances, systems with distant monitoring such as e-health can help to bridge the gaps in health facilities in some of the least developed areas of the country. An appropriate e-health strategy as discussed previously, can enhance the quality of access and viable health care. It can also promote the movement of health care from specialised clinical settings to primary care, and where possible, to grassroot levels.

An e-health facility is not an impossibility, but an achievable reality. Although Sri Lanka is a developing country, its tele-density is higher than average, with almost 100 per cent fixed line connectivity to all hospitals. Hence, rather than the existing system of reactive medical and health facilities, proactive medical and health services can be obtained through an e-health platform. This will benefit patients, hospitals and consultants. It is noteworthy that through the novel idea of 'ViduSuwa' – a patient centric telemedicine solution – a milestone in Sri Lanka's health sector has already been achieved (Box 9.2). ViduSuwa phase 1 (e-consultation clinic) was successfully initiated during 2009-2010 at the base hospital in Marawila, with the collective effort of the district hospital in Dankotuwa (Figure 9.2).

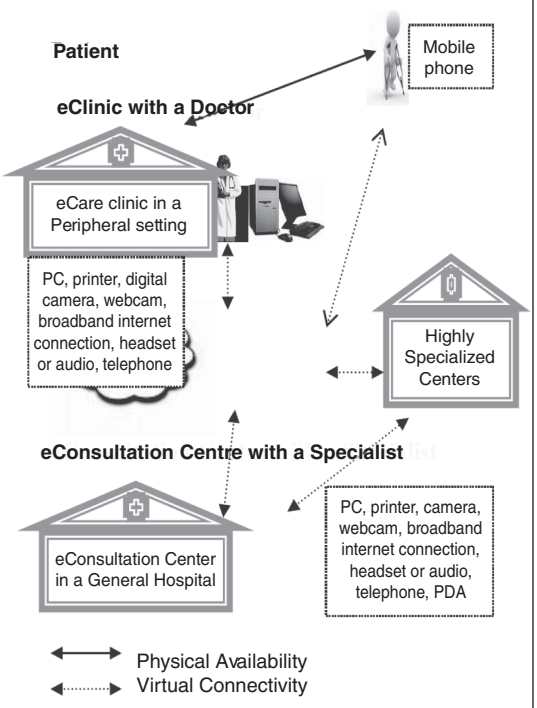
Box 9.2
E-health 'ViduSuwa'

'ViduSuwa' (vidyuth durastha suwaya) is active in three main phases for the convenience of patients. The first phase emphasises its 'e-consultation clinic' which successfully links (medical) specialists in the urban general hospital with patients in remote areas. It facilitates patients to contact specialists in general hospitals through its 'e-care clinic', which is a web-based e-health record system combined with a m-communication and e-consultation centre. The second and third phases are 'e-system integration' and 'remote patient monitoring', respectively. Thus, the ViduSuwa has been identified as a unique platform which has been introduced to elevate the prevailing health care services in the Sri Lankan context, while empowering patients who are in need of medical assistance in remote areas. It has won several awards and is a field of interest for locals and internationals due to its clear operating guide of using ICT in health improvement of the country.

This e-health platform is expected to see continuous improvement and more widespread use due to growing demand from patients. Such e-health platforms need sophisticated technology to store patient records and accurately monitor patient's conditions, without the physical presence of patients in hospitals.

Source: Chapman, K.R., & Arunatileka, S.M. (2010). ViduSuwa – Electronic Distant Healing: A patient centric telemedicine solution in Sri Lanka. *Sri Lanka Journal of Bio-Medical Informatics, 1(1)*, pp. 63–75. Retrieved from http://doi.org/10.4038/sljbmi.v1i1.1487

Figure 9.2
ViduSuwa eConsultation Clinic



Sri Lanka's first 3D technology in an operating theatre was introduced at the Sri Jayawardenapura general hospital, with the installation of a 3D high definition video laparoscopy system. The salient feature of the system is that when minimally invasive procedures are performed by the surgical team, sharp 3D views of organs are captured and displayed real time on the computer screen, allowing the surgical team to wear 3D glasses to view the images up-close. The commissioning of the 3D system allows the surgical team to get an in-depth perception, and improve their care and service for patients.

Sri Lanka has also experienced the applications of robotic-assisted surgery. The first ever robot-assisted surgery was carried out in 2018 by a team of surgical staff assigned to the Navy hospital ship 'Mercy', alongside partner surgeons from Sri Lanka. Using the da Vinci XI robot surgical system, the multinational surgical team

Source: Chapman, K.R., & Arunatileka, S.M. (2010). ViduSuwa – Electronic Distant Healing: A patient centric telemedicine solution in Sri Lanka. *Sri Lanka Journal of Bio-Medical Informatics, 1(1)*, pp. 63–75. Retrieved from http://doi.org/10.4038/sljbmi.v1i1.1487

Sri Lanka's first 3D technology in an operating theatre was introduced at the Sri Jayawardena-pura general hospital, with the installation of a 3D high definition video laparoscopy system.

removed the gall bladder of a Sri Lankan citizen, marking the first in the world where the da Vinci robot has been used on a patient while onboard. Apart from this, it also marked the first robotic-assisted surgery conducted in Sri Lanka.

9.4.3 Gaps and Challenges for Digital Health

In transforming health facilities compared to developing countries, developed economies have already made several historical landmarks with advancing technological accessibility. Thus, although the number of digital health initiatives continues to grow in the developing world, digital health is still in its infancy. This is due to several reasons including limited funding for health care, low scale of private sector health care provision, limited ICT infrastructure, etc.

Many pilot tests have not been followed by full-scale implementation due to lack of sustainable financing, limited private sector participation, and inadequate willingness to pay, as a majority of people in developing countries have low disposable incomes to self-finance their health care expenditure. For example, although Vidusuwa e-health pilot project phase 1 was successfully implemented during 2009-2010, the same has not been implemented as a large-scale project. This limits the usefulness and long-term scalability of current efforts and investments in digital health. In most of these projects, the initial investment is quite high, and thereby constrains the involvement of the local private sector. Further, some digital health solutions are ruled out, as these do not carry a viable business model.

In a developing country such as Sri Lanka, the transfer of technology among the general public takes place at a slow pace, due to

resource restrictions, lack of funds and proper infrastructure, and due to patients' low level of knowledge. Further, a patient's decision making is generally influenced by various factors such as lifestyle of people – elderly people, economic factors (low income, transport cost, etc) ignorance of illnesses and health care, religious and superstitious beliefs, opinion of others – relatives and friends; resistance arising out of fear or mistrust of new technology; availability of alternative medicine such as ayurvedic, traditional, etc.

9.5 Way Forward

Health care is a core sector which has been directly impacted by radical technological shifts. Digital tools are a means of raising the quality and efficacy of traditional health care services. Through a computer dominated world, physical presence has become immaterial in some instances. Overall, health care systems have seen significant developments, with critical steps taken to improve quality and efficacy.

Curing and diagnosing diseases have become easier and smoother, at the touch of high-tech health devices and utensils. Future appears to be awaiting the increase in accuracy and error free health services. With new technology, the internal and external parts of the human body can be 3D printed as necessary, and long-distance surgeries can be carried out remotely through a connection of wi-fi and well-equipped computer facilities. However, there are a number of challenges which prevent implementation due to lack of sustainable financing, high risks for individual stakeholders, and considerable time taken to market for commercial solutions and services.

Governments often need a 'packaged solution', thus, a lead central player in each market to

Collaboration among digital health stakeholders is key, as individual companies do not have the whole set of required capabilities – i.e. in health, ICT, marketing strategies, and resources – to raise funding, develop ICT infrastructure, and handle distribution.

assemble different technologies and multiple moving parts. Considering the required basic setup for digital health care services, multinational technology companies such as IBM and Microsoft can adopt the role of being holistic ICT and digital service partners for governments, health providers and health tech companies. Also, commercial tech players can team up with governments on existing national policy, priorities and procurement initiatives, including e-governance strategy and investment recommendations.

In addition, collaboration among digital health stakeholders is key, as individual companies do not have the whole set of required capabilities – i.e. in health, ICT, marketing strategies, and resources – to raise funding, develop ICT infrastructure, and handle distribution. To overcome these issues, some countries are in the process of developing national strategies that align digital health initiatives with ICT infrastructure and broadband plans.

Further, given the emerging health care needs and unequal distribution of resources, an appropriate e-health strategy can enhance access quality and viable health care. Therefore, measures should be taken to solve identified problems of proposed e-health solutions in order to move from a proof-of-concept of a proposed solution, to large-scale implementation in the appropriate setting. Further, such systems may function better if the process starts in a non-complicated environment which is user-friendly to the patients, doctors and other health care workers. Accordingly, the best would be to introduce e-health services to address real life limitations; in Sri Lanka, this means the introduction and implementation of such practices, making these accessible in areas with semi-urban and rural population. With advancements in technology under the 4IR, such e-health platforms are likely to see further rapid improvements, to be operated on a mass scale due to growing demands of patients.

10. Financial Inclusion in the 4IR: Opportunities and Challenges for Sri Lanka

10.1 Introduction

Financial inclusion has been looked upon as an important instrument for reducing poverty and vulnerability and achieving the sustainable development goals (SDGs). It denotes that "individuals and businesses have access to useful and affordable financial products and services that meet their needs – transactions, payments, savings, credit and insurance – delivered in a responsible and sustainable way".[1] While financial access is the core of financial inclusion, financial inclusion is not merely financial access – it also requires provision of high quality financial services at affordable prices, securely and efficiently through sustainable service providers.

The fourth industrial revolution (4IR) that is resulting from a rapid digital transformation across various industries around the world is driven by a set of data-driven technologies that have the potential to increase productivity and efficiency, and change the lives of people. The main characteristic of 4IR is "the fusion/interconnection of technologies which are leading to a blurring between the physical, digital, and biological spheres; collectively referred to as cyber-physical systems".[2] These 4IR technologies, in particular artificial intelligence (AI), blockchains, fintech solutions and biometrics can play an important role in achieving financial inclusion by improving quality, efficiency and transparency of financial services and extending the services to those who have been excluded, or underserved by the traditional financial institutions.

In Sri Lanka, the financial sector comprises a wide range of institutions – both formal and semi-formal – providing a variety of financial services like loans, savings, payment services, money transfer and insurance. Despite the high level of access to financial institutions compared to many South Asian counterparts, several issues remain that need to be addressed to achieve greater financial inclusion in the country.

In this context, this chapter analyses the current status and prospects to achieve financial inclusion in Sri Lanka in the age of the 4IR. The chapter begins with a detailed analysis of key technologies driving 4IR and how they have been deployed in the financial sector. This is followed by a brief overview of the status of Sri Lanka's financial inclusion and its gaps and challenges. Next, the chapter analyses whether

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[1] The World Bank. (2019). *Financial inclusion.* Retrieved from https://www.worldbank.org/en/topic/financialinclusion/overview

[2] Guarda, D. (2019). *Digital transformation and the 4IR – AI, blockchain, IoT, fintech part 1.* Retrieved from https://www.intelligenthq.com/digital-transformation-4ir-ai-blockchain-iot-fintech/

and how 4IR technologies have been used in Sri Lanka's financial sector and their potential role in promoting financial inclusion. The final section provides concluding remarks and highlights some of the key challenges of 4IR related to the financial sector.

10.2 4IR and the Financial Sector

The 4IR can be described as the fourth major industrial era, characterised by a range of "new technologies that are fusing the physical, digital and biological worlds, impacting all disciplines, economies and industries, and even challenging ideas about what it means to be human."[3] Some principal data driven technologies shaping the 4IR include AI, blockchain, the internet of things (IoT) and robotics. In addition, fintech or financial technology has been identified as one of the most important data driven technologies shaping the 4IR.[4]

These technological innovations have led to several developments in the financial sector. As pointed out by Lee-lark (2016), in the process where these technologies are integrated with the existing financial services, several new waves have emerged in the financial industry.[5] The first wave is the use of distributed ledger technology (DLT). DLT is a decentralised database that is managed by various participants, but without a central authority to act as an arbitrator. It is argued that hundreds of digital currencies using DLT have been developed and are being traded worldwide (e.g. bitcoins). Moreover, DLT has been used to record transaction data in areas such as cross-border remittance and transactions of stocks in over-the-counter markets and trade finance. Blockchain is an important form of DLT.

The second wave is the growth of innovative electronic payment services, such as easy payment and money transfer services.[6] These innovations have allowed clients to make various transactions simply by using their mobile phones. Mobile banking services are increasingly used today not only in developed countries but also in developing countries, particularly in Africa. Already in some countries, biometrics such as fingerprints and iris scans are used to verify user's identity, thereby enhancing security of the financial services used. The third wave is the fintech innovation in financial services beyond payments and settlements. Technologies shaping 4IR such as big data and AI are also used to promote these financial products and services. In addition, robo-advisors providing investment advisory services also have evolved in recent years. Crowdfunding is another important wave. It often refers to the practice of funding a business or a project by raising small amounts of money from a large number of people, normally through the internet.

The key technologies driving the 4IR and their applications and benefits to the financial sector are discussed below.

10.2.1 Blockchain

Blockchain is one of the most important technologies driving the 4IR. It is a form of a

[3] World Economic Forum. (2019). *The fourth industrial revolution, by Klaus Schwab.* Retrieved from https://www.weforum.org/about/the-fourth-industrial-revolution-by-klaus-schwab

[4] Guarda, D. (2019). *Digital transformation and the 4IR – AI, blockchain, IoT, fintech part 3.* Retrieved from https://www.intelligenthq.com/digital-transformation-4ir-ai-blockchain-iot-fintech-part-3/

[5] Lee-lark, Park. (2016). *Financial services and the fourth industrial revolution. Korea Times.* Retrieved from https://www.koreatimes.co.kr/www/biz/2018/07/488_217133.html

[6] *Ibid.*

distributed ledger, and is built up of blocks of transactions that are organised as chains. In a blockchain, transactions are grouped into blocks and timestamped so that the payment can be verified easily, and double payment can be avoided. In blockchain, peers are organised as networks, avoiding third party intervention. All parties involved will participate in the process simultaneously, thus there is no need for one person to complete his/her work for another to begin work. This ensures transparency and efficiency of financial transactions.

There are many advantages of using blockchain technology in the financial sector. One of the most important features is that it is secure. This is primarily because in blockchain, data is stored in multiple locations or across many computers in the network making it difficult to be hacked. It also helps improve transparency and reduces transaction costs. This technology can promote peer-to-peer transactions without involving any third parties. Furthermore, when a transaction is taking place between two people, both records are updated real time without any time lag. Due to these advantages, several financial institutions worldwide have started using blockchain technology for various activities like cross-border fund transfers, payments and know-your customer (KYC) processes.

10.2.2 Artificial Intelligence (AI)

AI is another important technology driving the 4IR. However, AI is not very new to the financial sector. Many banks around the world are already using AI in heavily manual processes for accuracy, efficiency, speed and cost benefits.[7] However, what is new is the use of AI by banks for other activities, in particular to improve interaction with their customers. AI can be deployed to better understand the needs and intentions of their customers and to interact better with them.

'The Accenture Banking Technology Vision 2017' report reveals that within the next three years, AI will be the main method used by many banks for interaction with their customers.[8] AI-enabled tools can help banks identify consumer preferences and empower their workforces, which in turn would help for successful consumer relationships. Using AI-enabled tools like centralised platforms and messaging bots to improve front-end services are some important innovations. For example, some banks have developed virtual assistants/ chatbots to help their customers with various information 24 hours, seven days a week.[9]

10.2.3 Biometrics

Biometrics is another important technology driving the 4IR that can particularly help financial institutions to enhance security of their financial transactions and also to improve convenience of their customers. As a measure to mitigate losses resulting from banking fraud, many financial institutions today are shifting their focus toward biometric technology from traditional authentication measures like personal identification numbers (PINs), traditional bank cards and passwords.[10] Especially, a combination of biometric measures such as fingerprints and

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7 Accenture. (2017). *Banking technology vision 2017- Technology for people: Banks' path to becoming their customers' everyday trusted advisor and their staff's employer of choice.* Retrieved from https://www.accenture.com/t20170322t205838z__w__/us-en/_acnmedia/pdf-47/accenture-banking-technology-vision-2017.pdf

8 *Ibid.*

9 *Ibid.*

10 AWARE. (2019). *How financial institutions secure mobile banking with biometric technology.* Retrieved from https://www.aware.com/blog-securing-mbile-banking-biometric-technology/

voice biometrics make them more secure than passwords and PINs. Moreover, many biometric modalities also use liveness detection algorithms that help distinguish between a real sample and a digital, printed, or recreated version of it, thereby minimising the use of fraudulent non-live images or videos taken from social media etc., to unlock a facial recognition scan. These advance features make them more secure than traditional measures like passwords and PINs that can easily be hacked. Furthermore, biometrics measures can be used more conveniently. For example, fingerprint scanning and facial recognition do not require users/clients to remember any information or carry a physical token. Authenticating is even simpler – just a simple motion such as placing a thumb on a sensor, or glancing into a camera is sufficient to unlock access to banking apps. Moreover, in an instance where a particular method of biometrics is not successful (e.g. fingerprint), another method like face or voice can be used instead.[11]

Biometric measures like fingerprint, face, and voice-recognition can be used by financial institutions more securely and easily to authenticate their customers across various channels involved in modern banking – mobile banking, ATM, online, over-the-phone and digital assistants /chatbots. Further, the type of biometric measure used for authentication can vary depending on the channel. For example, voice recognition might be more appropriate for phone banking or when interacting with a digital assistant, while face and fingerprint are more suited for general login purposes on a laptop or on a mobile device.[12]

10.2.4 Internet of Things (IoT)

Another key technology driving the 4IR is IoT, which involves "bringing together all things in the world and connecting them to the internet. In other words, it means expanding the capability of the internet beyond smartphones and computers to many other things, environment and processes".[13] There are many advantages of IoT technology to financial institutions like banks: it helps reduce banking fraud, detects risk in advance, secures funds from cyberattacks, improves customer services and helps stay ahead of their competitors. Further, IoT helps to save time, and simplifies work processes.

The IoT can be used in the financial sector in numerous ways, such as to collect and analyse customers' data in order to gain important insights into the needs of clients. This technology can also be used to enhance customer satisfaction by adopting geolocation marketing strategies. Moreover, it simplifies daily operations by reducing dependency on labour. IoT technologies can be used to enhance security of financial transactions as well, by detecting and preventing fraud in advance. Financial institutions can use IoT to track the location of a financial crime and even to identify the type of device used to perform the crime. Also, IoT can be used to prevent fraud through authentication, where wearable devices can be used to obtain the biometric details of clients. Such biometrics together with strong cryptography can often enhance security of information in the respective bank's database.[14]

However, it is not to say that IoT technologies are not without risks and challenges. In particular,

[11] AWARE. (2019). *How financial institutions secure mobile banking with biometric technology.* Retrieved from https://www.aware.com/blog-securing-mbile-banking-biometric-technology/

[12] *Ibid.*

[13] Joseph, R. (2019). *Scopes of internet of things (IoT) in the banking and financial industry.* Retrieved from https://www.intellectyx.com/blog/iot-in-banking-and-financial-industry/

[14] *Ibid.*

IoT technologies are quite complex and often require the connection of several devices through a network. The risk is that a malfunction in one of these devices can result in a complete disruption of the system, thus leading to huge losses to the financial institution. Moreover, as these technologies often depend less on labour, they can have a negative effect on workforce employment.

10.2.5 FinTech: Digital Financial Solutions

Fintech is another important data driven technology shaping the 4IR. It is an innovative approach with the ability to make financial services more accessible, affordable, timely and high quality. Fintech has benefitted massively from the mobile phone revolution that took place around the world in the recent decade. It operates mainly through 'apps' specifically developed for mobile phones. One of the most important innovations of fintech is mobile banking, which has the ability to connect the user to a variety of financial services, and enables financial transactions at one's fingertip, anytime from anywhere. Evidence from many developing countries has shown how mobile banking has helped those who have previously been excluded from the traditional banking system, by giving them access to a range of financial services and thereby enhancing financial inclusion. Some other innovations that have emerged under fintech include e-wallets, digital wallets, mobile apps and digital payment platforms, which also help enhance financial inclusion by providing access to a variety of financial services/products in a more convenient and secure manner.

Insurtech is revolutionising the insurance industry and changing the way insurance providers do business. It is a subdivision of fintech and refers to "new insurance technology that improves the customer experience, simplifies policy management, and increases competition".[15] A classic example is mobile microinsurance – which often refers to microinsurance products that leverage mobile channels. For example, BIMA (a leading insurance company based in Sweden) in partnership with leading mobile operators in developing countries has reached out to those from low income groups, particularly those who have not previously had any insurance policies from the formal sector, with various microinsurance policies via mobile phones. By mid-2018, BIMA had over 24 million customers in the Asian, African and Latin American markets, and operations in 14 countries, including Sri Lanka, Bangladesh and Pakistan.[16]

10.3 Financial Inclusion in Sri Lanka: Current Status and Issues

This section discusses the current status of the financial sector in Sri Lanka and highlights some of the existing gaps and issues related to achieving financial inclusion.

Sri Lanka's financial sector consists of a range of different service providers,[17] which include both (i) formal financial institutions like regulated banks and leasing and finance companies as well as (ii) semi-formal institutions like co-operatives, non-

[15] Insureon. (2019). *Insurtech.* Retrieved from https://www.insureon.com/insurance-glossary/insurtech

[16] InsuranceUp. (2018). *Social impact of Insurtech: The example of the Swedish BIMA.* Retrieved from https://www.insuranceup.it/en/startup/social-impact-of-insurtech-the-example-of-the-swedish-bima/

[17] Tilakaratna, G. (2016). Financial inclusion in Sri Lanka: Current status and issues. (Chapter 6). In S. Gopalan and T. Kikuchi (Eds.), *Financial Inclusion in Asia: Issues and Policy Concerns.* Basingstoke, United Kingdom: Palgrave-Macmillan.

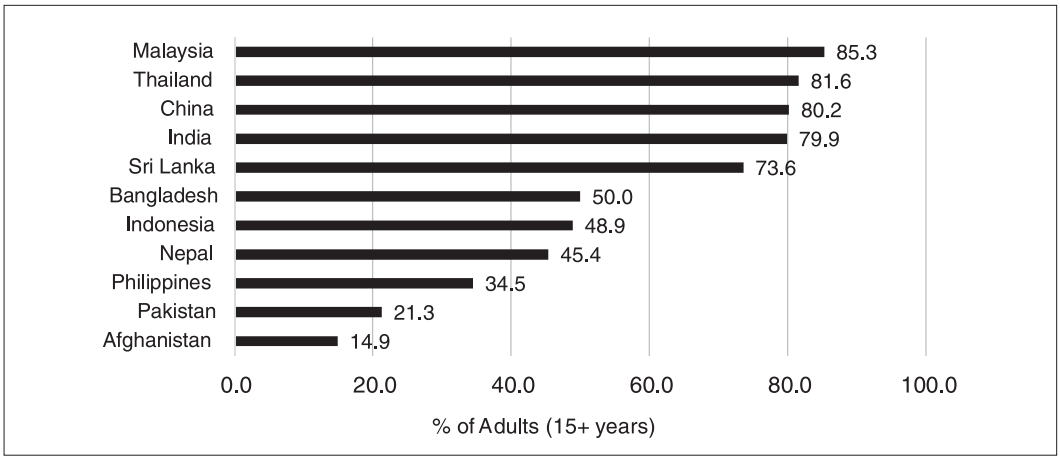
governmental organisations (NGOs), community-based organisations (CBOs), special government programmes like Samurdhi banking societies and microfinance institutions, which provide access to a range of financial services like loans, savings, payment services, remittances as well as insurance services. In addition, non-financial institutions such as mobile network operators have emerged in recent years as important providers of financial services, particularly in digital financial services.

As per the World Bank's latest 'Global Findex' data,[18] 73.6 per cent of the adults in Sri Lanka (15+ years) have an account – either in a bank or in other financial institutions such as cooperatives, microfinance institutions or a mobile money account. This is notably higher than the level of financial access in South Asian countries like Bangladesh, Pakistan and Nepal and on par with the average for upper middle-income countries (Figure 10.1 and Table 10.1). Moreover, the data indicate gender parity in access to financial services in Sri Lanka, with 73.4 per cent of women (15+ years) recorded as having an account at a financial institution. This figure surpasses the South Asian average (64.1 per cent) and the average for upper-middle income countries (69.3 per cent). Interestingly, over 70 per cent of adults belonging to the poorest 40 per cent of the population in Sri Lanka also have accounts in financial institutions – similar to the average of upper-middle income countries.

Despite the considerable share of the population with access to financial institutions (as shown by Findex data) and availability of a widespread network of financial service providers – including banks, leasing and finance companies, co-operatives, CBOs and insurance companies –several issues and challenges remain that need to be addressed to achieve financial inclusion in Sri Lanka.

High transactions costs, documentation requirements, long and cumbersome procedures

Figure 10.1
Share of Adults with an Account in Selected Asian Countries, 2017



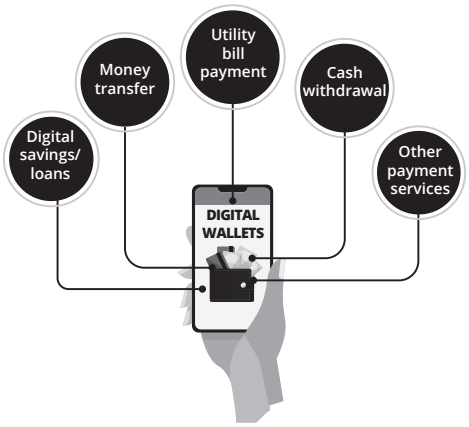
Source: World Bank. (2018). *The little data book on financial inclusion 2018.* Washington D.C.: World Bank.

[18] World Bank. (2018). *The little data book on financial inclusion 2018.* Washington D.C.: World Bank.

Table 10.1
Access to an Account – Comparative Statistics

% With an Account	Sri Lanka	South Asia	Lower-Middle Income	Upper-Middle Income
All adults	73.6	69.6	63.0	73.1
Adult women	73.4	64.1	58.6	69.3
Adults belonging to the poorest 40%	70.6	65.6	54.2	62.4
Young adults (aged 15-24)	76.6	60.1	49.4	65.9
Adults living in rural areas	72.8	69.2	62.0	72.9

Source: World Bank. (2018). *The little data book on financial inclusion 2018.* Washington D.C.: World Bank.



and time lags related to transactions, are often highlighted as some of the inefficiencies associated with financial services like savings, loans, and money transfers including remittances. Moreover, there are many other specific issues related to services like savings, loans and insurance, which need to be addressed in order to achieve financial inclusion in the country.

With regard to savings, although a large share of adults have bank accounts, there are several 'dormant' accounts with only a minimum balance, or with no transactions taking place for several years. Irregular savings in many cases are due to distance to bank branches, cumbersome procedures and high transaction costs involved in saving in small amounts whenever the clients can. Further, opening bank accounts in financial institutions often require several documents, which either discourage or prevent clients from opening an account with the bank. With regard to loans, the main issues are documentation and collateral requirements, cumbersome procedures and delays associated with loan approval and processing.[19]

Moreover, money transfer and payment activities are often associated with high transaction costs and time lags. High transaction cost is one of the key reasons why a substantial share of international remittances is also sent through informal channels by migrant workers. Using formal channels such as banks to send remittances is often considered costly and involves substantial paper work. Moreover, distance to the bank branches and lack of awareness on formal channels and their financial products are other contributory factors for the low utilisation of formal channels for remittances.[20]

[19] Tilakaratna, G. (2017, March 22). *Financial access is not financial inclusion: Current status and issues of financial inclusion of Sri Lanka' presentation made at the BankTech Asia conference in Colombo.* Retrieved from http://www.ips.lk/banktech-asia-conference-taj-samudra-hotel-colombo-21-22-march-2017/

[20] Kelegama, S., & Tilakaratna, G. (2017). Financial inclusion, regulation and education: Sri Lanka (Chapter 8). In Yoshino, N & P.J. Morgan (Eds.) *Financial Inclusion, Regulation and Education: Asian Perspectives.* Tokyo, Japan: The Asian Development Bank Institute.

The insurance penetration levels too appear to have stagnated at around 1 per cent, indicating low levels of insurance utilisation and the presence of untapped potential in the insurance market. A recent study jointly carried out by the Institute of Policy Studies of Sri Lanka (IPS) and the International Cooperative and Mutual Insurance Federation (ICMIF) reveals several reasons for the low level of utilisation of insurance by individuals/households through formal sources.[21] The study identified lack of affordability due to high cost of insurance, difficulty in paying premium at regular intervals, lack of trust/ confidence, as well as lack of awareness of benefits of insurance among low income groups, as the main reasons for the prevailing low utilisation of insurance in Sri Lanka, particularly among low income households.

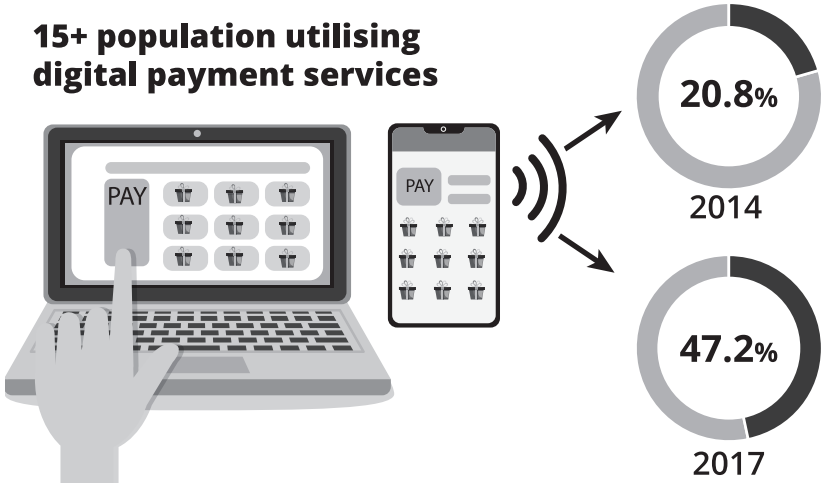
However, in recent years, various technology-based solutions including mobile money banking, mobile insurance, use of biometrics, etc., have emerged in the financial sector in Sri Lanka.

These trends can help address some of the above discussed inefficiencies related to transaction costs, time lags and cumbersome procedures, thus improving financial inclusion in the country.

10.4 Promoting Financial Inclusion through the 4IR in Sri Lanka

As revealed by the 'Global Findex 2017' data, the percentage of 15+ age population in Sri Lanka that have utilised digital payments services – either to make or to receive a payment – has increased remarkably in recent years from 20.8 per cent in 2014 to 47.2 per cent in 2017. This is notably higher than the average for South Asian countries (27.8 per cent).[22]

The rise in the use of digital financial services in Sri Lanka in recent years is a result of the



[21] International Cooperative and Mutual Insurance Federation. (2018). *Country diagnostic on mutual and corporative microinsurance in Sri Lanka.* Retrieved from https://downloads.icmif.org/Country-diagnostic%20on-mutual-and-cooperative-microinsurance-in-Sri-Lanka.pdf

[22] World Bank. (2018). *The little data book on financial inclusion 2018.* Washington D.C.: World Bank.

The rise in the use of digital financial services in Sri Lanka in recent years is a result of the growth of mobile phones and internet facilities.

growth of mobile phones and internet facilities, and development of innovative financial services/ products by financial institutions like banks as well as leading mobile network operators in the country. As of 2018, mobile phone penetration in the country is at 161.6 per 100 persons,[23] recording a significant increase over the past decade. Growth in the use of mobile phones and internet has contributed to a number of innovations in the financial sector, providing customers with access to a broad range of financial services/products that can be accessed easily and more conveniently through their mobile phones.

10.4.1 FinTech: E-Wallets, Mobile Wallets, Mobile Apps and InsurTech

E-wallets, mobile wallets and payment apps as well as insurtech innovations like mobile micro-insurance are among the key innovations taking place in the financial sector in recent years.

E-Wallet is a prepaid online account that can be used to store money and transact online and offline through a smartphone/computer wherever needed. Similar to a real wallet, it can be used by customers to transact conveniently and securely at anytime from anywhere. Compared to traditional bank accounts, e-wallets are often considered to be a faster mode of digital transactions.In Sri Lanka, a number of banks have launched their own e-wallets and payment apps in recent years allowing their clients to access a whole range of services at anytime from anywhere through their mobile devices. Once the mobile app is downloaded to the mobile phone and signed up for the digital account/wallet, the account holders can enjoy a range of services straight from their smart phones. These services often go beyond just banking services like money transfer to utility bill payments, payment at various retail outlets and for various other services.

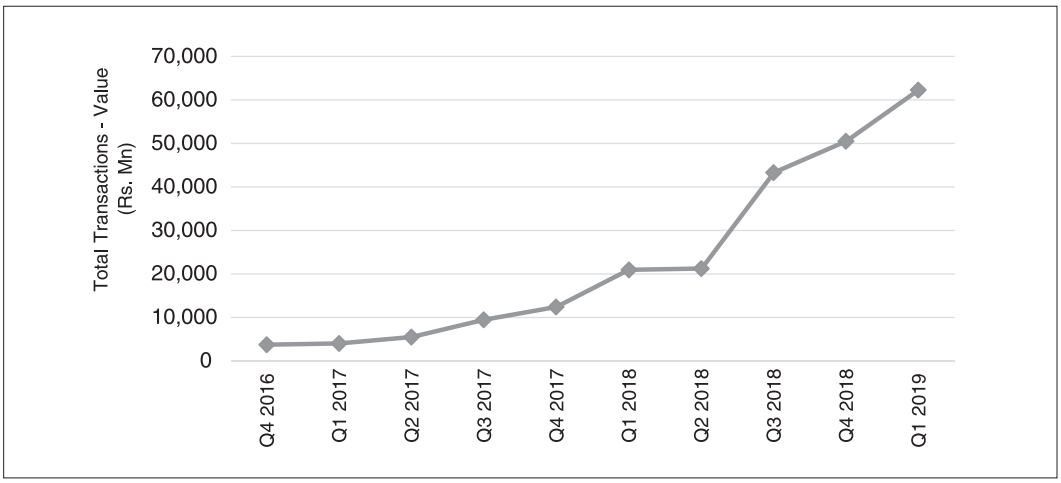
[23] Central Bank of Sri Lanka. (2019). *Annual report 2018.* Colombo, Sri Lanka: Central Bank of Sri Lanka.

As at the end of first quarter of 2019, there were 14 licensed service providers of mobile payment systems in Sri Lanka, which are of two types: (i) operators of customer account-based mobile payment systems, and (ii) operators of mobile phone-based e-money systems. While the first category includes 11 licensed commercial banks (LCBs) and one licensed specialised bank (LSBs), the second category is primarily two main mobile network operators in the country that obtained licenses from the Central Bank of Sri Lanka (CBSL) and commenced operations of their mobile phone-based e-money systems in June 2012 and November 2013, respectively.[24]

As shown in Figure 10.2, there has been a remarkable growth in customer account based mobile phone banking in recent years. The value of financial transactions during the fourth quarter 2016-first quarter of 2019 has grown by over 1,539 per cent, reaching over Rs. 62 billion.

In addition, the two main mobile network operators in the country have introduced mobile wallets /digital wallets allowing their customers to access a range of services easily through their mobile devices. The services received through these 'wallets' include money transfer, utility bill payment, digital savings and micro-loan facilities. Figure 10.3 depicts the composition of mobile phone-based e-money transactions over the past three years. Interestingly, the bulk of the mobile phone-based e-money has been used to pay utility bills, while a smaller share has been used to make institutional payments, transfer money to another account and to purchase products.

Figure 10.2
Mobile Phone Banking Value of Total Financial Transactions, 2016-2019



Source: Central Bank of Sri Lanka. (2019). *Payment bulletin (Various issues),* Payment and Settlement Department. Colombo, Sri Lanka: Central Bank of Sri Lanka.

[24] Central Bank of Sri Lanka. (2019). *Payment bulletin –First quarter 2019*, Payment and Settlement Department. Colombo, Sri Lanka: Central Bank of Sri Lanka.

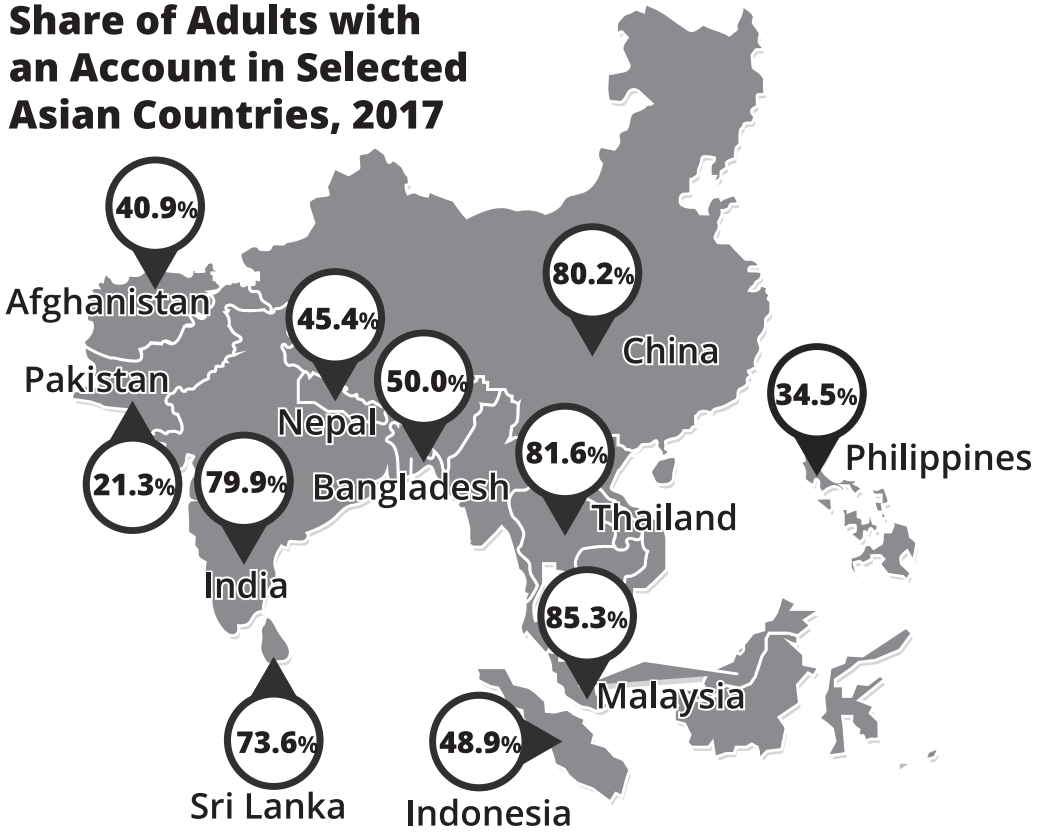
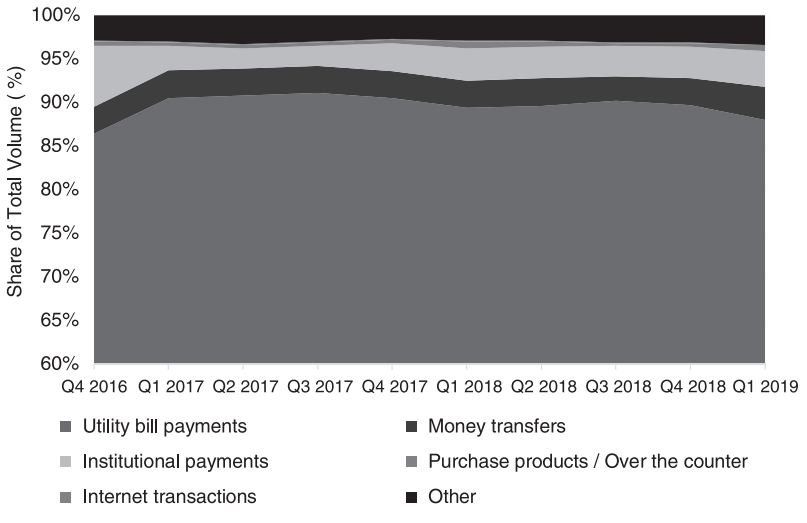


Figure 10.3
Composition of Mobile Phone-based E-money Transactions, 2016-2019



Source: Central Bank of Sri Lanka. (2019). *Payment bulletin (Various issues),* Payment and Settlement Department. Colombo, Sri Lanka: Central Bank of Sri Lanka.

Another important innovation in the financial sector is mobile microinsurance, which is channelled through mobile network operators. These insurtech innovations often help address a number of challenges related to microinsurance delivery such as high transaction costs, poor infrastructure, and lack of awareness and demand for insurance from clients, particularly those from low-income segments. For instance, in 2013, BIMA partnered with Dialog Axiata, a leading telecommunications network in Sri Lanka, and since then it has managed to sell over 1.5 million microinsurance policies (including accident cover and a hospital cover) within 2-3 years. The success of these mobile microinsurance products has been largely attributed to the simplicity of their design and customer training provided at the enrolment stages, addressing the psychological barriers associated with insurance among low income groups.[25]

The above discussed fintech innovations like mobile banking services, digital wallets, and payment platforms have many advantages. They play an important role in enhancing financial inclusion, particularly by providing access to a range of financial services in a convenient, secure and timely manner with lower transaction costs and extending access to these services to those who have previously had no access to traditional banking services. Furthermore, these digital innovations are playing a key role in taking the country closer towards a cashless society. The 'National Digital Road Map of Sri Lanka' launched in June 2019 also identifies 'smart money' that includes digital banking, mobile banking apps (e.g. mCash app) and digital lending and savings as one of its 16 pillars.

Digital innovations like mobile banking services, digital wallets and payment platforms play a key role in taking Sri Lanka closer towards a cashless society.

[25] Microinsurance Network. (2016.) *Insights on mobile network operators as a distribution channel for microinsurance in Asia.* Retrieved from https://www.microinsurancenetwork.org/sites/default/files/Insights%20on%20MNO%20as%20distribution%20channel%20for%20MI%20in%20Asia_2016.pdf

Furthermore, the CBSL has set up a committee to study developments in the financial technology (fintech) sector and to provide recommendations. As per the recommendations made by this committee, two key initiatives have already been taken: (i) the Payment and Settlement Systems Circular No. 06 of 2018 was issued to establish the National Quick Response (QR) Code Standard for Local Payments and (ii) initiated actions to establish a 'FinTech Regulatory Sandbox' to provide an environment that supports and promotes financial technology innovations in the country while maintaining appropriate regulatory standards.[26]

10.4.2 Biometrics, Blockchain and AI

As discussed earlier, biometric measures like fingerprint, face, and voice-recognition tools can bring several benefits to financial institutions as well as their customers. For instance, biometrics can be used by financial institutions more securely and easily to authenticate their customers across various channels like mobile banking, ATM, online and phone-banking. In addition to enhancing security of financial transactions, biometrics also help to improve convenience of their customers.

The banking sector in Sri Lanka has also recognised the benefits of using biometric measures. Some commercial banks have already taken initiatives to link biometric measures to their financial services allowing the customers to log into their accounts via facial, fingerprint, or voice recognition. This is considered to be a more convenient and secure method, in particular related to digital financial services. A good example is the Nations Trust Bank's FriMi (a mobile wallet and a digital payment system) which uses finger, face and voice authentication.[27]

Sri Lanka's financial institutions can also benefit from blockchain technology, which is secure, transparent and helps reduce transaction costs and time lags in transactions. Recognising the importance of blockchain technology for Sri Lanka's financial sector, a 'Committee on Blockchain Technology' has been established and as per its recommendation, a working committee has been appointed to further study the feasibility of adopting blockchain technology in the financial sector particularly in areas like KYC.[28]

In addition, AI-enabled tools like virtual assistants/ chatbots can be used by financial institutions to identify requirements and preferences of their customers, while providing 24/7 services to them. Hence, this could be a more time savings, cost effective method. A handful of financial institutions in Sri Lanka, including banks and insurance companies, have already started using AI-enabled solutions like chatbots and robots to cater to the needs of their customers in a more efficient and timely manner. One example is Sampath Bank's 'Banking Robot' which uses AI to understand vocal requests and perform the relevant transactions in the form of a humanoid robot. It can assist in performing some functions like withdrawing cash, attending to account balance inquiries and providing information on exchange rates, interest rates, loans, credit cards and how to open and account.[29] Further, some insurance companies in Sri Lanka

[26] Central Bank of Sri Lanka. (2019). *Annual report 2018.* (p. 292). Colombo, Sri Lanka: Central Bank of Sri Lanka.

[27] Daon. (2017). *Nations Trust Bank launches digital apps using biometric authentication powered by Daon's Identityx*. Retrieved from https://www.daon.com/newsroom/press-releases/497-nations-trust-bank-launches-digital-apps-using-biometric-authentication-powered-by-daon-s-identityx)

[28] Central Bank of Sri Lanka. (2019). *Annual report 2018.* Colombo, Sri Lanka: Central Bank of Sri Lanka.

[29] Sampath Bank. (n.d.). *Banking robot.* Retrieved from https://www.sampath.lk/en/personal/electronic-banking/banking-robot

Sri Lanka's financial institutions can also benefit from blockchain technology, which is secure, transparent and helps reduce transaction costs and time lags.

too have launched chatbots/AI insurance assistants that are capable of providing product recommendations and suggesting life insurance solutions for each individual by analysing their actual requirements.[30]

Nevertheless, there are many challenges in implementing AI in the financial sector, which include privacy issues and issues related to compatibility with the available IT structures of banks. Moreover, given that the customers often tend to prefer human interactions over machines, employing AI like robotics for front-desk activities can also be quite challenging, at least in the initial phases.

10.5 Challenges and Way Forward

As discussed, 4IR technologies can bring many benefits to Sri Lanka's financial sector – not only to the financial institutions, but also to the clients –thus, contributing towards financial inclusion. The potential benefits to clients include reduced transaction costs, access to a wider range of financial products and services from anywhere and at any time, greater convenience and timeliness. Digital innovations like mobile banking and mobile micro-insurance can also contribute to achieve financial inclusion through the provision of access to financial services to those who had previously been outside the reach of formal financial sector. Moreover, the 4IR technologies can help the financial service providers to address inefficiencies such as time-lags and high transaction costs, and to enhance security and transparency of financial transactions.

[30] Daily Mirror. (2017, October 20). *Union Assurance launches first insurance chatbot in Sri Lanka.* Retrieved from http://www.dailymirror.lk/article/Union-Assurance-launches-first-insurance-chatbot-in-Sri-Lanka-138837.html

4IR technologies can bring many benefits to Sri Lanka's financial sector – not only to the financial institutions, but also to the clients –thus, contributing towards financial inclusion.

A number of providers of financial services in Sri Lanka including banks, mobile network operators and insurance companies have already adopted various fintech solutions like e-wallets, mobile banking, and mobile microinsurance to provide access to diverse financial products and services in a more convenient, efficient and secure way. Despite many benefits of technologies like AI and biometrics to improve efficiency and to enhance security of financial services, only a handful of financial institutions so far have moved in to deploy these new technologies. Blockchain technology remains at an early stage of adopting in Sri Lanka's financial sector, with feasibility, particularly in areas like KYC, currently being studied by a blockchain working committee.

Despite several potential benefits of 4IR technologies to the financial sector, there are some challenges and concerns too that need to be addressed. One of the key concerns is the potential impact of 4IR technologies on the workforce. For instance, 4IR may make certain tasks of banking staff obsolete as these services can be easily accessible through mobile banking, e-wallets and online payment platforms. The need to visit banks by customers regularly for services like money transfers, receipt of money will be minimised. Moreover, the 4IR also creates concerns over employees being replaced by AI-enabled machines like robots or chatbots. However, the 4IR can create demand for IT-enabled high skilled employees for the financial sector who are capable of dealing with advanced technological innovations. This further stresses the need for skills upgrade and training for employees of financial institutions.

Another concern is that the 4IR may exacerbate the 'digital divide' in the country by improving

4IR may exacerbate the 'digital divide' by improving access to diverse services to those who are more tech savvy and have smart phones, while excluding the already marginalised groups.

access to diverse services and products to those who are more tech savvy and have smart phones, while excluding the already marginalised groups like the poorest groups who may not have access to smart phones and the internet. Moreover, 4IR technologies are likely to be embraced easily by the youth or millennials, but less likely to be used by older generation, thus widening the gap between different demographic groups.

Furthermore, it should be noted that technology is not a panacea for all issues related to financial inclusion. Along with technological advancements, several other measures are needed. For example, strengthening client protection, promoting financial literacy as well as developing sound regulatory measures/guidelines to support 4IR technologies to minimise any adverse effects are some of the more important issues to be tackled.

11. Digital Technologies and the Future of Trade

11.1 Introduction

Technology has always played an essential role in shaping trade, and this phenomenon is evolving at a tremendous rate under the fourth industrial revolution (4IR). The 4IR is marked by unprecedented technological change, and digital technologies such as the internet of things (IoT), artificial intelligence (AI), 3D printing and blockchain will have significant impact on trade.[1] These developments can open up many opportunities for both developed and developing countries alike, but this process is not automatic or guaranteed. Successfully navigating structural changes brought about by technology change is necessary to ensure that everybody benefits, while minimising the risks associated with technology disruptions by putting in place complementary policies.

Digital technologies are already shaping and changing consumer behaviour; for example, e-commerce is booming thanks to the widespread use of the internet and internet-enabled devices, which provide consumers with direct access to online markets/suppliers. Companies are also taking advantage of these developments, as digital technologies facilitate entry into markets and provide an opportunity to supply a variety of products by making it easier to produce, promote and distribute products at a lower cost. According to United Nations Conference on Trade and Development (UNCTAD) estimates, the value of the global e-commerce transaction stood at USD 25 trillion in 2015.[2]

11.2 How New Technologies Impact Trade

This chapter focuses on how the 4IR is impacting trade, and transforming international business that both create new opportunities for trade and raises new challenges. The discussion explores how governments in developing countries, including Sri Lanka, can respond to these changes.

New technologies can help to reduce the cost of trading. Costs of trading goods and services can be segregated into five components 1) transport costs, 2) logistic costs, 3) the cost of crossing borders, 4) information and transaction costs, and 5) trade policy barriers.[3] Transport costs and information and transaction costs together play

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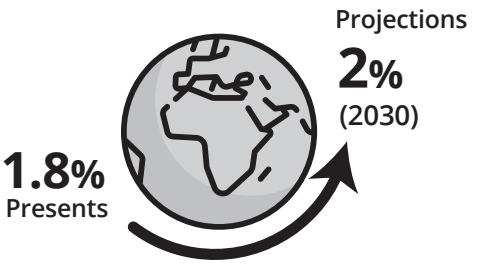
1 World Trade Organisation. (2018). *World trade report 2018.* Geneva, Switzerland: World Trade Organisation.

2 United Nations Conference on Trade and Development. (2017). *Information economy report.* Geneva, Switzerland: United Nations Conference on Trade and Development.

3 World Trade Organisation. (2018). *World trade report 2018.* Geneva, Switzerland: World Trade Organisation.

a critical role, and therefore its decline has the largest potential impact in further bringing down the overall trading costs. Transport costs alone account for 37 and 17 per cent of total trade costs in goods and services, respectively.[4] Substantial benefits can also be realised by lowering costs associated with logistics, trade policy barriers, and crossing a border. Logistics costs account for 11 per cent of overall trade costs in goods and services, while trade policy barriers account for 11-15 per cent of trade costs.

While trade costs have declined in both developed and developing countries, new technologies can further contribute to this. Between 1996 and 2014, for example, technological innovation is estimated to have lowered international trade costs by 15 per cent, while projections show that trade could grow by 1.8 to 2 percentage points more annually till 2030, as a result of falling trade costs, brought about by technological change.[5]



11.2.1 Transport and Logistics Costs

Certain AI applications can promote trade in goods; for example, by optimising route planning through the use of global positioning system (GPS) and autonomous driving capabilities with AI applications. A combination of vehicle telematics, robotisation and AI allow for cargo and shipment tracking, thereby reducing transport and logistics costs. Smart robots and AI can also help to reduce the cost of storage and inventory while speeding up distribution to end customers.

Several e-commerce firms already use AI and robotics intensively in their businesses to make the most of their storage and distribution networks by optimising the use of warehouses and planning the most efficient routes for delivery. In Sri Lanka, Singer PLC is already using AI to automate and streamline sales forecasting. It is moving away from a tedious manual forecasting process by using machine learning and coming up with algorithms that take into account various economic indicators, store specific attributes to come up with information for procuring and placing the order for the right product, at the right time and place.[6] Also, Singer uses technology for route optimisation to ensure that orders are delivered to stores; every delivery route is carefully planned and manually checked to ensure that products are delivered on time. By minimising the distance travelled and improving vehicle utilisation, overall logistical costs are lowered.[7]

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4 World Trade Organisation. (2018). *World trade report 2018.* Geneva, Switzerland: World Trade Organisation.

5 *Ibid.*

6 Cassim, N. (2019, March 18). *Dhammika makes strong case for national strategy for AI.* Retrieved from http://www.ft.lk/top-story/Dhammika-makes-strong-case-for-national-strategy-for-AI/26-674868

7 Perera, D. (2019, April 18). *Artificial intelligence and Dhammika Perera's vision for Sri Lanka.* Retrieved from https://www.facebook.com/chairmandhammikaperera/

Additive manufacturing or 3D printing, also has the potential to reduce transport and logistics costs by reducing the number of inputs that need to be traded by locating production closer to consumers/end markets. For instance, sports shoes are 3D-printed in automated factories in Germany and the US, reducing the time from design to shops to less than one week. Adidas is at the forefront in this area. As a leader, they have brought the technology to a mass production level. Their sneaker (the Alphaedge 4D) mixes traditional manufacturing with 3D printing. By the end of 2018, Adidas introduced 100,000 pairs of their new shoes and are planning to push the technology even further in 2019 aiming to produce in the millions in the coming year.[8] A few companies in Sri Lanka have started to offer 3D printing, offering services ranging from concept development to 3D printing. However, the level of application is still limited: these include 3D printing of toys, ornaments and models catering to sectors such as interior design/architecture, engineering, etc. Despite the existence of technology, 3D printing still remains a rather unexplored area within Sri Lanka.[9]

New technologies not only reduce trade costs by reducing transportation and storage costs, but these also lower transport time and uncertainty of delivery times. Technologies such as blockchain and AI can reduce the time spent on customs compliance, while the use of tracking technology in goods shipments provides opportunities for countries to monitor international trade better, preventing evasion of border taxes. The potential is highest for time-sensitive products linked to global value chains or perishables. Changes in the production process can result in quicker delivery, cost reductions in shipping and storage, and lower trading costs of the final products. For developing countries, however, including Sri Lanka, investments in basic infrastructure will be required if there are to be savings associated with new technologies (Box 11.1).

New technologies not only reduce trade costs by reducing transportation and storage costs, but these also lower transport time and uncertainty of delivery times.

[8] Michelle, S. (2019, January 2). *3D printing in footwear: Disrupting the shoe industry?* Retrieved from https://www.3dnatives.com/en/3d-printing-in-footwear-disrupting-industry-020120194/

[9] Sri Lanka Association of Printers. (2017, December 7). *Next hurdles to conquer in print, is 3D printing a genuinely developing sector?* Retrieved from http://slap.lk/next-hurdles-to-conquer-in-print-is-3d-printing-a-genuinely-developing-sector/

Box 11.1
Sri Lanka's Logistics Performance

Logistics consist of services that support the physical movement of goods within and across borders. The World Bank 'Logistics Performance Index' (LPI) scores countries on how efficiently they move goods across and within borders. This index includes six dimensions: efficiency of the clearance process by border control agencies, including customs; the quality of trade and transport-related infrastructure; ease of arranging competitively priced shipments; competence and quality of logistics services; tracking and tracing of consignments; and, timeliness of shipments in reaching destination within the scheduled or expected delivery time. In 2018, Sri Lanka ranked at 94 and lags behind its regional competitors on these indicators. Compared with regional peers, Sri Lanka's LPI ranking and performance in values are lower than those of Singapore, Malaysia and India.

Detailed LPI Rankings of Sri Lanka and Regional Peers, 2018

	Singapore	Malaysia	Thailand	India	Sri Lanka	Pakistan	Myanmar
LPI Rank	**7**	**27**	**32**	**44**	**94**	**122**	**137**
LPI Components							
- Customs	6	23	36	40	79	139	131
-Infrastructure	6	28	41	52	85	121	143
-International shipments	15	26	25	44	122	97	144
-Logistics competence	3	26	32	42	109	89	128
-Tracking and tracing	8	28	33	38	78	136	143
-Timeliness	6	26	28	52	122	136	108

Source: World Bank. (2018, July 24). *Logistics performance index 2018.* Retrieved from https://www.worldbank.org/en/news/infographic/2018/07/24/logistics-performance-index-2018

11.2.2 Costs of Crossing Trade Borders

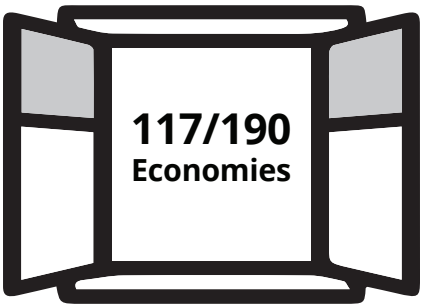
It is not just the transport infrastructure and distance which affect cross-border trade. It is also what happens at the border. Excessive procedures and burdensome regulations can be significant impediments to the free flow of goods, especially for smaller firms, which lack competency in accessing world markets. Time and resources spent on compliance can sometimes be more significant impediments to trade, than traditional barriers such as tariffs.

The World Bank's 'Ease of Doing Business' records the time and cost associated with the logistical process of exporting and importing goods.[10] The index measures the time and cost (excluding tariffs) associated with three sets of procedures – documentary compliance, border

[10] World Bank. (2019). *Ease of doing business in Sri Lanka.* Retrieved from http://www.doingbusiness.org/en/data/exploreeconomies/sri-lanka#DB_tab

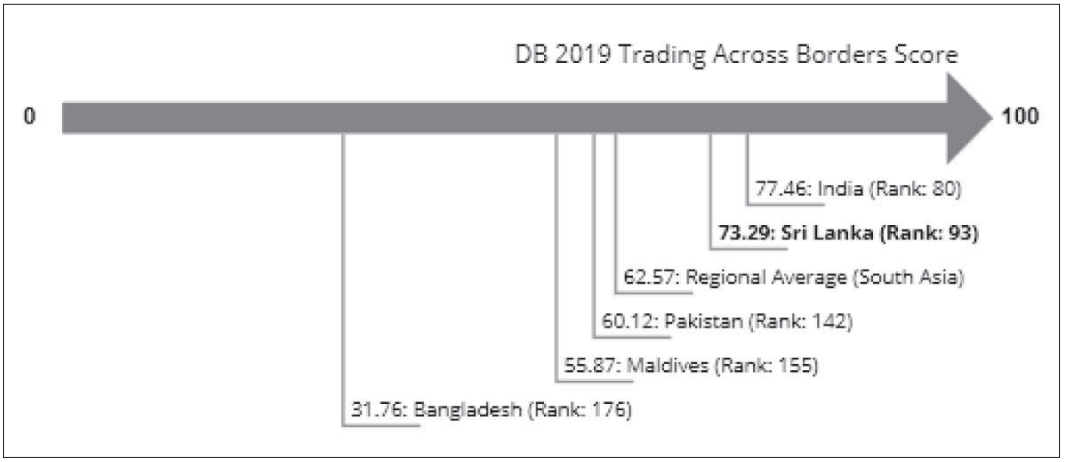
compliance and domestic transport – in shipping goods. Sri Lanka has made progress in improving trading across borders in the recent past; for example, by developing a single customs window, introducing an electronic payment system for port services, etc. While Sri Lanka performs relatively better than its regional counterparts except for India, a lot more can be done towards reducing time and cost of border and documentary compliance (Figures 11.1 and 11.2).

In this regard, tools such as the electronic data interchange (EDI) and electronic single window (ESW) can play an important role. The EDI allows trade-related documents to be transferred electronically while the ESW is more comprehensive, enabling stakeholders to submit documentation and other information through a single point of entry to complete customs and other trade-related procedures. While many countries including Sri Lanka use EDI systems, the use of a single window lags far behind across regions (Box 11.2). According to the World Bank's 'Doing Business: Trading Across Borders 2018' report, a majority of economies around the world have EDI systems already in operation or progress. Also, 117 out of the 190 surveyed economies have either already established or are in the process of putting in place an ESW.



Electronic Single Window (ESW)

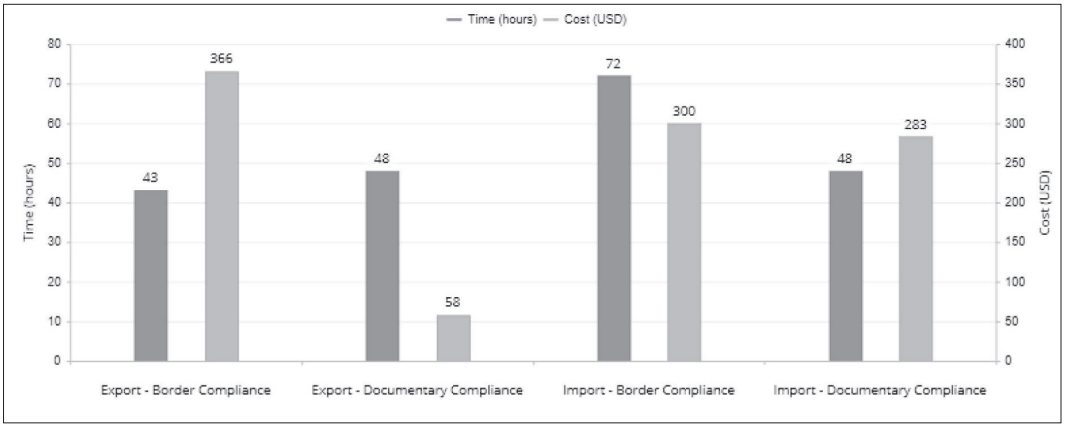
Figure 11.1
Trading Across Borders in Sri Lanka and Comparator Countries, Ranking and Score, 2019



Note: The ranking of economics on the ease of trading across borders is determined by sorting their scores for trading across borders. These are the simple average of the scores for the time and cost for documentary compliance and border compliance to export and import

Source: World Bank.(2019). *Ease of doing business in Sri Lanka*. Retrieved from http://www.doingbusiness.org/en/data/exploreeconomies/sri-lanka#DB_tab

Figure 11.2
Trading Across Borders in Sri Lanka – Time and Cost, 2019



Notes: The time and cost for 'border compliance' include time and cost for obtaining, preparing and submitting documents during port or border handling, customs clearance and inspection procedures; The time and cost for 'documentary compliance' include the time and cost for obtaining, preparing, processing, presenting, and submitting documents. Source: World Bank. (2019). *Ease of doing business in Sri Lanka*. Retrieved from http://www.doingbusiness.org/en/data/exploreeconomies/sri-lanka#DB_tab

Source: World Bank.(2019). *Ease of doing business in Sri Lanka.* Retrieved from http://www.doingbusiness.org/en/data/exploreeconomies/sri-lanka#DB_tab

Box 11.2
Current Status of Paperless Trade in Sri Lanka

Implementation of an Electronic Single Window (ESW) provides an excellent opportunity to reduce the complexity of cross-border formalities. Although an ESW has been discussed for many years in Sri Lanka, it has never realised. The lack of an ESW means that the country does not have a single entry point, and the facility for a single submission to fulfil all import/export related documentation activities.

The creation of an operational ESW for trade is an ambitious and complex task, which relies on the close cooperation between all stakeholders concerned and therefore needs careful preparation. Sri Lanka is at the very beginning of the project life cycle in the establishment of an ESW. Currently, Sri Lanka Customs (SLC) is partially automated and connected to other government agencies and ports electronically through ASYCUDA – a computerised customs management system covering trade procedures. The current version is 'ASYCUDAWorld'. While the system implemented covers both imports and exports, it has not eliminated the need for paper handling; currently, traders/agents can only electronically submit documents (CUSDEC and Manifest)/data and make online payments of duties/fees to SLC through selected banks. However, traders/agents still have to visit SLC to submit paper documents in person for reprocessing because of the need for a signature and obtaining approvals/clearance. In 2018, an online payment platform was launched while digital signatures were accepted in 2019, but the uptake has been low by the trading community.

SLC is ready to move to a completely paperless system with an accompanying digital signature; this is under a trial basis with selected traders. Of over 30 government agencies that are involved in the import/export process, only a few are electronically and partially linked to SLC through the ASYCUDA system; the required documents still need to be submitted by traders/agents to these agencies for relaying of approvals to SLC. In addition to SLC, Sri Lanka Ports Authority (SLPA) and Sri Lanka Cargo (SLAC) have their automated management systems (NAVIS and Sky chain, respectively) which are connected to SLC through ASYCUDA to reduce paperwork and expedite the trading process. SLAC and SLC are currently working towards an electronic transfer of the manifest, but this is not yet in place, and the transmittal remains for now as a paper document.

The transition to an ESW will be facilitated due to some level of automation of government agencies, ports and airports in Sri Lanka. Moreover, much of the trading process in Sri Lanka only involves a few government agencies (less than 10 out of the 30 plus agencies), and most of the trade is channelled through one port (Colombo), which should help in the implementation of a single window in the country.

Status of Paperless Trade in Sri Lanka

	Status
Internet Connection Available to Customs and Other Trade Control Agencies	●
Electronic Single Window System	◐
Electronic Submission of Customs Declarations	●
Electronic Application and Issuance of Import and Export Permit	◐
Electronic Submission of Sea Cargo Manifests	○
Electronic Submission of Air Cargo Manifests	○
Electronic Application and Issuance of Preferential Certificate fo Origin	◐
E-Payment of Customes duties and fees	●
Electronic Application for Customes Refunds	○

● Fully implemented ◐ Partially implemented ○ Not implemented

Source: International Trade Centre. (2018). *Making the digital marketplace fairer: A roadmap for e-commerce legal frameworks in Sri Lanka*. Colombo, Sri Lanka: International Trade Centre.; International Trade Centre. (2018). *Functional scope of the national single window for trade in Sri Lanka.* Colombo, Sri Lanka: International Trade Centre.; Wijayasiri, J., Hewage, K., & Senaratne, N. (2018, April 26). *Walk before you run: Defining the scope of the 'single window' for trade in Sri Lanka*. Retrieved from http://www.ips.lk/talkingeconomics/2018/04/26/walk-before-you-run-defining-the-scope-of-the-single-window-for-trade-in-sri-lanka/

The World Bank finds significant gains for economies with fully operational electronic systems for customs, including lower levels of corruption.[11] Time spent on border compliance to import and export falls by more than 70 per cent when customs declarations are submitted and processed online. Thus, simple technologies can help to reduce trading costs and boost competitiveness of countries.

Technology can save both time and resources spent on customs procedures. While digitalisation can reduce trade costs substantially, inefficient customs still hamper trade. New technologies, such as blockchain and AI, promise further reductions.[12] The highest potential of new technologies will be for time-sensitive goods flows, such as global value chain (GVC)-related trade. Furthermore, since cumbersome customs procedures are very harmful to micro, small and medium enterprises (MSMEs), their simplification will in particular encourage MSMEs to enter export markets rather than confine their produce to domestic markets. Finally, reducing the cost of crossing borders has the largest potential to boost both imports and exports in developing

[11] World Bank. (2017). *Trading across borders: Technology gains in trade facilitation.* Washington D.C.: World Bank.

[12] AI can be used to help businesses deal with regulatory compliance. For example, AI software can be used to monitor and analyse regulatory changes continually, and to make recommendations to clients to ensure compliance by going through a multitude of pages of regulations, saving both time and money. Blockchain or distributed ledger technology could also allow single windows to be administered in a more efficient, transparent and secure manner.

countries including Sri Lanka, where these costs are currently the highest. However, some challenges – both technical and regulatory – have to be addressed before the technology can be fully utilised, including lack of interoperability of various platforms, the legal status of smart contracts, etc.

11.2.3 Information and Transaction Costs

Long distance trading with partners from foreign countries viz. local partners is more difficult because it is harder to find information about potential buyers/sellers, their products and product quality. It is also harder to determine their reputation, verify information and enforce contracts. While there are several public and private organisations in Sri Lanka providing trade information and promotion activities, there are issues in terms of collection, analysis, dissemination of trade information and trade promotion.[13] More specifically, there is an absence of a centralised, reliable, accessible and affordable export information and promotion; weak coordination between agencies with regard to gathering and sharing information; limited resources of overseas missions to effectively collect and analyse market, product and regulatory information; trade information and opportunities are not easily accessible to exporters in regional areas; promotional activities conducted by Sri Lankan missions overseas, including overseas trade fairs and business-to-business (B2B) activities, are inadequate, branding of Sri Lanka and its products in target markets is limited, and SME participation in international trade missions is low.

Studies that investigate the potential of technology to boost trade show that more access to market information through simple technology such as mobile phones decreases trading costs especially in developing countries.[14] Online platforms can further help to reduce costs of matching buyers and sellers, to obtain market information and provide information about potential consumers. Such platforms can help to boost the participation of firms in international trade even more than in domestic trade, and provide feedback and guarantees that improve consumer trusts in online sellers. New technologies such as IoT and blockchain also offer better and cheaper ways to ensure confidence through certification and verification. Various initiatives already exist to improve transparency and prevent counterfeiting in the supply chain, with applications ranging from pharmaceuticals to luxury items.[15]

Services offered by online platforms facilitate the participation of MSMEs in export activities.[16] For small agricultural producers, in particular, e-commerce provides direct access to more consumers and better prices, as intermediary costs are eliminated. There is also evidence that easier access to information and reduction in face-to-face interactions facilitated by digital trade, allows increased participation of women in trade.[17] These are all more beneficial for developing countries which tend to face higher costs with regard to obtaining information and guaranteeing transactions. Easier verification procedures and

[13] Government of Sri Lanka. (2018). *National export strategy 2018-2022: Trade information and promotion strategy.* Retrieved from http://www.srilankabusiness.com/pdf/nes/sri-lanka-trade-information-and-promotion-4-1-web.pdf

[14] International Trade Centre. (2009). *Mobile technology: Driving change and opportunity in developing countries.* Retrieved from http://www.tradeforum.org/Mobile-technology-Driving-change-and-opportunity-in-developing-countries/

[15] World Trade Organisation. (2018). *World trade report 2018.* Geneva, Switzerland: World Trade Organisation.

[16] International Trade Centre. (2017). *New pathways to E-commerce: A global MSME competitiveness survey*. Geneva, Switzerland: International Trade Centre.

[17] *Ibid.*

Studies that investigate the potential of technology to boost trade show that more access to market information through simple technology such as mobile phones decreases trading costs especially in developing countries.

guarantees also help agricultural producers to enter the GVCs, with new technologies enabling electronic exchange of information such as food safety requirements. Producers are therefore able to connect with new, and high-value markets.

Innovations in cross-border payment systems also have the largest impact on developing countries and MSMEs. Selling and buying internationally involve international financial transactions. Currently, cross-border transactions are almost exclusively handled by banks through correspondent banking, whereby local banks carry out transactions on behalf of each other, as many banks do not have a local presence. Distributed ledger technology is being explored to reduce the cost of cross-border payments, in particular, transaction fees, exchange rate costs, and costs associated with correspondent banks. Both start-ups and well-established financial institutions are investing the potential of distributed ledger technology to streamline payments for international trade. E-commerce platforms are developing their payment systems for cross border e-commerce transactions; in-house payment systems mean corresponding banking infrastructure can be circumvented, resulting in quicker processing times and no fees.

Communication barriers are also crucial for international trade; some estimates suggest that a common language increases trade flows directly by 44 per cent.[18] However, when trading partners are linguistically different, dissimilarities have a strong negative influence on bilateral trade volumes.[19] In recent years, the internet has broken down such language barriers, with technologies going beyond text translation. Now, software is available that performs real-time interpretation (for example, Skype real-time

[18] Egger, P., & Lassmann, A. (2012). The language effect in international trade: A meta-analysis. *Economics Letters,* 221-224.

[19] Isphording, I., & Otten, S. (2013). The costs of Babylon - Linguistic distance in applied economics. *Review of International Economics,* 354-369.

translation), thereby reducing the importance of language barriers and opening up trade opportunities, especially for small businesses that cannot afford professional translations.[20] Another channel through which the internet has overcome language and communication barriers is e-commerce platforms, which have reduced the need for direct interactions between buyers and sellers, and allowed customers to browse for goods/services in their language.

Box 11.3
E-commerce in Sri Lanka

Sri Lanka's online platforms are expanding, with banks, travel companies, hotels and retail offering online trading services. The e-commerce market, with travel included, is estimated at around USD 40 million. This could grow by tenfold to USD 400 million by 2021/2022, while traditional retail is expected to grow 30 per cent from USD 10 billion to USD 13 billion by 2021/2022 (LBO, 2017). Domestic business-to-consumer (B2C) e-commerce sites have seen significant growth in recent years. Takas.lk, for example, is one of the top online retailers, offering around 9,000 electronics products, and 6,000 products in categories such as apparel, personal care, car care and home appliances. There are an estimated 1.6 million e-commerce users, with taxi services being the most popular e-commerce service accounting for more than half of the users.

Despite the high awareness of e-commerce platforms, most internet users are reluctant to use e-commerce platforms to purchase goods or services due to lack of trust; for example, about 70 per cent of internet users are aware of e-commerce platforms, but only 43 per cent use them (Fernando, 2019). Cross border e-commerce is also limited to purchases of products from popular overseas sites such as e-bay and Amazon. Numerous local e-commerce companies sell imported goods through such platforms. More recently, a regulation was introduced whereby Sri Lankan companies can engage in B2C e-commerce transactions with customers outside the country. Hereafter, companies in Sri Lanka can export goods worth a maximum of USD 3,000 each, without submitting CUSDEC application to SLC (Daily News, 2018). At the end of the month, the exporter has to send one CUSDEC application to SLC covering all transactions. Recent regulation issued by the Ministry of Finance on e-commerce will govern B2C operations carried out using online trading platforms.

While awareness of online shopping is increasing, financial institutions are also developing payment gateways to offer reliable online payment services to support the e-commerce sector. However, despite the presence of e-commerce legislation for many years, Sri Lanka has trailed behind many other Asian counterparts (ITC, 2018). Potential barriers or impediments that should be addressed to help support e-commerce in Sri Lanka include:

- Access: Updating the Sri Lankan legal framework to facilitate e-commerce better and ensure appropriate and adequate consumer protections; ensuring that all Sri Lankans have access to affordable internet; safeguarding consumer access to the internet and a healthy online competitive environment
- Improving digital education and awareness
- Easy-to-use payment systems
- Tax policy on digital sales
- Fostering consumer trust: Several legislative and regulatory reforms that would facilitate greater consumer trust, including modernised consumer rules, privacy, security and electronic marketing rules such as anti-spam legislation

Source: Fernando, N. (2019, May 23). *Internet users reluctant to use e-commerce despite high awareness: survey.* Retrieved from http://www.dailymirror.lk/business-news/Internet-users-reluctant-to-use-e-commerce-despite-high-awareness:-survey/273-167697; Lanka Business Online. (2017, May 24). *Interview: E-commerce shakes up Sri Lanka's retail sector, says Takas CEO.* Retrieved from https://www.lankabusinessonline.com/interview-e-commerce-shakes-up-sri-lankas-retail-sector-says-takas-ceo/; Daily News. (2018, October 23). *Govt introduces B2C direct transaction under e-commerce*. Retrieved from http://www.srilankabusiness.com/blog/govt-introduces-b2c-direct-transaction-under-e-commerce--703.html; International Trade Centre. (2018). *A roadmap for e-commerce legal frameworks in Sri Lanka.* Colombo, Sri Lanka: International Trade Centre.; International Trade Centre. (2018). *Making the digital marketplace fairer: A roadmap for e-commerce legal frameworks in Sri Lanka.* Colombo, Sri Lanka: International Trade Centre.

[20] Roswell, T. (2015, February 18). *Real-time translation software: Will it change marketing?* Retrieved from https://spinsucks.com/communication/real-time-translation-software/

While new technologies offer many opportunities for firms to organise their production and reach consumers more efficiently, challenges also remain. For example, services, such as logistics and transport, are essential determinants of goods trade. The role of digital platforms in lowering trade costs can only go so far in markets where there are uncompetitive transport services and excessive transport costs. Efficient services markets, therefore, are a prerequisite to reaping the benefits of digital technologies.

11.2.4 Trade Policy and Regulatory Barriers

Consumers demand assurances about basic food standards, and therefore, authorities need to ensure that imported products comply with national regulations, which can give rise to many non-tariff measures (NTMs). While regulatory harmonisation and mutual recognition reduce the compliance burden, NTMs remain significant. The compliance burden becomes magnified in complex supply chains affecting both, large and MSMEs. According to the WTO (2018), product certification, product testing, and inspection requirements represent more than half of all firms' complaints about technical barriers to trade/ sanitary and phytosanitary (TBT/SPS) measures in developing countries. Similarly, companies in Sri Lanka report difficulties with a broad range of measures, in particular with technical testing, inspection and certification, which are required to demonstrate conformity with SPS measures.[21] Almost 70 per cent of exporting firms and 70 per cent of importing firms in Sri Lanka report that NTMs were burdensome. In particular, they must cope with poor trade-related infrastructure and cumbersome procedural requirements.

The adoption of the electronic window and electronic certificates (e-certificates) can significantly reduce the time and resources spent in regulatory compliance.

[21] International Trade Centre. (2011). *Sri Lanka: Company perspective. An ITC series on non-tariff measures*. Geneva, Switzerland: International Trade Centre.

Interestingly, the problems lie on both sides of the border – both in partner countries and in Sri Lanka itself – limiting the companies' competitiveness, especially smaller ones, and their ability to integrate into the global economy. The adoption of the electronic window and electronic certificates (e-certificates) can significantly reduce the time and resources spent in regulatory compliance.

The government has prioritised the need to reduce paper documentation in trade. A number of heavy traffic trade-related government agencies – the Sri Lanka Standards Institution, Import and Export Control Department, Animal Quarantine Office, National Plant Quarantine Services, etc., – are in the process of automating their front-end services (issuing e-certificates, e-licenses, permits, etc) or there are plans in the pipeline to automate and connect them to SLC to facilitate trade.

11.3 Implications on MSMEs and Developing Countries

A decline in trade costs can be especially beneficial for MSMEs, and those based in developing countries, if right policies are put in place and challenges related to technology diffusion are addressed. Many trade costs, including logistics, transaction costs and customs procedures, weigh heavily on MSMEs. Since distance matters less in online trade, digital technologies provide opportunities for remote countries and remote areas to connect with the rest of the world. Therefore, the potential benefit of new technologies to facilitate trade for MSMEs and developing countries can be considerable.

In Sri Lanka, MSMEs form the backbone of the economy and can be found in all sectors. The small and medium enterprise (SME) sector alone accounts for 52 per cent of gross domestic product (GDP) and 45 per cent of total employment, while constituting more than 75 per cent of the total number of enterprises in the country.[22] Moreover, SMEs are significant employers of women and youth. But, SMEs participation in trade does not equal their economic importance domestically; SMEs trade relatively less internationally compared to their larger counterparts in both developed and developing countries. In Sri Lanka, there are 3,027 SMEs registered as exporters. However, these contribute to less than 5 per cent of Sri Lanka's exports (compared to 235 large firms, which account for the bulk of the export revenue). Trade barriers, poor access to information, costly requirements/regulations, burdensome customs procedures and lack of trade finance are significant hurdles to international trade for SMEs. These costs in trading represent more significant barriers for SMEs than large firms, and this appears to be true in the case of Sri Lanka.

If digital technologies are to deliver their promises especially to SMEs, ICT services are essential. While much progress has been made in digital connectivity in terms of mobile/cellular, fixed broadband and internet penetration, such growth has not been uniform across and within countries, between urban and rural population, causing difficulties for some smaller businesses. This is true for Sri Lanka, as shown in Table 11.1. Other challenges include inadequate regulatory frameworks, institutional weaknesses, insufficient private investment and poor infrastructures (including payment mechanisms).

[22] Wijayasiri, J. (2016, November 30). *Role of Sri Lankan SMEs in trade*. Retrieved from http://dailynews.lk/2016/11/30/business/100590

While much progress has been made in digital connectivity in terms of mobile/ cellular, fixed broadband and internet penetration, such growth has not been uniform across and within countries, between urban and rural populations.

11.4 Changes in Trade Patterns

Advances in digital technologies can also bring about changes in the composition of trade in goods and services. The importance of services in the composition of trade is expected to increase; the share of services trade is predicted to grow from 21 per cent to 25 per cent by 2030 with the facilitation of services trade and emergence of new services.[23]

Over the last decade, exports of goods and services from Sri Lanka grew from USD 9 billion in 2009 to reach USD 20 billion in 2018.[24] However, this positive sign is counterbalanced by the fact that the export composition has remained somewhat unchanged. Currently, Sri Lankan exports rely on a mix of traditional industries and growing services sectors. In 2018, the export sector consisted mainly of apparel, followed by travel services, transport services, tea and spices, and rubber. Sri Lanka doubled its export value by intensifying exports of traditional industries rather than through export diversification. Sri Lanka has increased its exports of electrical machinery, gems and processed food products such as coconut-based products; however, more than half of the exports can be categorised as low tech (54 per cent), followed by primary (23 per cent) and resource-based (17 per cent) exports. Medium tech (6 per cent) and high technology exports (2 per cent) remain rather limited.[25]

Even though exports of goods show limited diversification, the services sector has been evolving more dynamically, becoming one of the drivers of recent export performance, and

[23] World Trade Organisation. (2018). *World trade report 2018.* Geneva, Switzerland: World Trade Organisation.

[24] Central Bank of Sri Lanka. (2018). *Annual report.* Colombo, Sri Lanka: Central Bank of Sri Lanka.

[25] Government of Sri Lanka. (2018). *National export strategy 2018-2022: Trade information and promotion strategy.* Retrieved from http://www.srilankabusiness.com/pdf/nes/sri-lanka-trade-information-and-promotion-4-1-web.pdf

Table 11.1
Percentage Distribution of Device Use to Connect to Internet/Email by Household Population, by Sex, Sector, and Age Group

Gender, Sector, Age Group	Desktop/ Laptop	Smart Phone	Tablet Computer	Mobile Phone
Sri Lanka	38.1	56.9	2.1	2.9
By Sex				
Male	36.8	58.4	1.6	3.2
Female	39.8	55.0	2.7	2.5
Sector				
Urban	40.1	55.4	2.7	1.8
Rural	37.2	57.7	1.8	3.3
Estate	31.7	52.8	1.0	14.6
By Age Group (Years)				
5-9	41.2	48.0	8.7	2.2
10-14	43.4	52.1	2.3	2.1
15-19	36.7	58.1	1.2	4.0
20-24	35.0	60.2	1.5	3.3
25-29	34.9	60.2	2.0	2.9
30-34	32.3	61.8	2.0	3.9
35-39	35.8	59.4	2.5	2.2
40-49	42.5	53.2	2.0	2.3
50-59	50.8	45.4	2.4	1.4
60-69	55.6	39.1	4.6	0.6

Source: International Trade Centre. (2018). *A roadmap for e-commerce legal frameworks in Sri Lanka.* Colombo, Sri Lanka: International Trade Centre.; International Trade Centre. (2018). *Functional scope of the national single window for trade in Sri Lanka.* Colombo, Sri Lanka: International Trade Centre.; International Trade Centre. (2018). *Making the digital marketplace fairer: A roadmap for e-commerce legal frameworks in Sri Lanka.* Colombo, Sri Lanka: International Trade Centre.

accounting for almost one-third of Sri Lanka's total export of goods and services. Compared with 2009, Sri Lankan exports of services quadrupled to USD 8.4 billion in 2018.[26] In relative terms, service exports have risen to nearly 9 per cent of GDP in 2018. The services sector also enjoyed a trade surplus, which stood at USD 3.8 million in 2018. Within services exports, the highest growth is from the travel, and information and communications technology (ICT) industries, with 23 per cent and 11 per cent annual growth between 2009 and 2018, respectively. The transportation sector enjoyed 10 per cent annual growth over the same period. The travel industry overtook transportation services in 2014 and became the largest service export, bringing in USD 4.4 billion of earnings. Recently, financial, insurance and pension – as well as construction – services have gained, but still, play a less significant role in the overall Sri Lankan exports

[26] Central Bank of Sri Lanka. (2018). *Annual report.* Colombo, Sri Lanka: Central Bank of Sri Lanka.

of services; together these account for about 5 per cent of total export of services.

Digital technologies can further facilitate services trade and enable new services to emerge – to be purchased online and supplied digitally across borders. Whereas digital technologies have expanded trade in certain goods, trade in some other goods has gradually declined. In the past decades, trade in information technology (IT) products has seen a steady increase with the development and increasing adoption of digital technologies. Trade in IT products have tripled in the past two decades, and is expected to reach USD 1.6 trillion in 2030.[27] Digital technologies can lead to a further reduction in trade costs, paving the way for trade in notably time-sensitive goods, certification-intensive goods and contract-intensive goods.

Technologies have also enabled mass customisation of goods, creating virtually infinite varieties to meet individual consumer needs. On the other hand, digitalisation has resulted in a decline in the trade of certain digitisable goods (for example, CDs, books and newspapers) and the trend is likely to continue with the advent of 3D printing technology. In this context, intellectual property rights (IPRs) will have a pivotal role to play in the future of trade.

11.5 Changing Comparative Advantages and GVCs

Digital technologies will change established trade patterns, as the importance of traditional sources of comparative advantage change and new sources arise. An accurate assessment of how future trade patterns in digital intensive sectors will change is difficult, given that many new technologies such as self-driving cars or the IoT have not been widely adopted yet. Nonetheless, a preliminary evaluation by the WTO (2018) suggests that several new sources of comparative advantage could allow high-income economies to become net exporters of digital intensive sectors and reinforce existing trade patterns. High-tech activities will continue to be based in developed economies; these economies typically have a large stock of capital and skilled workers at their disposal. Also, internet content restrictions are minimal, and the broadband infrastructure is usually well developed. Combining this with strong formal and informal institutions provide them with a comparative advantage in digital-intensive sectors.

An accurate assessment of how future trade patterns in digital intensive sectors will change is difficult.

[27] World Trade Organisation. (2018). *World trade report 2018*. Geneva, Switzerland: World Trade Organisation.

However, several developing countries might be equally competitive in other activities. Traditional sources of comparative advantage in which developing economies might lag are likely to become less important for certain types of products. When trade becomes digitalised, inadequate infrastructure and layers of border procedures become less burdensome for trading. For example, advances in technologies like blockchain can overcome weak contract enforcement abilities; digital technologies can amplify economies of scale and scope. In fact, large developing economies stand to be the primary beneficiaries of this development. Also, knowledge externalities can facilitate technological leapfrogging of countries. As developed economies strengthen their comparative advantage in skill and capital-intensive sectors with digitalisation, developing countries may gain comparative advantages in industries most affected by the shift to digital trade. Thus, digital technologies can increase gains from trade to countries across all income levels.

There is already evidence that digital technologies help developing countries to export digital-intensive products.[28] While developed countries are responsible for much of the exports in digitally-enabled services, developing countries too have seen their exports growing. Some developing countries have built up strong positions and reputations as exporters of ICT services. India, for example, is the leading exporter of computer services, whilst the Philippines is ranked as a top 20 exporter of ICT services globally. In the past 10 years, the Sri Lankan IT-BPM industry has expanded by 300 per cent to reach USD 1.2 billion in export revenue.[29] The sector employs more than 80,000 professionals and contributes to 12 per cent of Sri Lankan services exports. The sector has considerable potential to increase export revenue with a demonstrated competitiveness internationally, based on reasonable costs, high-quality services and an educated workforce.

In the case of GVCs, digital technologies can have ambiguous effects. On the one hand, new technologies can help to coordinate geographically dispersed tasks, which will lead to longer and more complex value chains in the future. But on the other hand, digital technologies can reduce the relative cost of domestic production to offshore production, leading to less GVC trade. Sri Lanka's participation in apparel and footwear value chains are high, accounting for over 40 per cent of total trade and 60 per cent of manufactured exports.[30] However, the outlook is uncertain because different digital technologies have different effects, and the same technology could increase or decrease GVC trade in the future. For example, most 3D printing is now concentrated in upstream activities – prototyping, product development and research and development (R&D). In such a scenario, 3D printing will complement traditional production methods rather than compete. However, in the long run, 3D printing may, to some extent, substitute conventional manufacturing methods. By making it possible to produce final goods at the point of sale, the need for outsourced production and assembly will be reduced, thereby lowering the number of production steps/stages in the chain.

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[28] Loungani, P., Mishra, S., Papageorgiou, C., & Wang, K. (2017, March). The future wealth of nations: World trade in services. *IMF Research Bulletin*, pp. 4-8.

[29] Export Development Board. (2019). *ICT/BPM.* Retrieved from http://www.srilankabusiness.com/national-export-strategy/nes-ict-bpm.html

[30] World Bank. (n.d.). *World integrated trade solution (WITS)*. Washington D.C.: World Bank.

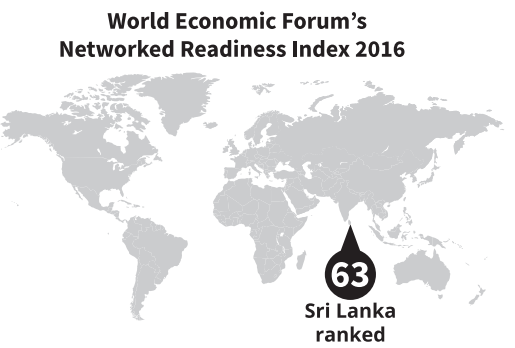
Also, the shift from mass production to mass customisation will have significant implications for value chain trade. Long and complicated GVCs emerged as an efficient means of organising the production of standardised mass products, exploiting economies of scale, and gains from specialisation. When shifting from mass production to mass customisation, long and complex value chains do not provide the necessary flexibility to adapt to changing demand conditions. Therefore, value chains may become shorter, with production emerging near to the customer base.

11.6 Policy Implications

Digital technologies not only create new markets, new types of trade and new products, but these also lower trade costs and affect trade patterns. These changes offer new opportunities and trade gains, and governments have a role to play in ensuring that firms can seize these opportunities and avoid falling behind by addressing challenges in areas such as investment in digital infrastructure and human capital, trade policy measures and regulations.

Firstly, the effect of digital technologies on trade will depend on access to low-cost digital infrastructure/infrastructure services and appropriate skills. To fully realise the potential benefits of digital trade, most governments have adopted digital development strategies which involve cross-cutting policy measures aimed at improving infrastructure, establishing an adequate regulatory framework, reducing the cost of doing business and facilitating relevant skills development.[31] In Sri Lanka, the Ministry of Digital Infrastructure and Telecommunications and Ministry of Development Strategies and International Trade are to develop a 'National Digital Economy Strategy', which will be implemented by the first half of 2019.

The need for investment in infrastructure is more acute in developing countries, including Sri Lanka, as they tend to lag behind developed countries, as highlighted in their digital strategies. According to the World Economic Forum's 'Networked Readiness Index', Sri Lanka is ranked at 63 out of 139 countries in 2016 and does relatively well compared to other lower-middle income countries.[32] Sri Lanka scored relatively high in terms of ICT skills, affordability, governmental ICT usage, and social impacts, but fared poorly in other pillars especially infrastructure, ranking at 103 out of 139 economies.



Various measures and tools are being used to promote and facilitate investment in broadband infrastructure/digital industry including improving the regulatory framework and investment climate, providing of investment incentives, facilitating investment, setting up of clusters and incubators,

[31] World Trade Organisation. (2018). *World trade report 2018.* Geneva, Switzerland: World Trade Organisation

[32] Word Economic Forum. (2019). *Global information technology report 2016*. Retrieved from reports.weforum.org/global-information-technology-report-2016/economies/#indexId=NRI&economy=LKA

The need for investment in infrastructure is more acute in developing countries, including Sri Lanka.

making available affordable payment solutions, etc. However, investments in other infrastructure (electricity supply, trade logistics, and payment systems) are also needed to complement with digital infrastructure. In Sri Lanka, access to an affordable online payment platform for all businesses is reported to be a key barrier to the development of the e-commerce industry.[33]

Support from the private sector is also required to develop and facilitate access to affordable digital infrastructure and digital infrastructure services. In addition to the development of digital infrastructure, many governments in developing countries are undertaking substantial investment in human capital through training and skills development to facilitate the uptake of digital technologies. According to the Department of Census and Statistics (DCS) Sri Lanka, country's digital literacy rate is 33.8 per cent (36.7 per cent for males and 31.2 per cent for females) – whereby digital literacy is defined as a person (aged 5-69) who can use a desktop computer, laptop computer, tablet or smartphone on their own. Given that digital literacy is an essential pre-requisite in the 4IR, efforts to integrate digital literacy into the education system are vital.

Secondly, trade policies can affect the development and performance of both digital infrastructure services and digitally-enabled and other supporting services. Despite the global financial crisis and its aftermath, an examination of policy changes in services since 2000 reveals a significant push towards greater services liberalisation, under preferential trade agreements as well as unilaterally.[34] International cooperation at the multilateral level or regional agreements can help countries to open up and stimulate competition in their digital infrastructure services, together with adequate regulatory frameworks. Similarly, trade policies on goods can have an impact on the development and performance of digital infrastructure and the use and uptake of digital technologies. Some countries such as Argentina, Brazil and Switzerland have reduced and eliminated import tariffs on specific informatics and telecommunication equipment as a start.[35]

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[33] Ceylon Chamber of Commerce. (2017, January). *Modernising online payments regulations to support e-commerce in Sri Lanka.* Retrieved from https:// www.chamber.lk/10015-2/

[34] World Trade Organisation. (2018). *World trade report 2018.* Geneva, Switzerland: World Trade Organisation.

[35] *Ibid.*

Thirdly, while improving the enabling regulatory framework to promote and facilitate investment in digital infrastructure/services, it is also important to introduce regulations to achieve public policy objectives such as consumer protection, data privacy and cybersecurity. To facilitate digital trade, many countries have undertaken steps to build an adequate legal framework that regulates electronic transactions, and ensure the validity of electronic contracts and signatures. Seventy-one countries, including Sri Lanka, have adopted legislation based on UNCITRAL Model Law on Electronic Commerce.[36]

A legal framework to ensure consumer protection to foster consumer confidence and enhance trust in digital markets and online transactions is another important feature. Out of the 125 countries for which data exists, 97 countries have

It is also important to introduce regulations to achieve public policy objectives such as consumer protection, data privacy and cybersecurity.

Figure 11.3
Cyber Legislation Worldwide – Sri Lanka



Source: United Nations Conference on Trade and Development. (2019, March 27). *Cybercrime legislation worldwide.* Retrieved from https://unctad.org/en/Pages/DTL/STI_and_ICTs/ICT4D-Legislation/eCom-Cybercrime-Laws.aspx

[36] United Nations Conference on Trade and Development. (2017). *Information economy report.* Geneva, Switzerland: United Nations Conference on Trade and Development.

[37] International Trade Centre. (2018). *Making the digital marketplace fairer: A roadmap for e-commerce legal frameworks in Sri Lanka.* Colombo, Sri Lanka: International Trade Centre.

adopted consumer protection legislation related to e-commerce. Sri Lanka's consumer protection rules require updating to reflect the emergence of electronic commerce.[37]

Lack of data protection legislation can reduce trust and confidence in a wide range of commercial activities. According to the UNCTAD Global Cyberlaw Trackers, Sri Lanka has not introduced legislation to ensure the protection of data and privacy, although 107 countries including 66 developing countries have done so. Alongside the need for modernised consumer protection legislation, there consensus on the need for Sri Lanka to adopt data privacy or data protection legislation.

The growth in digital trade has also raised questions relating to cybersecurity and the need to protect IT systems and their contents from cyberattacks. According to the ITU global cyber security index which measures the commitment of countries to cybersecurity at a global level, Sri Lanka ranked at 84 out of 174 countries in 2018.[38] While the legal framework for a digital economy has improved significantly, institutional arrangements are still lagging, and need to be addressed.

[37] International Trade Centre. (2018). *Making the digital marketplace fairer: A roadmap for e-commerce legal frameworks in Sri Lanka*. Colombo, Sri Lanka: International Trade Centre.

[38] International Telecommunication Union. (2019). *Global cybersecurity index.* Retrieved from https://www.itu.int/en/ITU-D/Cybersecurity/Pages/global-cybersecurity-index.aspx

12. Smart Digital Farming in Agriculture: Status and Prospects for Sri Lanka

12.1 Introduction

A number of global trends are influencing the overall sustainability of food and agricultural systems, and exerting enormous pressure on agriculture to meet future demand. These primarily include demographic changes such as population growth, urbanisation and rising income, scarcity of natural resources, climate change and food waste.[1] Back in 1700, much of the world had agriculture in limited scale, with relatively small amounts of land being used inefficiently to produce low yields which was still sufficient to sustain a low population of about 0.6 billion at the time. There are currently over 7.5 billion people in the world, with an expected population of over 8.5 billion by 2030 and 9.7 billion by 2050.[2] Approximately 55 per cent of the world's population lives in urban areas at present, which is expected to increase to 68 per cent with an addition of another 2.5 billion people to urban areas by 2050.[3]

Urbanisation tends to raise income which hastens a dietary transition towards higher consumption of high nutritious and processed food, requiring adequate shifts in output and adding pressure on natural resources. While productivity enhancements have been driven by investments on technological innovations, the growth of yields has slowed to rates that are not too conducive. The Food and Agriculture Organisation (FAO) estimates that farmers will be compelled to produce 70 per cent more food by 2050 in order to meet the needs of the expected population of over 9 billion.[4] While farming is predominantly a smallholder business in the developing world, as an occupation, it is on the decline. In 1991, the agricultural labour force was more than 43 per cent of total employments in the world, but now it contributes to about 28 per cent of the total population.[5] Not only is the population involved in agriculture declining

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1 Clercq, De M., Vats, A., & Biel, A. (2018). *Agriculture 4.0: The future of farming technology.* Dubai, United Arab Emirates: World Government Summit.

2 The World Bank. (n.d.). *Open data catalogue.* Retrieved from https://data.worldbank.org/indicator/sp.pop.totl

3 United Nations, Department of Economic and Social Affairs, Population Division. (2018). *World urbanisation prospects: The 2018 revision, methodology.* Working Paper No. ESA/P/WP.252. Retrieved from https://population.un.org/wup/Publications/Files/WUP2018-Methodology.pdf

4 Food and Agriculture Organisation. (2017). *The future of food and agriculture – Trends and challenges.* Retrieved from http://www.fao.org/3/a-i6583e.pdf

5 The World Bank. (n.d.). *Open data catalogue.* Retrieved from https://data.worldbank.org/indicator/sp.pop.totl

in certain economies, the age of individuals in farming households are increasing as well. For example, in South Korea, more than 50 per cent of the population of farm households is over 60 years old, and over 40 per cent is over 65 years.[6]

While the demographic transition has put tremendous pressure on agricultural systems in terms of providing safe, nutritious food to the growing population, the required acceleration in productivity is hampered by the degradation of land and water resources, and impacts of climate change. The State of the World's Land and Water Resources for Food and Agriculture (SOLAW) reports that 25 per cent of farmland is highly degraded and another 44 per cent is either moderately or slightly degraded.[7] The report also highlights growing competition for water resources. Today, more than 40 per cent of the world's rural population is estimated to live in water-scarce regions. The impacts of climate change are already being felt in every aspect of food security, and are expected to intensify considerably in the coming years unless corrective action is taken. Moreover, considerable market inefficiency in the form of food waste persists; around one-third of food produced – equivalent to approximately 1.3 billion tonnes per year – is lost along the food value chain, from production to consumption.[8] All these often translate into economic losses for farmers and others stakeholders within the food value chain, as well as higher prices for consumers, both of which constrain food security by making food less accessible for vulnerable groups.[9]

The global food systems today are in need of transformation in order to cope with these disruptive drivers. It is evident that emerging technological innovations driven by the fourth industrial revolution (4IR) have real potential to overcome the structural weaknesses of the current agricultural systems and as such, to deliver a more productive, competitive and sustainable outcome, based on a more precise and resource-efficient approach.[10] The expectations are high that smart farming will change agriculture positively, while bridging the gap between large and small-scale farmers, not only in developed countries but also in developing countries. This chapter reviews the different 4IR technologies available in today's world while giving emphasis to the status quo and prospects of adapting such technologies in Sri Lanka.

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6 Sung, J. (2018). The fourth industrial revolution and precision agriculture. In Stephan Hussmann (Ed.), *Automation in Agriculture: Securing Food Supplies for Future Generations.* London, United Kingdom: IntechOpen.

7 Food and Agriculture Organisation. (2011). *The state of the world's land and water resources for food and agriculture (SOLAW*) – Managing systems at risk. Rome and Earthscan, London: Food and Agriculture Organisation of the United Nations.

8 Food and Agriculture Organisation. (2011). *Global food losses and food waste – Extent, causes and prevention.* Rome, Italy: Food and Agriculture Organisation of the United Nations.

9 Food and Agriculture Organisation. (2018). *Gender and food loss in sustainable food value chains – A guiding note*. Rome, Italy: Food and Agriculture Organisation of the United Nations.

10 Webb, Patrick., & World Economic Forum. (2018). *Innovation with a purpose: The role of technology innovation in accelerating food systems transformation.* Geneva, Switzerland: World Economic Forum. Food and Agriculture Organisation. (2011). *The state of the world's land and water resources for food and agriculture (SOLAW)* – Managing systems at risk. Rome and Earthscan, London: Food and Agriculture Organisation of the United Nations.

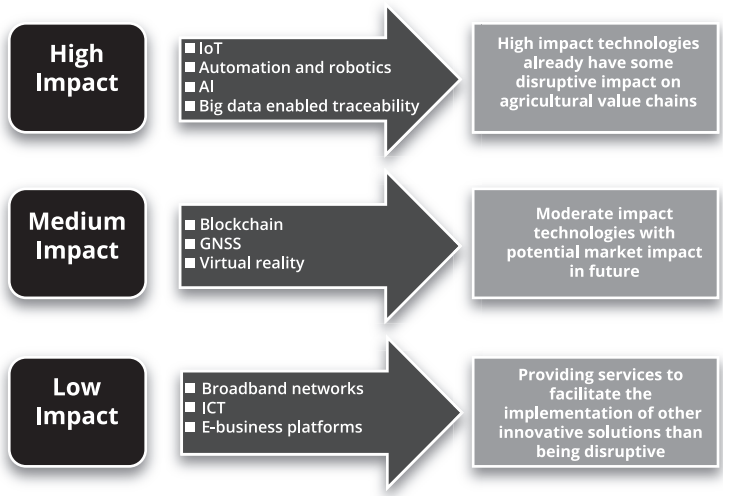
12.2 Transforming Agriculture with the 4IR

Disruptive drivers such as emerging challenges that include climate change, rising demand due to urbanisation and growing population have given birth to disruptive 4IR technologies that can help farmers cope better with such challenges. Depending on the level of impact on agricultural value chains, 4IR technologies can be categorised into three components as; high impact, medium impact and low impact (Figure 12.1). High impact technologies already have some disruptive impact on agricultural value chains and will have more in future. These include internet of things (IoT), automation and robotics (A&R), artificial intelligence (AI) and big data enabled traceability. Medium impact technologies are the innovative technologies that may create high impact in the long run, such as blockchain, global navigation satellite system (GNSS) and virtual reality (VR). Low impact technologies are providing services to facilitate the implementation of other innovative solutions rather than being disruptive. These technologies include broadband networks, information and communication technology (ICT) and e-business platforms.[11]

12.2.1 High Impact Agricultural Technologies

Internet of Things (IoT): The IoT refers to any object/thing that is connected to the internet. Unlike in the past, in today's economy, multitude of connected sensors and devices can communicate and react with each other,

Figure 12.1
Technologies Impacting Agricultural Value Chains

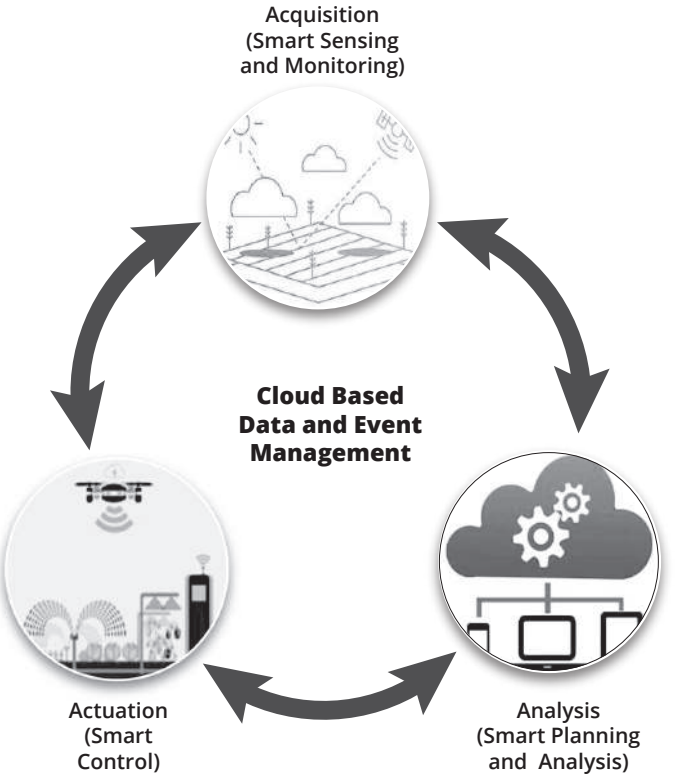


Source: Adopted from Shaji, Shanto (2019). *IoT Applications in Agriculture.* Retrieved from https://www.tomsonelectronics.com/blogs/news/iot-applications-in-agriculture

[11] Pesce, M., Kirova, M., Soma, K., Bogaardt, M-J., Poppe K., Thurston, C., …Urdu D. (2019). *Research for AGRI Committee – Impacts of the digital economy on the food-chain and the CAP,* European Parliament. Brussels, Belgium: Policy Department for Structural and Cohesion Policies.

without the need for human intervention.[12] IoT is highly capable of offering many solutions towards the modernisation of agriculture, especially on tracking, tracing, monitoring and event management. The structure of IoT in agriculture is based on three layers: acquisition layer (sensing), analysis layer (planning), and actuation layer (control). IoT makes use of technologies such as wireless sensor networks (WSN), radio frequency identification (RFID) and near field communication (NFC) that can record agricultural data from crops, soil, environment, etc. The collected data are then transferred to a cloud-based IoT platform with predefined decision rules that identify any deficiencies or needs, based on the monitored conditions. The actuation layer facilitates the implementation of the IoT by providing necessary intelligence for specific control tasks for automated equipment like robots and drones.[13]

Figure 12.2
IOT Applications in Agriculture



Source: Adopted from Shaji, Shanto (2019). *IoT Applications in Agriculture*. Retrieved from https://www.tomsonelectronics.com/blogs/news/iot-applications-in-agriculture

[12] Western Cape Government. (2017). *Western Cape sector digital disruption impact assessment.* Synthesis report [Online]. Retrieved from https://www.usb.ac.za/wp-content/uploads/2018/07/THE-FUTURE-OF-THE-WC-AGRICULTURAL-SECTOR-IN-THE-CONTEXT-OF-4IR-FINAL-REP.pdf.

[13] Pesce, M., Kirova, M., Soma, K., Bogaardt, M-J., Poppe K., Thurston, C., …Urdu D. (2019). *Research for AGRI Committee – Impacts of the digital economy on the food-chain and the CAP,* European Parliament. Brussels, Belgium: Policy Department for Structural and Cohesion Policies.

For optimum performance, IoT devices installed on a farm should collect and process data related to soil, weather, crops, etc., in a repetitive cycle that enables farmers or/and cloud-based platforms to react quickly to emerging issues and changes. The most important aspect For optimum performance, IoT devices installed on a farm should collect and process data related to soil, weather, crops, etc., in a repetitive cycle that enables farmers or/and cloud-based platforms to react quickly to emerging issues and changes. The most important aspect of IoT is that different types of data created at different places in the value chain, can be combined and made accessible for a wide range of applications used by different players in the value chain.[14] In combination with big data, IoT has the potential to transform the agricultural sector by making available a huge amount of data required to improve the farm production processes.[15] This data can also be used to improve controls, and increase the business efficiency and the overall quality of value chain processes.

Agriculture Automation and Robotics: Most farming operations are labour intensive. Yet much of the labour is composed of repetitive and standardised tasks which create an ideal niche for agricultural automation. One of the main aspects of agricultural automation is concerned with the substitution of human labour by field robots or mechanised systems that can handle tasks more accurately and uniformly, at a lower cost and higher efficiency. A major development in agriculture is the appearance of agricultural robots *(AgBots)* on farms, performing tasks ranging from land preparation for planting to harvesting. Traditional farming machines like

One of the main aspects of agricultural automation is concerned with the substitution of human labour by field robots or mechanised systems that can handle tasks more accurately and uniformly, at a lower cost and higher efficiency.

[14] Pesce, M., Kirova, M., Soma, K., Bogaardt, M-J., Poppe K., Thurston, C., …Urdu D. (2019). *Research for AGRI Committee – Impacts of the digital economy on the food-chain and the CAP,* European Parliament. Brussels, Belgium: Policy Department for Structural and Cohesion Policies.

[15] Tzounis, A., Katsoulas, N., Bartzanas, T., & Kittas, C. (2017). Internet of things in agriculture, recent advances and future challenges. *Biosystems Engineering.* Vol. 164, pp. 31-48.

tractors and unmanned aerial vehicles (drones) can also be utilised by robots in the field of agriculture.[16]

As autonomous driving technologies advance, tractors are expected to become some of the earliest machines to be converted. *Robotra* is a commercially available tractor modified into a robotic vehicle with an ability almost equivalent to that of customary manned-driven tractors, and can perform unmanned land preparation (tilling).[17] Weed control and precise spraying are perhaps those applications that are in demand the most for agricultural field robots. Various promising technologies have been introduced and implemented for this purpose over the past decade or so.[18] The concept of micro-spraying – using computer vision technology to detect weeds and then spraying a targeted drop of herbicide onto them – can significantly reduce the amount of herbicide used in crop cultivation. *AgBot II* prototype is equipped with cameras, sensors and software, and is designed to navigate fields, detect and classify weeds, and manage them either chemically or mechanically. Other than that, it applies fertilizer for site-specific crop management.[19]

Robots are used for assessing agricultural fields by monitoring factors such as pests and diseases, weed growth and collecting data. Some of the most advanced robotic technology for automated field scouting and data collection include OSCAR, Trimbot 2020, Ladybird, MARS and SMP S4. While 'robot-assisted precision irrigation' can reduce wastage of water by targeting specific plants, robots can be used for precision fertilization as well.[20] In robotic harvesting, advances in sensing and imaging technology have led to the employment of sophisticated devices such as infrared, hyperspectral cameras and light-detection and ranging (LiDAR) for developing robotic harvesting platforms for extracting spatial information from the images for fruit detection, recognition, localisation, and tracking.[21]

Another technology that fits into the category of agricultural automation is the use of drones. Drones are equipped with sensors to collect data from the soil, environment as well as crops. It can also be used throughout the crop cycle in different field operations that include soil and field analysis, planting, precision variable rate application of pesticides, fertilizers and herbicides, crop monitoring, precision irrigation, varietal selection, weather analysis and health assessment. It has been estimated that precision farming will be the largest contributor in usage of drones over the next decade, due to its possibility to acquire information quickly and consistently at a cheaper cost.[22] Drones are also increasingly

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[16] Sung, J. (2018). The fourth industrial revolution and precision agriculture. In Stephan Hussmann (Ed.), *Automation in Agriculture: Securing Food Supplies for Future Generations.* London, United Kingdom: IntechOpen.

[17] Matsuo, Y., Yukumoto, O., Noguchi, N., (2012). *Enhanced adaptability of tilling robot. Jarq-Japan Agricultural Research Quarterly 46*(4): 295- 303. Retrieved from https://doi.org/10.6090/jarq.46.295

[18] Shamshiri, R R., Weltzien, C., Hameed, I A., Yule, I J., Grift, T E., Balasundram, S K. (2018). Research and development in agricultural robotics: A perspective of digital farming. *International Journal in Agriculture & Biological Engineering, 11*(4): 1–1.

[19] The Queensland University of Technology. (n.d.). *Partner with us-Case study.* Retrieved from https://www.qut.edu.au/research/partner-with-us/case-study-agbot-ii

[20] Shamshiri, R R., Weltzien, C., Hameed, I A., Yule, I J., Grift, T E., Balasundram, S K. (2018). Research and development in agricultural robotics: A perspective of digital farming. *International Journal in Agriculture & Biological Engineering, 11*(4): 1–1.

[21] The Queensland University of Technology. (n.d.). *Future farming.* Retrieved from https://research.qut.edu.au/future-farming/projects/harvey-the-robotic-capsicum-sweet-pepper-harvester/

[22] European Global Navigation Satellite Systems Agency. (2017). *GNSS market report issue 5.* https://www.gsa.europa.eu/system/files/reports/gnss_mr_2017.pdf

used in agricultural insurance, because drone imagery can help improve predictions of crop losses (picture-based insurance) and thereby reduce basic risks in insurance.[23]

Artificial Intelligence (AI): AI is concerned with the simulation of intelligent behaviour in computers so that these exhibit human intelligence by performing acts such as language recognition, learning, reasoning, perception, planning and problem solving. The driving intelligence behind AI is the machine learning (ML) method, which determines the decisions that are enabled by AI technologies, and discovers hidden patterns or trends that can be used to make predictions.[24] AI-based systems are usually embedded in hardware devices that are used in agriculture such as advanced robots, autonomous vehicles, drones and IoT applications in order to ensure they work in harmony.

AI is already in use to analyse farm data that is collected real time through a system of sensors around a farm in an IoT network, which can be trained to send the correct response to that area. For instance, the AI system will be able to recognise the irrigation requirements based on soil data received by soil moisture sensors and weather data. Similarly, AI can determine chemical and fertilizer requirements based on the crop condition and soil analysis data. Most importantly, AI can also advise farmers in terms of optimal planting and harvesting times based on weather predictions and cropping characteristics. Huxley has already developed an AI system to determine optimal growing conditions and actively monitor crops, and is working on combining AI with augmented reality (AR). Purpose is to offer recommended actions based on farming information while the farmer is tracking the entire field through the AR device.[25]

Big Data Analytics: While farmers are trying to achieve the twin objectives of maximising profitability/efficiency and minimising costs, they need to take more optimal decisions to improve farm management. It is expected that big data technologies help to achieve these goals in a better way.[26] Big data refers to a massive amount of data that can be captured, analysed and used for decision making. The data can be 'process mediated' such as business data resulting from agricultural processes like purchasing inputs, feeding, seeding, applying agrochemicals and fertilizer, etc.; 'machine generated' such as data that are derived from sensors and smart machines like robots and drones in the form of farm data, weather data, soil data, etc.; or 'human sourced' such as human experiences recorded in books, photographs, audio and video.[27]

Big data are fully dependent on other types of technologies such as IoT, sensors, drones, etc., and can be used for several operations in agriculture. Two of the major uses of big data are food logistics management and insurance. Big data enabled track and trace agriculture applications – from the field through the supply

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[23] Food and Agriculture Organisation. (2018). *E-agriculture in action: Drones for agriculture* (In G. Sylvester (Ed.). Retrieved from http://www.fao.org/3/I8494EN/i8494en.pdf

[24] Gour, R. (2019, April 1). *Artificial intelligence vs machine learning vs deep learning vs data Science.* Retrieved from https://medium.com/@rinu.gour123/artificial-intelligence-vs-machine-learning-vs-deep-learning-vs-data-science-71bd4a8402ec

[25] Huxley. (n.d.). *Huxley has developed the worlds first augmented operating system. And this is just the beginning.* Retrieved from Plant Vision:http://www.huxley.io/

[26] Sonka, S. (2015). Big data: from hype to agricultural tool. *Farm Policy Journal*, 12, 1–9.

[27] Wolfert, S., Lan, Ge., Cor, Verdouw., & Marc-Jeroen, Bogaardt. (2017). Big data in smart farming–a review. A*gricultural Systems,* 153: 69-80.

chain and in food processing environments – can lead to effective identification and traceability in the food supply chain. Big data derived from mobile applications, satellite and radar-based imaging and drone-based imaging can be used to reduce the risks of providing insurance products to farmers in both index based and indemnity based insurances.[28] Other uses of big data include yield prediction which allows the farmer to extract insights on planting practices; tracking natural trends/risky events, and forecasting on same; food safety and food wastage reduction; and operation and equipment management.[29]

12.2.2 Medium Impact Agricultural Technologies

Blockchain: Blockchain is a secure, decentralised, and transparent means of recording and sharing technology which can be applied to agricultural transactions as well. Blockchain technology improves several areas within the agricultural sector. Blockchain enabled traceability can support the increase of transparency at all levels in agricultural value chains.

It reduces the time for tracking and tracing, while helping to find the source of the problem and report a dysfunction in the value chain in real time with IoT. It prevents costly and substantial procedures in proof of compliance, and fosters confidence between all value chain actors by allowing access to information in an open and easy way.[30]

Big data derived from mobile applications, satellite and radar-based imaging and drone-based imaging can be used to reduce the risks of providing insurance products to farmers in both index based and indemnity based insurances.

[28] Webb, Patrick., & World Economic Forum. (2018). *Innovation with a purpose: The role of technology innovation in accelerating food systems transformation.* Geneva, Switzerland: World Economic Forum.

[29] Eleks. (2019). *The many practical uses of big data in agriculture.* Retrieved from https://eleks.com/blog/practical-uses-of-big-data-in-agriculture/

[30] Sylvester, G. (2019). *E-agriculture in action: Blockchain for agriculture, opportunities and challenges.* Bangkok, Thailand: The Food and Agriculture Organisation of the United Nations and the International Telecommunication Union.

Despite the increasing climate risks and multiple benefits, the rate of adoption of insurance products by farmers still remains relatively low, mainly due to lack of trust and lengthy time associated with claim validation and pay out. Blockchain enabled smart insurance contracts can facilitate instant pay-outs to the insured in case of adverse weather incidents, by automating and significantly simplifying the process of claim settlement. Automated and decentralised systems, coupled with the elimination of on-site claim assessments, can immensely reduce transaction costs of insurance products. Facilitating direct sales from producers to end users without any additional costs, blockchain also helps farmers to sell commodities at fair prices and lowers transaction fees, thereby supporting smaller farmers to enter the market. Moreover, blockchain technologies can prevent price extortion and delayed payments, while simultaneously eliminating middlemen and lowering transaction fees, leading to fairer pricing and helping smallholder farmers capture a larger part of their crop value.[31]

Global Navigation Satellite System (GNSS): GNSS refers to a collection of satellites providing signals to transmit positioning and timing data to GNSS receivers to determine location. The GNSS includes the European Galileo, American GPS, Russian GLONASS and Chinese BeiDou Navigation Satellite System. GNSS applications have become a key part of precision agriculture technologies as location information is necessary for site-specific crop management such as precision chemical applications and weed management. In addition, GNSS are used in yield monitoring, plant mapping, soil condition monitoring, automatic steering and farm machinery guidance, variable rate applications, and robotic applications.[32]

Augmented Reality (AR) and Virtual Reality (VR): Both the AR and VR are becoming increasingly popular in agricultural operations in developed countries. While, both the AR and VR can have some similarities, VR is more advanced than AR; latter is developed in the form of an interactive application and used mainly on mobile devices to blend digital components into the real world. VR is an artificial, computer-generated simulation of a real-life environment or situation. Sensors are being installed in the field, and these scan the crop. In agriculture, VR technology is allowing to take a closer look at crops without physically visiting the fields, and receive all the necessary information required such as weather, plant health, fertilizer needs, etc., on a tablet or smartphone. This makes it easier to make quick operational decisions, with less cost and labour. Virtual tours within the farm fields can be useful not only for farmers, but also to potential remote customers who prefer to buy directly from farmers.

12.2.3 Low Impact Agricultural Technologies

Technologies that are already well established and have a low impact on agricultural value chains such as broadband networks, ICT and platforms for e-business, belong to this category. These technologies provide supportive function for the disruptive technologies discussed earlier. Broadband internet refers to internet access that

[31] Tripoli, M., & Schmidhuber, J. (2018). *Emerging opportunities for the application of blockchain in the agri-food industry.* Rome and Geneva: The Food and Agriculture Organisation of the United Nations and International Centre for Trade and Sustainable Development.

[32] Perez-Ruiz, Manuel., & Upadhyaya, Shrini K. (2012). GNSS in precision agricultural operations, new approach of indoor and outdoor localisation systems. *IntechOpen.* DOI: 10.5772/50448.

connects the user to high-speed internet such as fixed-broadband technology (ADSL) and mobile broadband (2G, 3G, 4G and upcoming 5G). ICT refers to activities involving computers and other electronic devices and technology including mobile applications, networks, sensors, etc. The application of ICT in the agriculture sector is also known as e-agriculture. The expansion of digital infrastructure and mobile technologies is vital for reaching agricultural development goals. Digital tools and services delivered on mobile phones include access to improved financial services, mobile payments and financing, provisioning of agricultural information (weather, prices, crop related), traceability and tracking, supplier chain management, access to markets, etc. E-commerce is the online purchase of goods and services via the internet by consumers and e-business is the exchange of information and purchase of products and services between businesses using the internet.[33]

12.3 Why Sri Lanka's Agriculture Sector Needs 4IR Technologies

Traditionally, agriculture has been one of the key sectors of the Sri Lankan economy with significant contribution to gross domestic product (GDP), employment, and income of people. However, agriculture still continues to be a significant source of employment and livelihood, accounting for about 26 per cent of the employed in 2018. Rice and tea– the two dominant sub sectors in the non-plantation and plantation sectors,

Digital tools and services delivered on mobile phones include access to improved financial services, mobile payments and financing, provisioning of agricultural information (weather, prices, crop related), traceability and tracking, supplier chain management, access to markets, etc.

[33] Pesce, M., Kirova, M., Soma, K., Bogaardt, M-J., Poppe K., Thurston, C., …Urdu D. (2019). *Research for AGRI Committee – Impacts of the digital economy on the food-chain and the CAP,* European Parliament. Brussels, Belgium: Policy Department for Structural and Cohesion Policies.

account for the largest shares of employment generation. Further, the sector utilises 43.7 per cent of Sri Lanka's total land area, and continues to be the backbone of the rural economy in the country.[34] Domestic agriculture still continues to provide more than 85 per cent of the country's food requirement; with near self-sufficiency in rice, local production of all major food items is notable, with the exception of sugar, pulses, canned fish and milk powder. These are imported in large volumes and exceed 75 per cent of total available volumes in the country.[35] In terms of agricultural exports, earnings have not experienced a healthy growth in the past decade, and exports continue to be limited to a few traditional products, and others such as spices, vegetables and fruits, with some processing involved.

Since independence, Sri Lanka's agriculture has transformed in many aspects. A focus on field crops other than rice is particularly noteworthy, while reducing the food deficit in many varieties of crop products. The declining percentage of the country's labour force employed in agriculture and agriculture's contribution to GDP over the years cannot be considered as issues, as it is not unusual to see the role of agriculture changing relatively with economic development. However, long unsolved problems remain in achieving the major objectives of the sector that are evident in a relatively high incidence of agrarian poverty and food insecurity. Dramatically increasing productivity, and thereby food supply and export earnings, is a daunting challenge on its own which needs certain reforms in the current policy structure in order to bring about some innovative solutions.[36] These problems exist in all facets of the food system that include food production, processing, distribution, access, consumption, and resource/waste recovery.

The yield levels of domestically grown food crops, except for rice, have stagnated for more than a decade at unimpressive levels even by the standards of developing countries. Therefore, domestic production will not be able to meet national requirements even under present levels of per capita food consumption. As the population grows at approximately 1 per cent annually and real per capita income is rising at 4.7 per cent per year,[37] the national requirement for food will also be rising constantly in the years to come. A possible solution to this problem from the domestic production front should come through yield improvement. However, data indicate that the rates of growth in average yields have declined in recent times, and growth in production is mainly due the expansion in land area. Latter will be somewhat impossible in future due to land constraints.

One of the most informative measures of agricultural productivity is total factor productivity (TFP) which takes into account all inputs employed in farm production in comparison with the total amount of output. If total output is growing faster than total inputs, then the TFP is increasing. TFP differs from measures like crop yield per acre or agricultural value-added per worker because it takes into account a broader set of inputs that are used in production. Figure 12.3 depicts the decadal growth rates of TFP in

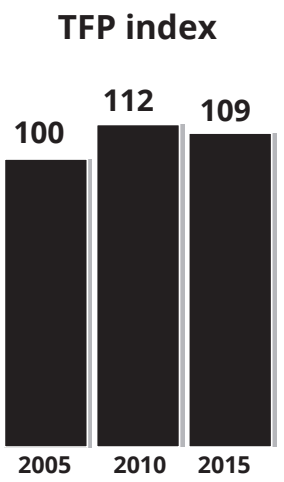
[34] The World Bank. (n.d.). *Open data catalogue.* Retrieved from http://data.worldbank.org/indicator/AG.LND.AGRI.ZS

[35] Department of Census and Statistics. (2015). *Food balance sheet-2015.* Colombo, Sri Lanka: Department of Census and Statistics.

[36] Institute of Policy Studies of Sri Lanka. (2015). *Sri Lanka: State of the Economy 2015.* Colombo, Sri Lanka: Institute of Policy Studies of Sri Lanka.

[37] Average percentage change in real per capita GDP during 2010-18.

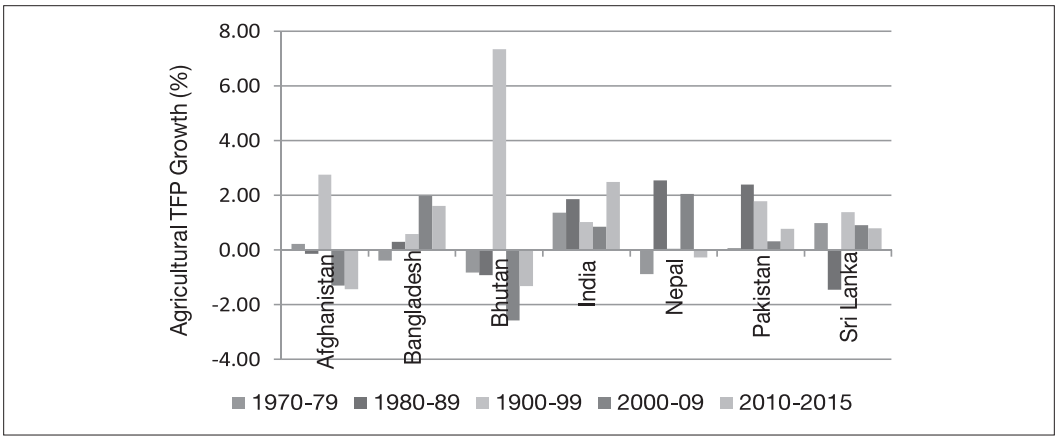
Sri Lanka in comparison to other South Asian countries. It shows that Sri Lanka is not only performing poorly in South Asia, but also that its TFP growth itself is on a declining trend. The change in TFP index reported as 100 in 2005 (base year), is 112 in 2010 and 109 in 2015 for Sri Lanka.



The domestic agricultural sector in Sri Lanka is characterised by small-scale farming. Many smallholders do not earn a sufficient income from farming, and poverty is a predominant phenomenon among them. Agrarian poverty and vulnerability are widespread in rural areas where approximately 87 per cent identified as poor is living.[38] Also, almost half of the poor rural population consists of small-scale farmers.[39] Low productivity coupled with non-competitiveness both in the domestic and export markets are partly responsible for rural agrarian poverty. Thus, it is critical to enhance agricultural productivity, income diversification and economic growth in rural areas.

The agriculture sector has to make the largest contribution for poverty reduction efforts as majority of the poor live in rural and plantation sectors, where agriculture is the predominant economic activity. A majority of the rural poor

Figure 12.3
Decadal Percentage Growth Rates of Agricultural TFP among South Asian Countries from 1970-2015



Source: The International Food Policy Research Institute. (2018). *Dataset*. Retrieved from http://dx.doi.org/10.7910/DVN/IDOCML

[38] Department of Census and Statistics. (2015). *Poverty indicators: Household income and expenditure Survey - 2012/2013.* Retrieved from http://www.statistics.gov.lk/poverty/PovertyIndicators2012_13.pdf

[39] International Fund for Agricultural Development. (n.d.). *Countries; Sri Lanka.* Retrieved from http://www.ifad.org/operations/projects/regions/pi/factsheets/srilanka.pdf

and all estate workers rely on agriculture for their livelihood. Even though the causes of agrarian poverty and means available to overcome it vary across regions, the poor basically suffer from a set of common issues such as low resource endowment, low skills, poor access to technology, inadequate institutional support and low productivity.

Historically, Sri Lankan agricultural economy has been heavily dependent on irrigation. Rice being staple food, Sri Lanka has been a rice-based country endowed with sophisticated irrigation infrastructure. Both irrigation infrastructure and storage of water delivered are treated as public goods supplied free of charge to farmers. Being considered as a common property with no ownership, no one takes the responsibility for management and maintenance, except in certain cases where the government has sought participation of farmers. Apart from the fiscal cost, free provision leads to overuse and wastage of water, giving rise to an unaccounted economic loss. The losses are accruing over time, creating a financially and economically unsustainable system in the long run.

Currently, the irrigated agriculture sector faces two major problems; inefficiency of irrigation water utilisation, and poor management of irrigation systems owing to a rising budgetary burden of providing irrigation water. Inefficiency in relation to irrigation water use implies that a unit of irrigated land uses more water than that required for the crop. Consequently, the extent cultivated with the total volume of water available will be less than the maximum cultivable extent. This result is from; (a) a lack of technical know-how on water management and/or (b) lack of an incentive to use water sparingly. At zero price of irrigation water, no incentive is available for farmers to limit their water use or to adopt water saving technologies. The global demand for water for agricultural and non-agricultural purposes is increasing steadily, and Sri Lanka is no exception to this general trend.

Agriculture in Sri Lanka has evolved in close harmony with the prevailing climatic conditions of respective agro-climatic regions of the island. However, Sri Lanka's climate has undergone changes to an extent that the expected amount of rainfall does not come at the correct time in the cultivating season. Agricultural productivity is likely to suffer severe losses because of high temperature, severe drought, flood conditions, sea level rise and soil degradation. Increased occurrence of extreme rainfall events arising due to climate change, such as droughts and floods lead to crops losses caused by moisture stress and excess water. Besides the water stresses, these conditions obstruct the management of operations such as land preparation, transplanting, weed control, and fertilizer and agro-chemical application that result in yield losses. Moreover, increased occurrence of rainfall irregularity is likely to cause severe damage to existing irrigation infrastructure, limiting the water availability for irrigated crop production.

Sri Lanka being a tropical island, crop injuries due to high temperatures are also inevitable. The same will lead to rapid drying up of tanks giving rise to scarcity of water for agriculture. Apart from the direct impact of increased variability of rainfall and rise of ambient temperature, indirect effects of increased rainfall intensities worsen land degradation, especially in hilly areas where plantation crops are grown. Thus, the future of agriculture in a changing global climate in the context of an increasing human population has to be a policy priority, and an issue of topical importance to the scientific community.

Rapid and ongoing changes are occurring in domestic and export procurement systems, with the growing dominance of supermarkets, high quality retail, bulk procurement by domestic manufacturing firms, and increased quality awareness in the global trading system. As in other developing countries, the food retail market in Sri Lanka has gradually evolved from fragmented local markets to centralised wholesale markets, and eventually to the emergence of supermarkets. The most intractable issue arising from the global market is public concern regarding food safety in industrialised countries that has resulted in increased and tightened public standards over the past two decades.[40] The inferior quality of most Sri Lankan farm gate products has been a serious issue in the present context of high-quality consciousness. A large proportion of the produce leaving the farm gate are of a quality that is far below the expected level at the high-end of the supply chain.[41] This is mainly attributed to poor weather conditions, low cost processing technology, poor storage facilities, early harvesting habits and small-scale nature of production. Poor quality leads to a direct loss of potential exports and foreign exchange earnings. Many producers do not have proper processing facilities and are unaware of quality parameters. Thus, the impact of modern and restructured markets has had a number of repercussions on small-scale farmers who are unable to keep up with emerging marketing trends.[42]

Under these circumstances, agriculture survives due to direct and indirect support measures provided by the government such as free irrigation, a large fertilizer subsidy, support prices for rice, and ad hoc trade protection measures for selected crops. The economic costs of these measures are a reflection of the unsustainable and misdirected measures adopted by successive governments to achieve self-sufficiency in domestic production. In a bid to overcome such disruptive drivers, Sri Lankan agriculture too has seen a number of technological transformations in the last decades or so, albeit on a fairly limited scale.

12.4 Smart Farming in Sri Lanka: Prospects and Challenges

Sri Lanka's agriculture sector has undergone various milestones over the years, where the technologies, tools, equipment, machineries and methods have advanced to carryout tasks more easily and efficiently. A few decades back, paddy farmers used buffaloes to pull a plough or harrow for land preparation and for threshing the harvested grain. With passing of time, two-wheel tractors replaced the task which was traditionally done by animals or manually. Likewise, technology has entered into the farm field gradually. Today, the agriculture sectors is using different modern technologies at each and every step of the farming system, such as crop development, land management, breeding, agrochemical usage, wholesaling and distribution, processing, storing and marketing.

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[40] Product quality standards such as ISO 9000, ISO 14000 certification and process quality standards such as HACCP have become essential parameters in the food industry.

[41] Samaratunga, P. (2007). *Sri Lanka: Innovative practice in integrating small farmers into dynamic supply chains: A case study of MA's tropical food Company.* Regoverning markets innovative practice series. London, United Kingdom: International Institute for Environment and Development.

[42] Weerahewa, J., Thibbotuwawa, M., & Samaratunga, P. (2017). *Dynamic transformation of agriculture in Sri Lanka: Trends, challenges and opportunities.* Paper presented at the Agricultural Economic Researchers Association (AERA) Conference, Mumbai, India.

While the agriculture sector has not seen much of high impact and medium impact technologies as yet, different initiatives taken by the government as well as private agribusiness firms to improve production in an efficient and sustainable way are commendable.

Sri Lanka also has a vibrant ICT sector with some e-agriculture solutions in place or in the pipeline, and is much keen on harnessing its potential. While the agriculture sector has not seen much of high impact and medium impact technologies as yet, different initiatives taken by the government as well as private agribusiness firms to improve production in an efficient and sustainable way are commendable. Following the framework proposed by the FAO and ITU (International Telecommunication Union),[43] the Sri Lanka E-agriculture Strategy was developed with the aim of harnessing the ICT potential to achieve agricultural goals. The strategy guide proposes an e-agriculture governance framework, comprised of a leadership committee, a steering committee and a task force. An e-agriculture task force was set up, comprising members from various departments of the Ministry of Agriculture (MOA) and Telecommunications Regulatory Commission of Sri Lanka (TRCSL), Information and Communication Technology Agency (ICTA) and Telecom and ICT providers in Sri Lanka.[44]

The Department of Agriculture (DOA) and other relevant organisations have already initiated several e-agriculture programmes that include interactive ICT and mobile platforms, software applications, etc., to disseminate agriculture information. Some of these are highlighted in Table 12.1.

Other than the above e-agriculture services, a seed and planting material management information system, progress monitoring system for National Food Production Programme, and a QR code system for good agricultural practices (GAP) certification programme are under development. Sri Lanka 'E-agriculture' Strategy

[43] Food and Agriculture Organisation. (2019). *E-agriculture strategy guide.* Retrieved from http://www.fao.org/in-action/e-agriculture-strategy-guide/en/

[44] Department of Agriculture. (2016, June). *Sri Lanka e-agriculture.* Retrieved from https://www.doa.gov.lk/ICC/images/publication/Sri_Lanka_e_agri_strategy_-June2016.pdf

Table 12.1
Smart Agriculture Initiatives in Sri Lanka

ICT Application	Description
Crop recommendation platform	Web based platform for the farmers to help them select crops suitable for a particular Grama Niladari Division (Source: Natural Resources Management Center. (n.d.). Crop suitability recommendation for grama niladhari divisions in Sri Lanka. Retrieved from http://nrmc.lk/NRMC/).
'CropRec' desktop software	It can be used online and offline for easy and fast dissemination, sharing displaying and data processing which helps information in decision making for various cropping patterns.
'Croplook'	An early warning system for vegetable farmers where the crop selection can be done based on price predictions (Source: Croplook. (n.d.). Early warning messages for vegetable farmers (Price prediction and crop selection). Retrieved from http://croplook.net/grid_vegewar001/)
Wikigoviya	Facilitates all stakeholders in agriculture to have progressive dialogues (Agriforum) and distance learning in agriculture (e-learning). It also provides a public knowledge repository in agriculture (Agripedia). (Source: Department of Agriculture. (2013). Wiki goviya. Retrieved from https://www.goviya.lk/en/)
Krushilanka agriculture portal	Gateway for all agriculture related institutes and their services relating the agricultural sector including acts and regulations and publications. (Source: National Agriculture Information & Communication Centre. (n.d.). Krushi Lanka gateway. Retrieved from https://www.krushilanka.lk/en/)
AgMIS (Agriculture Management Information System)	Developed and implemented as a pilot project in 2006 to strengthen value chain activities, especially catering to policymakers to decide on crop production.
'GoviSahanaSarana' agriculture advisory service	Farmers can directly contact agriculture technical officers. All conversations are recorded and information gathered into a 1920 call centre database.
e-SMS service	e-SMS service has been introduced to integrate with the 1920 agriculture advisory service. Farmers can send messages to the call centre team requesting advice on their issues.
Krushi FM web radio	The web radio has been operated since December 2013 by DOA (Source: Department of Agriculture. (n.d.). Krushifm. Retrieved from https://www.liveonlineradio.net/sri-lanka/krushi-fm.htm). The web-based programme has been enabled for android phones through the app called Krushi fm.
Rice-Pest Spread Analysis System	The plant protection service of the DOA maintains a database (pest incident intensities, type of pest, damage level, affected crop varieties, etc.) for major pest incidents in the country since 2015. This data can be analysed and viewed as projected graphs and maps. (www.ricepestpps.com)
Govi Mithuru	A mobile agriculture initiative which is being jointly implemented by Dialog Telecom, CABI International and DOA to strengthen technology transfer in agriculture to the farming community using mobile technology.
Tradenet	A daily market price information system operated by Dialog network ('977').
Interactive Voice Response (IVR) service	Crop market price information disseminated through '6666' short code by Mobitel network.
Govipola App	Digital classified AgriApp creating a digital market for the farming community. Buyers and sellers are able to come together in a transparent manner, procuring agriculture commodities and services through a listing mechanism.

Source: Department of Agriculture. (2016, June). *Sri Lanka e-agri strategy.* Retrieved from https://www.doa.gov.lk/ICC/images/publication/Sri_Lanka_e_agri_strategy_-June2016.pdf

has identified some of the potential applications of ICTs to improve existing agriculture system information collection, efficiencies and services. These include mobile-based integrated agriculture advisory service; food crop forecasting and marketing information service; pesticide registration and pesticide information e-service; plant protection e-service; research information management system; soil test results e-service; e-agriculture library service; natural resources management information services; plant genetic resources information service; plant quarantine e-service; weather forecasting and advisory service; land use and soil conservation mapping and e-information system; geospatial information service; and farm machinery e-information service.[45]

Box 12.1
Pioneering Agriculture Technology in Sri Lanka

Automated Climate Control and Fertigation Systems

Cropwiz, one of Sri Lanka's largest agriculture projects with an investment of approximately Rs. 1 billion is an international joint venture which employs cutting-edge greenhouse technology such as automated climate control and fertigation systems, as well as hydroponics. The system enables 'climate smart,' year-round production, mitigating the impact of climate change.

Source: CIC PLC. (2017). *CIC's Rs. 2 billion agri-investment to boost Sri Lanka's economy.* Retrieved from https://www.cic.lk/cics-rs-2-billion-agri-investment-to-boost-sri-lankas-economy/

Drone Technology

CIC PLC announced their latest innovation, the use of agriculture drones for 'smart agriculture practices' such as scanning fields and distributing agro chemicals and fertilizer with minimum human involvement and wastage. Hayleys Agriculture Holdings (HAH) with DJI Technologies carried out a series of field trials at pre-approved locations to assess the aerial spraying capabilities of DJI Agras MG-1 Agriculture Drone in challenging terrains and elevations. HAH intends to fine-tune this technology to local conditions and crop application requirements in collaboration with the DOA and relevant research institutions.

Source: Hayleys. (2016, December 12). Retrieved from https://www.hayleys.com/hayleys-agriculture-unveils-dji-agras-mg-1-agriculture-drone-in-sri-lanka/

Smart Weather Solution

Dialog Axiata PLC and Ideamart announced the launch of an aggregate weather solution, 'Weather Guru', in partnership with Earth Networks, the largest global hyper local weather network providing weather intelligence data to organisations and governments worldwide. Using real-time weather data, weather forecasts and alerts can be accessed in order to create personalised weather-related solutions through Dialog's advanced IoT platform.

Source: Sunday Observer. (2018, December 16). Dialog and ideamart introduce weather app. Retrieved from http://www.sundayobserver.lk/2018/12/16/business/dialog-and-ideamart-introduce-weather-app

[45] Department of Agriculture. (2016, June). *Sri Lanka e-agri strategy.* Retrieved from https://www.doa.gov.lk/ICC/images/publication/Sri_Lanka_e_agri_strategy_-June2016.pdf

Various private sector companies pioneering agriculture technology in Sri Lanka have initiated some advanced medium and high impact agricultural technological solutions, although latter are still at the preliminary stage (Box 12.1).

12.5 Way Forward

Today, farmers have access to smart technologies which make it easier to precisely measure inter and intra-field variations, and to adapt strategies and farming practices accordingly and selectively. Digitalisation of agriculture is occurring across a broad spectrum, from low impact solutions using mobile devices and platforms to provide management decision services, to medium and high impact smart digital farms. Smart farming not only optimises the production output and focuses on preservation of scarce resources, but it also addresses issues of population growth, climate change, labour scarcity and post-harvest losses that affect the whole value chain, from planting to harvesting and distribution.

Digital transformation is much essential for Sri Lanka's agriculture given its significant role in the economy as a contributor to GDP, employment, food, and income of people. Yet, the sector faces a growing number of challenges and constraints that include low productivity, poor product quality, climate change, etc. It is much clear that Sri Lanka is lagging behind in introducing 4IR technologies in agriculture in relation to ongoing developments in the field. However, it is also commendable that state sector institutes involved in the agriculture sector have stepped in to introduce low impact 4IR technologies and have already developed a vision to move towards medium and high impact 4IR technologies in future. Moving away from traditional and old-fashioned farming and towards high tech agriculture can be identified as a positive step in agricultural development in the country.

Sri Lanka is gradually entering into the flow of the 4IR. Currently, the country performs reasonably well in using mobile technology in farming. In the past, nobody may have assumed that Sri Lankan farmers would adapt to mobile phones for their farming operations as they have done swiftly. Today, many young-middle aged farmers tend to use mobile phones for agriculture marketing as well as weather alerts through short massages, voice mails and apps. Sri Lanka's large agri-business companies have already started popularising drones, sensors, satellite image techniques and nanotechnology for its farming operations. These developments are likely to motivate young farmers and technologies will begin to be embraced by them slowly, as demand grows.

Since Sri Lanka is still a developing country, more research and development (R&D) needs to be carried out to improve the use of modern technologies. Both the government and private sector involvement on R&D in technology should be strengthened by collaborating with more foreign institutions as well as with local universities. The country's marginal farmers may not be able to use these sophisticated technologies as yet. Hence agriculture companies need to implement these at the field level. Farmer participation in technology usage can also be strengthened through contract farming systems.

Smallholder farms are a crucial part of food systems and rural economies, and will play a major role in sustainable food systems in future as well. However, their lower resource endowments such as lack of capital and other resources, and poor access to markets and institutions – including extension services – may affect and put them at a disadvantage in reaping the benefits associated with 4IR in agriculture. Thus, the government will need to adopt a

different approach for such farmers in facilitating the technological transformation. Government support will be needed to reduce the costs of technology using different management and incentive schemes, such as shared platforms, financing schemes, and subsidised services, etc. Additionally, the ability to use digital technologies in agriculture depends not only on access to basic infrastructure connectivity, but also on the development of data collection and analysis services, as well as on the regulatory environment. Thus, necessary steps to create an enabling policy and regulatory environment are also important.

13. 4IR and Environmental Sustainability in Sri Lanka

13.1 Introduction

Raising hopes and rising fears are being expressed about the gradually unfolding fourth industrial revolution (4IR), the economic transformation ushered in by a bundle of new-generation technologies that are emerging and being adopted swiftly by suppliers and consumers alike, around the world. As in past episodes of revolutionary change that transformed the global economy, the 4IR also carries a sense of inevitability and inescapability; any economic actor, whether in developed or developing world, has to adapt for survival or be left behind.

An uncommon circumstance which the 4IR does not share with its forerunners, however, is that it unfolds at a time when the global community is compelled to embrace another revolutionary shift in technology, which aims at transforming the world into a green economy. Similar to the 4IR, the green economic revolution has also become an inevitable and inescapable reality. Ironically, the green economic revolution was rather urged as necessary by the consequences of the preceding three industrial revolutions that effectively made way for the 4IR. The earlier episodes have been instrumental in pushing humanity over planetary boundaries with dire consequences; these can only be reversed by adopting a green economic path towards sustainable development. Hence, one of the core development challenges that the present generation has to cope with at this historic moment is how the two streams of technologies – i.e. 4IR and green technologies – can be made complimentary to each other, so that a win-win situation can be generated.

The two revolutionary shifts of technology and economic transformation have invariably captured the attention of policymakers at global and national levels. However, their efforts do not appear to be closely coordinated especially in the developing world, Sri Lanka is no exception. On the one hand, policymakers who deal with the 4IR look towards science, technology, innovation, industry and export development policies – treat it mostly as a matter of transferring technology and capturing a share of the global information and communication technology (ICT) market. On the other hand, those who are involved with the green economy are mostly preoccupied with environment, agriculture, energy and disaster management policies, etc., and hence paying limited attention to opportunities made available by the global tech industry to assist their efforts. However, an understanding is seen to be developing gradually, on potential green-economic applications of 4IR technologies such as artificial intelligence (AI), big data and cloud computing. These technologies are making steady inroads into a stage of practical application in developed countries and emerging economies in Asia, a trend that is largely unnoticed by policymakers and practitioners alike in developing economies.

Despite the above, literature suggests that some level of knowledge on the potential use of smart phone-based mobile applications – an apt vehicle to carry 4IR technologies to the masses – to address sustainable development issues which has already dawned even in many least developing economies. To a certain extent, enthusiasm over the practical use of mobile-based applications can be observed in Sri Lanka too. Nevertheless, the potential of 4IR technologies to address growing challenges for environmental sustainability is relatively a less explored area in Sri Lanka. This chapter makes an attempt to fill this gap. It begins with a brief review of key linkages and potential areas of 4IR technology applications on the environment. This is followed by a summary of major environmental challenges faced by Sri Lanka. An assessment of priority areas of 4IR applications on the environment in Sri Lanka is discussed next, with relevant policy implications emanating from the review, which are set out in the final section.

13.2 Environment and 4IR: Key Linkages and Promising Areas of Green Technological Applications

The environmental sustainability dimension of 4IR has rarely been discussed in the Sri Lankan context. Hence, initially, this section focusses on understanding the basic conceptual and practical implications regarding the linkage between environment and the 4IR. It begins with an examination on broad conceptual strands that connects the environment to the 4IR.

13.2.1 Environment and the 4IR

The earth systems are under unprecedented stress as a result of the previous industrial revolutions led by technological breakthroughs associated with steam power (19th century), internal-combustion engine and electricity (20th century) and computers (from the 1970s onwards).[1] The environmental consequences of the past industrial revolutions include, among others, the growing threat of climate change, depletion of the ozone layer in the atmosphere, acceleration of land degradation, loss of global biodiversity and ecosystem services, depletion in stocks of economically harvested species (e.g. fisheries), unsafe levels of air and water pollution, and the ever rising burden of waste in land and oceans. Scientists have identified that four out of the earth's nine 'planetary boundaries': namely climate, biodiversity, land-system change, and biogeochemical cycles, have already been crossed as a result of previous industrial revolutions.[2]

Despite the mixed record of past industrial revolutions, there are growing expectations about the unique opportunities that the 4IR offers to address environmental issues, by redesigning ways to manage the global environment. The 4IR is based on a bundle of technologies that comprises of AI, robotics, internet of things (IoT),

[1] Cordes, F., & Stacey, N. (2017). *Is UK industry ready for the fourth industrial revolution?.* Boston, MA: The Boston Consulting Group.

[2] Stockholm University, Stockholm Resilience Centre. (2015). *Planetary boundaries – An update.* Retrieved from http://www.stockholmresilience.org/research/research-news/2015-01-15-planetary-boundaries---an-update.html.

The earth systems are under unprecedented stress as a result of the previous industrial revolutions led by technological breakthroughs associated with steam power (19th century), internal-combustion engine and electricity (20th century) and computers (from the 1970s onwards).

cloud computing, big data analytics, blockchain, quantum computing, autonomous vehicles and drones, nanotechnology and biotechnology, of which some developments are still at the experimental stage. The 4IR is unfolding in connection with innovative applications of these technologies, using novel customer-centric business models that are based on technology-enabled platforms. This process is disrupting existing industry structures, lowering barriers for individuals and businesses to invest and create wealth, and fundamentally altering the economic and business conditions with far reaching consequences.[3]

Unlike past episodes of industrial transformation, the 4IR has opened up novel opportunities to redesign linkages between the economy and the environment. The gains enabled by emerging technologies are many: increased efficiency of energy use; smart manufacturing facilities for reduction of waste and better use of physical resources; reduced ecological footprint of economic transactions through platform-based markets; and the opportunity for increased substitution of transportation with communication in business/economic transactions. These are only a few examples of how the 4IR can assist to reduce the accumulated burden of environmental stress that the world economy has undergone during the last few decades. The beneficial effects that the 4IR can bring in through such fundamental changes in the economy-environment nexus can be further augmented by enhanced capabilities of environmental management offered by 4IR technologies.

[3] Schwab, K. (2015). *The fourth industrial revolution.* Geneva, Switzerland: World Economic Forum.

Despite the mixed record of past industrial revolutions, there are growing expectations about the unique opportunities that the 4IR offers to address environmental issues, by redesigning ways to manage the global environment.

13.2.2 Technological Options Enabled by 4IR Innovations for Environmental Sustainability

An interconnected set of technological options enabled by 4IR technologies offers considerable promise to pave the way towards a green economy with many potential applications. These include: capability to develop and operate smart systems; system optimisation, real-time monitoring and management; robotics and autonomous systems; and prediction and early warning capability. Brief descriptions of these technological options/capabilities are given below.



Smart Systems: Smart systems are capable of performing self-adaptive intelligent actions by undertaking sensing, actuation, and controlling functions in a given operational process with a capacity to analyse a situation and make decisions, based on available data in a predictive or adaptive manner.[4] The 'smartness' of such systems can often be attributed to autonomous operation based on closed loop control, energy

[4] *Smart systems*. (n.d.). Retrieved from https://en.wikipedia.org/wiki/Smart_system

An interconnected set of technological options enabled by 4IR technologies offers considerable promise to pave the way towards a green economy with many potential applications.

efficiency, and networking capabilities in many cases. Smart systems are among the widely hailed innovations of the 4IR with numerous economy-wide applications. These can have clear beneficial effects on environmental sustainability through applications such as smart grids for generation /consumption of electricity, smart traffic control systems for urban mobility management, and smart manufacturing and recycling facilities.

Process Optimisation: This is closely connected with automation of systems. The capabilities developed by 4IR technologies offer the opportunity for minimising cost while maximising output and efficiency of processes involved in various systems. Such systems include manufacturing, energy, transportation, etc., through adjusting some specified parameters to optimum levels.[5] System components that are commonly used for optimisation are equipment, operating procedures and control loops. A few examples for processes that can be optimised to enhance environmental sustainability are energy management systems, traffic control systems, transport management systems, green buildings and industrial water usage systems.

Real-time Monitoring and Management: Another promising area where 4IR technologies can be applied for environmental management is real-time monitoring and management. Capabilities enabled by AI, big data and cloud computing in combination with technical advancements such as high-tech sensors, smart meters, drones and satellites provide an opportunity for real-time monitoring and management of the environment. Some of the areas where real-time monitoring and management can be used fruitfully are detection

[5] *Process optimisation.* (n.d.). Retrieved from https://en.wikipedia.org/wiki/Process_optimisation

of illegal fishing activities, tracking wildlife and illegal poaching and monitoring of; habitat losses and ecosystem damages, river quality, pollution levels and pollutant dispersal.

Robotics and Autonomous Systems: Autonomous systems assisted by a variety of 4IR technologies such as AI and robotics, provide for various environment-friendly applications. A few of the more well-known applications are autonomous vehicles such as driver-less cars, unmanned aerial vehicles ((UAVs), i.e. drones), deep sea autonomous vehicles, etc. Certain applications such as driver-less cars can provide sustainable transport solutions in combination with smart systems of transport infrastructure. Applications such as drones and deep sea vehicles can be effectively used to explore and monitor critical habitats such as wetlands and deep sea areas.

Prediction, Early Detection and Warning: Prediction, early detection and warning of hazards are some promising areas for 4IR tech applications to improve environmental sustainability. Technological innovations such as big data analytics, AI and cloud computing are some of the important technological tools that can be used to enhance model-based predictions, while real-time monitoring can assist early detection of hazards. Early warning systems require combining these capabilities with sophisticated communication systems. Some of the potential applications are extreme weather event modelling and prediction, climate modeling and long-term projections, disaster early warning and media-enabled disaster response, and pollution level forecasting and air quality alerts. A closely associated area is environmental risk analysis which involves applications such as rapid multi-source risk analysis, disaster risk mapping, impact analysis of risk mitigation and risk communication.

The above discussed are some important technological capabilities enabled by 4IR tech innovations that have the potential to be useful as applications in environmental management. These capabilities can be used beneficially in different areas of environmental management such as planning, analysis, observation and monitoring, protection, and impact mitigation and capacity building. Besides offering brand new technological options, these can also be used to enhance the effectiveness of technologies that have already found wider applications in environmental management, such as geographic information systems (GIS) and satellite monitoring systems.

13.3 Key Challenges for Environmental Sustainability in Sri Lanka

The use of technical capabilities enabled by 4IR innovations for green development should be determined according to the problems of environmental sustainability faced by a given country. This section presents a review of key environmental challenges currently experienced by Sri Lanka to understand the prospects of applying 4IR technologies for environmental management. It can be considered as a scoping exercise to identify priority areas where high-tech green applications are required the most. According to reviews, the growing threats of climate change and disaster risks, widespread land degradation, rising scarcity of water, degradation of biodiversity and ecosystems are the most critical.

The use of technical capabilities enabled by 4IR innovations for green development should be determined according to the problems of environmental sustainability faced by a given country.

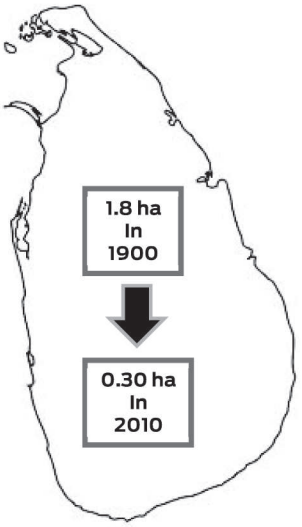
13.3.1 Climate Change and Disaster Risks

Sri Lanka is ranked second in the global climate vulnerability index published by the German Watch in 2018, highlighting the country's level of vulnerability to the global environmental threat. Both historical observations of climate data and future climate projections confirm that Sri Lanka's climate is undergoing significant changes. Observations from many weather stations around the country report that ambient air temperature is rising. Besides the warming trend, data also indicate that the normal pattern of rainfall is changing throughout the country. Even though no clear pattern has been identified on the direction of rainfall change as in the case of a warming trend, many researchers agree that the variability of rainfall has increased, and that the established pattern of spatial distribution of rainfall is changing. Moreover, there is growing evidence to suggest that the intensity and frequency of extreme events (e.g. heavy rainfall events and droughts) are also increasing. Such extreme events are frequently leading to hazardous events such as floods, landslides and droughts. Projections by the Department of Meteorology (DOM) in 2016 predict that an overall increase in annual rainfall is likely in the long-run (i.e. 2040-2060 and 2070-2090).[6] However, significant regional variations are also have been indicated. The highest level of increase in rainfall can be expected in the southwestern quarter of the country. In contrast, the northern and eastern areas will experience a decline in rainfall due to high negative anomalies in the north-east monsoon (NEM).

[6] Jayawardena, S., Darshika, T., & Herath, R. (2017). Observed climate trend, future climate change projections and possible impacts for Sri Lanka. *Neela Haritha: The Climate Change Magazine of Sri Lanka,* 2: 144-151.

13.3.2 Land Degradation

Land is a critical resource, since about one-third of Sri Lanka's population is dependent on agricultural livelihoods, with about 65 per cent of land area being utilised as agricultural land. Sri Lanka's population growth has lowered the per capita availability of land from 1.8 ha in 1900 to 0.30 ha in 2010.[7] The National Action Programme for Combatting Land Degradation in Sri Lanka 2015-2024 (NAP-LD) identifies that many land uses in the country are affected by land degradation. Among many forms of land degradation, soil erosion due to agricultural land uses, land degradation caused by mining, rising incidence of landslides, and coastal erosion can be considered as most critical.



SRI LANKA'S POPULATION GROWTH HAS LOWERED THE PER CAPITA AVAILABILITY OF LAND

Erosive agricultural land uses such as cultivation of tobacco, clean weeded tea, potato and vegetables in upcountry areas with intense rainfall and high slope terrain have been affected by serious off-site effects. Latter include rapid siltation and capacity reduction of downstream reservoirs,[8] drying up of streams and triggering flash floods. In addition, on-site effects include top soil loss, declining soil fertility and landslides.

Soil erosion has become an issue in low country dry zone areas also. This is due to the spread of commercial highland farming on encroached lands in catchments of irrigation reservoirs. Mining is another major cause of land degradation in Sri Lanka. The major types of mining activities include those carried out pertaining to gem, clay, sand and excavation of earth for construction and infrastructure. Degradation of lands due to all types of causes leads to rising risks of landslides. The National Building Research Organisation (NBRO) has identified a number of locations in Nuwara Eliya, Badulla, Kegalle, Ratnapura, Kalutara, Galle and Matara districts as landslide prone areas. Nearly all these lands are located in highland areas of wet and intermediate zones. Besides the rising incidence of extreme rainfall events, a variety of human-induced factors are also responsible for landslides. Coastal erosion due to both natural and man-made causes has serious impacts on shoreline retreat, intrusion of salt water into freshwater sources, loss of productive lands, and development of salinity in coastal lands. The land loss due to coastal erosion has been estimated at around 200,000-300,000 m^2 per year.[9] Certain areas in the coastal zone have been identified as erosion prone areas.

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[7] Ministry of Environment and Renewable Energy. (2014). *National action program (NAP) for combating land degradation in Sri Lanka*. Colombo, Sri Lanka: Ministry of Environment and Renewable Energy.

[8] Some estimates suggest that around 40 per cent capacity of Polgolla and 60 per cent of Rantambe reservoirs had been lost due to siltation by 1990s (Based on Natural Resources, Energy and Science Authority (NARESA) 1991).

[9] Coast Conservation Department. (2004). *Coastal zone management plan*. Colombo, Sri Lanka: Coast Conservation Department.

13.3.3 Rising Scarcity of Water

Sri Lanka is heavily dependent on rainfall for supply of water for agriculture, domestic, industrial and energy generation purposes. The groundwater potential in the country is limited.[10] Sri Lanka gets a relatively abundant supply of water from monsoon and inter-monsoon rains in a normal year, which is distributed over 103 river basins. Nevertheless, high inter-annual variation and uneven spatial distribution of rainfall lead to situations of scarcity of water, which has become much more frequent of late. Besides atmospheric and geological factors relating to water supply, human-induced factors – namely, destruction of critical watersheds and water pollution – intensify water scarcity situation across the country.

Two major concerns associated with watersheds in Sri Lanka are degradation of upper watersheds and destruction of reservoir catchments. The upper watersheds of major rivers are located in central highlands. As such, the vegetation cover in upper watersheds plays a critical role in ensuring availability of water in many parts of the country. Hence, the destruction of vegetation cover in upper watersheds poses a major threat that increases the scarcity of water supply. In the downstream lowland areas, the water supply depends heavily on a network of irrigation tanks. Rapid clearing of forests and vegetation of surrounding catchments for commercial highland agriculture has become a prime threat for sustaining water levels of these reservoirs. Commercial highland farming in tank catchments has also been identified as a major driver of deforestation in the country.[11]

13.3.4 Loss of Biodiversity and Degradation of Ecosystems

Sri Lanka has been listed among 35 'Biodiversity Hot Spots' in the world.[12] The rich endowment of biodiversity in the country covers a range of terrestrial and aquatic ecosystems with over 9,400 described species of fauna and flora, with a high level of endemism that exceeds over 20 per cent in certain categories of fauna and flora.[13] Despite the natural richness, however, biodiversity and ecosystems in Sri Lanka have been undergoing a rapid process of degradation due to anthropogenic and natural causes. The key challenges faced by country's biodiversity and ecosystems include: rapid deforestation and degradation of natural forest; destruction and degradation of critical habitats (e.g. wetlands); growing risk of extinction of species due to over exploitation; spread of invasive alien species (IAS); and, rising incidence of human-wild life conflict.

Among the major drivers which are currently responsible for deforestation are infrastructure development activities, encroachment for commercial highland farming and smallholding

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[10] Panabokke, C.R. (2008). *Groundwater conditions in Sri Lanka: A geomorphic perspective.* Colombo, Sri Lanka: National Science Foundation.

[11] Fernando, S., Senaratna, A., Pallewatta, N., Lokupitiya, E., Manawadu L., Imbulana, U., … Ranwala, S. (2015). *Assessment of key policies and measures to address the drivers of deforestation and forest degradation in Sri Lanka.* Final report of a consultancy awarded to the Colombo Science and Technology Cell, Faculty of Science, University of Colombo. Colombo, Sri Lanka: United Nations Development Programme for the Sri Lanka UN-REDD Programme.

[12] The term 'hot spot' implies that the biodiversity in the country has high level of endemism that has been affected by threatens.

[13] Weerakoon D. (2012). *A brief overview of the biodiversity of Sri Lanka, Sri Lanka red list.* Colombo, Sri Lanka: The International Union for Conservation of Nature (IUCN), Sri Lanka and Ministry of Environment and Renewable Energy.

tea, and rehabilitation and resettlement activities in the former conflict zone.[14] In addition, several scattered local drivers are responsible for degradation of forests, such as illegal harvesting of timber and non-wood forest products.

Besides deforestation, there are threatened habitats which offer numerous ecosystem services. A majority of wetland ecosystems in the country are currently under the threat of degradation due to human activities such as land reclamation, clearing of vegetation, garbage disposal and unplanned infrastructure development. Deforestation and degradation of critical ecosystems increase the risk for extinction of species. According to the National Biodiversity Strategic Action Plan 2016-2022 (NBSAP), there are 487 species which are critically endangered where another 196 species have possibly extinct already.[15] The risk of extinction of local species is further aggravated by competition from IAS. Gradually emerged as a threat to Sri Lanka's ecosystems, IAS pose a threat to both natural as well as agro-ecosystems by competing with and dominating over local species. The Ministry of Environment has identified a national list of IAS with 15 fauna species and 14 flora species, each having separate top 10 lists. Some of these species were deliberate introductions for known purposes (e.g. agriculture, animal husbandry, freshwater fish production, ornamental fish industry, mosquito control), while a few have entered through accidental introductions and negligence. Another threat for Sri Lanka's biodiversity is intensified human-wildlife conflict, arising as a result of expansion of agricultural and human settlements.

13.3.5 Pollution: Water, Air and Solid Waste

Another major environmental challenge faced by Sri Lanka is pollution. There are three major forms of pollution which are associated with water, air and garbage. Water pollution occurs due to pollutants from major sources of domestic wastewater, industrial effluents, fertilizers and agro-chemicals, and solid waste. Besides being a major environmental problem, water pollution also increases the scarcity of water by reducing the quantity available for agricultural, domestic and industrial purposes. In addition to pollution of freshwater in inland areas, marine pollution has become a serious issue in the Indian Ocean region surrounding Sri Lanka. Pollution of marine environments occurs due to land-based as well as ocean-based pollutants. Key sources of ocean-based pollution around Sri Lanka include oil/ chemical spills from transportation and accidents in the sea, disposal of non-degradable litter substances by vessels (e.g. plastics), periodic dry docking and servicing of vessels and ballast water discharges. Since the marine traffic in sea lanes around the country is growing fast, the problem of marine pollution can be expected to increase in future.

Air pollution holds dual threats of outdoor air pollution (OAP) and indoor air pollution (IAP). The major source of OAP is vehicle emissions, whereas the major cause of IAP is burning of firewood which is the main source of domestic fuel used by rural population. Major pollutants that are responsible for health issues in Sri Lanka are particulate matter (PM), ground level

[14] Fernando, S., Senaratna, A., Pallewatta, N., Lokupitiya, E., Manawadu L., Imbulana, U., … Ranwala, S. (2015). *Assessment of key policies and measures to address the drivers of deforestation and forest degradation in Sri Lanka.* Final report of a consultancy awarded to the Colombo Science and Technology Cell, Faculty of Science, University of Colombo. Colombo, Sri Lanka: United Nations Development Programme for the Sri Lanka UN-REDD Programme.

[15] Ministry of Mahaweli Development and Environment. (2016). *National biodiversity strategic action plan 2016-2022 (NBSAP).* Colombo, Sri Lanka: Ministry of Mahaweli Development and Environment.

ozone (O3), carbon monoxide (CO), sulphur oxides (SOx), nitrogen oxides (NOx), lead (Pb) environmental tobacco smoke (ETS), formaldehydes and polycyclic organic matter. According to assessment of the World Health Organisation (WHO), the number of deaths attributable to IAP is higher than those occur due to OAP in Sri Lanka.[16]

Solid waste is a significant issue in densely populated urban areas where buildup of garbage is in large quantities. Many local authorities have adopted open dumping as the usual method of disposal, giving rise environmental and sanitary hazards. The collapse of the Meethotamulla waste mound, claiming 32 lives in 2017, provides a prime example of public health, social and environmental hazards caused by the current unsatisfactory practices of waste management in the country. Of the total collection of municipal solid waste, 93 per cent is disposed through open dumping while the rest is being used for options such as composting, or sanitary/engineering landfills.[17] As a result of lack of proper solid waste management practices, garbage and wastewater often end up in streams, water bodies, urban wetlands and finally in the sea. According to the latest greenhouse gas (GHG) inventory being prepared for the Third National Communication, waste is a main source of GHG emissions, especially CH4 and N2O, in Sri Lanka.[18] Poor management of waste leads to haphazard entry of these GHGs to the atmosphere. Therefore, improving current waste management practices represents an important aspect of climate change mitigation in Sri Lanka.

13.4 4IR Technologies for Environmental Management in Sri Lanka: Prospects for Promising Applications

Balancing the impact of complex interactions between the economy and natural environment is the key to sustainable development. The 4IR technologies offer a unique opportunity to address environmental issues by redesigning ways to manage the global environment. This section explores the prospects for using tech capabilities that have been made available by 4IR technologies to address the key environmental challenges discussed above. Promising tech applications relating to following areas will be examined: clean energy, transportation and logistics, weather and disaster resilience, water management, biodiversity conservation and clean air.

13.4.1 Clean Energy

Sri Lanka has submitted nationally determined contributions (NDCs) to the Paris Climate Agreement in 2015. It aims to reduce GHG emissions from power generation, transportation and industrial sectors, whereas clean energy is the main solution for emissions for these. Fundamental approaches towards cleaning of the energy system are renewable energy and improvement of energy use efficiency. Both

[16] World Health Organisation. (2009). *Country profile of environmental burden of disease – Sri Lanka.* Geneva, Switzerland: World Health Organisation.

[17] Ilangasinghe, A. (2017). *Current waste management systems related to local authorities.* Paper presented at the National Forum on Solid Waste Management organised by the Coordinating Secretariat for Science, Technology and innovation (COSTI), 23-24 June 2017, Colombo, Sri Lanka.

[18] Based on observations participating in meetings on 'Third National Communication', at the Ministry of Mahaweli Development and Environment.

renewable energy and energy use efficiency are areas where tech applications have been widely explored. A number of 4IR technological options have been identified in relation to energy planning, renewable energy generation, transmission and distribution of power and end-use of energy.

Advanced modelling made possible by big data analytics and cloud computing has significantly improved energy planning and forecasting capabilities for energy managers. Optimised energy system forecasting is one such application. Energy planning ensures sustainable use of energy resources with minimum waste and increased efficiency. In renewable energy, virtual power plants enabled by 4IR technologies can improve efficiencies in energy generation. These integrate various energy sources through IoT and cloud-based platforms for more reliable power supply and decentralised energy storage networks. In transmission, sensor-based smart electric grids and intelligent grid management are helping utilities to monitor assets, model use and ensure efficient and cost-effective operations. Sensors, smart meters and occupant controls for efficiency and to control energy are becoming popular in distribution and consumption. Other 4IR technology applications involved in this context are blockchain-enabled asset and contract management, and demand forecasting and AI-powered modelling. Advanced batteries for energy storage and electric vehicles are another important area of clean energy applications which are assisted by high-tech applications.

The potential to apply 4IR technologies is relatively high in areas such as roof-top solar systems, smart meters and energy efficiency in buildings. These are gaining rapid momentum in Sri Lanka and also opportunities are available for applications such as smart grid management and decentralised energy storage networks in the national power supply system. Lack of information from reliable sources makes it difficult to assess the current level of development in tech applications in Sri Lanka's energy sector.

13.4.2 Transport and Logistics Management

Transport and logistics management is an area which offers significant opportunities for efficiency gains through technological applications. The efficiency gains can be achieved through a variety of ways such as integrating transport systems, real-time transport and traffic management, low-carbon mobility solutions for people to walk and bike freely, and cleaner vehicles. The 4IR technologies can provide opportunities to improve system efficiency through applications in areas such as transport and logistics planning, traffic forecasting, real-time traffic flow and pollution management, smart traffic and transport control, vehicle-to-infrastructure communication and optimisation, demand-response to charging infrastructure, and autonomous vehicles providing on-demand shared transport mobility. Among the key technological options that are being explored for developing tech capabilities in transport and logistics management are AI, sensors, IoT, advanced materials, drones and virtual reality (VR).

Transport and logistics can be one of the most promising areas that Sri Lanka can gain from applying 4IR technologies given the poor status of transport infrastructure and public transport services in the country. For instance, applications such as integrated transport systems, real-time traffic flow management and smart traffic control systems can produce not only efficiency gains in energy and low emissions, but improve overall standards of living of the urban as well as rural public by easing transportation and mobility.

13.4.3 Weather and Disaster Resilience

Another area for potential beneficial applications of tech capabilities is weather and disaster resilience. Climate change related weather extremes, and associated increases in disaster incidents, have made the public more and more vulnerable to such events. The 4IR tech innovations can lead to vast improvements in areas such as weather predication and forecasting, early warning and resilience planning. Enhanced computing power, big data analytics, cloud computing and advanced modelling techniques are helping to develop model-based weather predictions in combination with advanced real-time weather monitoring facilities. Some of the developments with wider applications are numerical weather forecasting, extreme weather event modelling and predications, and climate informatics and climate modelling.

Enhanced predication and monitoring capabilities lay the foundation for early warning systems for natural disasters, real-time communication of disaster information and media-enabled disaster responses. The resilience planning involves the use of capabilities in technological options such as GIS applications which have become more powerful with 4IR tech innovations. Some of the areas that are undergoing advancements are impact and risk mitigation analytics, real-time disaster risk mapping and real-time disaster response coordination.

The DOM is the sole agency involved in weather prediction and forecasting in Sri Lanka. The DOM has made progress in its predication capacity using modelling techniques such as numerical weather predication, to a certain extent. Certain efforts are being made to develop long-term climate projections using downscaling techniques, based on global circulation models (GCM) too. However, these improvements are at early stages of development and there is significant room for further improvement. Efforts are on its way to develop disaster risk management and risk and hazard mapping facilities, using information technology (IT) based systems. However, the level of application of 4IR tech innovations in such systems has not been systematically assessed.

13.4.4 Water Security

Overcoming water scarcity through prudent water management has become a critical need against the backdrop of growing climate change threats. The key areas involved here are water resource planning, management of water supply, increasing water use efficiency, and catchment management. Technological applications can witness improvements in all these areas. Opportunities for system level developments in water supply monitoring and management in urban water supply systems, residential water use monitoring and management, water quality management and optimisation of industrial water usage are some of these areas. Smart meters are an option to improve water use efficiency at households. Application of technology has also enabled subtle improvements in systems with significant benefits, such as detection of underground leaks in portable water supply systems. Drought planning is an important area of water management under conditions of scarcity; drought predications and drought impact assessments are two potential areas for such tech applications. Enhanced modelling capabilities means the accuracy of stream flow forecasting to assist in catchment management improves considerably.

Sri Lanka is a country with an extensive network of irrigation reservoirs with multiple uses such as irrigation, drinking water and energy generation. While the system's engineering designs and water management aspects have been well studied, the application of water resource planning, monitoring and efficiency improvements are still at a relatively underdeveloped stage. Modern tech applications for areas such as model-based water resource planning, water supply monitoring and management, drought prediction and stream-flow forecasting etc., can provide more efficient management of water resource in the country at all levels and for all purposes.

13.4.5 Biodiversity Conservation

A wide range of technology applications has been developed around the world to address the needs of sustainable management of biodiversity. These cover critical areas such as monitoring and protection of habitats, protecting species, restoration of ecosystems and control of IAS. Tech applications such as drones provide new avenues for monitoring of habitat losses and detection of illegal activities such as poaching, logging and illegal trade of wildlife that are harmful for biodiversity. Similar to drones, autonomous deep-sea vehicles facilitate exploring and monitoring of marine habitats. In addition, precision monitoring of ecosystems means more in-depth assessments of ecosystems and data collection are possible. Advanced ecosystem modelling approaches can be used to analyse and predict dynamic changes taking place in ecosystems, enabling better information for decisions on conservation of biodiversity.

Sri Lanka's use of advanced technological tools for biodiversity and ecosystems conservation is still at a relatively low level of development. The country has produced periodic forest cover inventories using satellite images. GIS applications are used for planning, and academic purposes more frequently. Other than in occasional academic studies, however, the use of advanced monitoring and modelling approaches for regular operations of biodiversity conservation appear to be limited. Nevertheless, a few online spatial data portals have been launched recently, with the National Forest Monitoring System and National Spatial Data Initiative being two important sources among them.

13.4.6 Clean Air

Degraded air quality contributes to deteriorating health and economic productivity, especially in urban areas. Some major issues to be addressed in pollution management are prevention, monitoring and controlling. Scientific facilities and skills are needed to handle these activities. Scientific approaches involve physical, chemical and biological methods, and application of these methods is usually an expensive and a time-consuming exercise. The 4IR technologies offer opportunities for advanced tech applications such as real-time air pollution monitoring, air pollutant source detection, pollution forecasting, pollution dispersal prediction and tracking, optimised sensor-based air purifying systems and air pollution alerts, all of which significantly enhance the capacity for pollution management.

Sri Lanka has very limited air quality monitoring facilities in a few urban areas. One of the major challenges is maintenance of these systems in the long-run in an effective manner. A key advantage of 4IR tech applications is that these support automated and smart systems which help to overcome certain operational and maintenance issues associated with such systems. The 4IR innovations in prevention, monitoring and control

of pollution can be integrated to deliver better environmental quality in city areas.

13.5 Conclusions and Policy Implications

For policy makers and environment managers, there is a window of opportunity made available by the advances of the 4IR technologies. This is to help their policies and management decisions to attain sustainable development objectives. Tech innovations unlocked by the 4IR can help optimise social and environmental outcomes of policy and management decisions, while addressing those impacts that are responsible for most critical environmental challenges. However, to attain these gains, substantive technical, policy and institutional arrangements have to be in place. Among the more critical interventions are: a sector development strategy for the 4IR; innovation units in relevant areas of environmental management; conducive policy and regulatory environment; innovative financing mechanisms; information platforms; and, skills and capacity development.

For policy makers and environment managers, there is a window of opportunity made available by the advances of the 4IR technologies. This is to help their policies and management decisions to attain sustainable development objectives.

Sector Development Strategies for the 4IR: A major issue faced in introducing 4IR tech capabilities to environmental management is lack of awareness or poor understanding amongst stakeholders about the tech opportunities available and their benefits. Therefore, a 'strategy document' need to be prepared on the prospects for application of 4IR technologies in environmental management. This should be carried out with the participation of relevant stakeholders under the guidance of experts on the technologies involved. Given that environmental management involves multiple sectors that have direct and indirect influences on the environment, it should be a multi-sector strategy. The identified

strategies in the said 'strategy document' need to be clear, tailored to fulfill national needs, and integrated with other relevant strategies, policies and plans, and have the support and acceptance of the private-sector and citizens at large.

Innovation Units in Relevant Areas of Environmental Management: Innovation units need to be established in different agencies dealing with environmental management, as well as other sectoral agencies with impacts on the environment. These units should focus on specific tech capabilities and applications that can be useful in specific areas of environmental management. These should be recruited with or hire the services of relevant technical experts and develop agency level strategies to gradually mainstream 4IR applications at the institutional level - as identified by the above 'strategy document', to pursue innovation and context-specific 4IR applications.

Innovation units need to be established in different agencies dealing with environmental management, as well as other sectoral agencies with impacts on the environment.

Policy and Regulatory Environment: The national and sectoral policymakers should ensure that necessary policies and investments that foster the deployment of 4IR-based tech capabilities are in place. These policies should enable scaling up of 4IR technologies, while creating a conducive environment and the necessary incentives for public agencies, private sector as well as citizens to adopt them. The government should introduce transparent, practical and feasible, adaptable and enforceable policies, regulations and standards.

Innovative Finance Mechanisms: Unlike other potential areas of application of 4IR technologies with commercial benefits, environmental management in Sri Lanka is dominated by public sector agencies that operate on a non-profit basis, with limited prospects for revenue

generation. Therefore, the government should invest in selected innovations and technologies. However, options to seek partnership with private sector companies and obtain the assistance of donor agencies should be available. The public sector agencies should pursue options which are consistent with their needs, and capable of being managed with limited financial, physical and human resources. The government needs to work with technology companies to ensure that relevant public agencies will develop necessary capacities.

Information Platforms: Online information platforms that are necessary to ensure collection, sharing and public availability of data should be established. The relevant public agencies should take the lead in setting up such platforms with collaboration of technical experts and private sector tech companies. These platforms should also provide for open and transparent forums to exchange expert, public, and academic views, and be equipped with capabilities to consult the views of relevant stakeholders whenever necessary.

Skills and Capacity Development: Necessary capacity development measures for implementing 4IR strategies within relevant agencies and amongst them, should be undertaken. Given that the 4IR tech applications are highly knowledge-driven products, developing necessary human resources capacity is the most important. The agencies can hire the support of external technical experts until their in-house capacities are developed. Furthermore, technical capacity of institutions in terms of necessary physical facilities also should be upgraded, given that existing ICT capacities within organisations may not be fully adequate to handle the needs of the new generation technologies.

POLICY BRIEFS

14. 4IR and Women in the Workforce: Sri Lanka's Apparel Industry

14.1 Introduction

There are different interpretations to the link between technological transformation, structural change and female employment. Men and women are at risk of job displacement owing to technological transformation; women in developing countries are particularly at risk of being impacted by technological transformation compared to men, due to being employed in low-skilled, low-wage sectors of employment that can be replaced by technology. Sectors such as the apparel industry can be particularly vulnerable as production processes undergo transformative changes in the future.

If managed effectively, fourth industrial revolution (4IR) can also present an opportunity for women to progress into better quality, higher paid employment as the future of work transitions to more specialised tasks using technology. However, transformational 4IR technology will lead to changing job profiles in the future, raising demand for different sets of skills and a more tech-savvy workforce across industries. This policy brief examines the prospects for women's employment in the apparel sector – where case studies suggest that there are both challenges and opportunities concerning women's employment. It re-emphasises the need to invest in women's education and training in technology and related fields to better equip women with the necessary skills, to leverage the 4IR for improved employment outcomes.

14.2 4IR Technologies and Apparel Sector Production Processes

The adoption of 4IR technology is likely to transform the apparel industry in the future, by changing its traditional production processes through the application of automation and robotics, and therefore is crucial for ensuring long-run competitiveness of the industry.

4IR, known as the transformative 21st century revolution in which digital technologies such as robotics, artificial intelligence (AI), 3D printing and genome editing are blurring the lines between the physical, digital and biological spheres, is currently reshaping the apparel industry like never before. 4IR involves smart manufacturing in which machinery powered by the internet is being used to automate the entire apparel production process.

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[1] See Chapter 8 of this report on "4IR: A Challenge or an Opportunity for Gender Equality?".

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The adoption of 4IR technology enables apparel manufacturers to cater to the rapidly evolving, demand driven global fashion market. The industry is shifting from a 'push' model, where customer demand was set by promotional campaigns of manufacturers and brands, to a 'pull' model where demand is being set by customers themselves. Today, customer demand is determined by exposure to fashion trends and customer insights through social media, while the industry has to respond rapidly to such instant changes in customer demand through shorter production cycles. The six-month long time to market a fashion cycle, which was previously considered to be fast, is now six weeks or shorter. The automation of the apparel production process through 4IR technologies is crucial in responding to such shorter turnaround cycles.[2] For instance, automated finishing technology cuts the finishing time of a pair of Levi's jeans made using manual processes from 20 minutes, to just 90 seconds.

Furthermore, the need to respond to such quick production cycles, combined with speed and efficiency gains delivered by application of 4IR technology such as robotics in the production process, is making a strong case for production 'nearshoring'. 'Off-shoring' apparel production to Asia, where labour costs are low, was traditionally considered to be a competitive production strategy. However, the need to respond more quickly to demand changes, coupled with rising labour costs in Asia, has made off-shoring less competitive. For instance, although the cost of producing a pair of denim jeans is lower in Bangladesh compared to Mexico, where wages are higher, introducing automation to the production process can equalise the cost advantage between the two countries.[3] In the

[2] McKinsey Apparel, Fashion & Luxury Group. (2018). *Is apparel manufacturing coming home? : Nearshoring, automation, and sustainability – Establishing a demand-focused apparel value chain.* Retrieved from https://www.mckinsey.com/~/media/mckinsey/industries/retail/our%20insights/is%20apparel%20manufacturing%20coming%20home/is-apparel-manufacturing-coming-home_vf.ashx

[3] *Ibid.*

planned Tianyuan factory in Little Rock, Arkansas, 'SewBots' – robots that are capable of sewing – are expected to produce t-shirts at USD 0.33 each, lower than the current cost of production in low cost countries.[4]

Thus, the traditional cost advantages of off-shoring production to Asia can be offset in the future by introducing automation to nearshore markets.[5] In this context, the potential for major apparel destination markets such as the US and European Union (EU) in adopting technology to automate the production process and produce more competitively in nearer markets in the long run, compared to the current practice of sourcing from off-shore markets, is gaining ground.

14.3 Impact of Work Reorganisation on Women in the Apparel Sector

Although 4IR technologies allow manufacturers to stay competitive by changing production processes to respond more quickly to demand changes, such changes in production processes can have important implications on labour employed in the apparel sector. This is particularly so on women, who make up the majority of apparel sector workforce in developing countries, including Sri Lanka.

The apparel industry is a major source of employment for women across the developing world, with women accounting for around 68

4IR technologies allow apparel manufacturers to stay competitive. However, such changes can have labour market implications.

[4] International Labour Organisation. (2019). *The future of work in textiles, clothing, leather and footwear.* Working paper No. 326. Retrieved from https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/publication/wcms_669355.pdf

[5] Donaldson, T. (2018). *Automation in apparel could make a strong cost-savings case for nearshoring by 2025, Mckinsey says.* Retrieved from https://sourcingjournal.com/topics/sourcing/automation-nearshoring-mckinsey-survey-123086/

per cent of the clothing industry workforce.[6] Moreover, routine occupations in the apparel industry that are at risk of being automated, are filled mostly by women. A majority of the clothing industry workforce is made up of young women with relatively low skills,[7] although the industry is recognised for providing the first step to formal employment for most women.[8] Moreover, women's role in apparel sector work is concentrated mostly in entry level low-skilled work.[9] A survey in Bangladesh highlights that four out of every five production line workers were female, while women's representation in higher skilled categories of work is limited, with women representing only one in 20 supervisors.[10]

The most promising automation technologies identified to have the biggest impact on apparel manufacturing, can lead to notable reductions in labour demand for women. Labour-intensive tasks such as sewing is identified to be an occupation with an exceptionally high risk of automation,[11] where up to 90 per cent of sewing of simple garments can be automated.[12] Estimates by the Indian apparel manufacturer Raymonds, highlight that one robot could replace up to 100 garment workers,[13] giving a foretaste of what technological advancements may mean for work displacement in these types of jobs.

Furthermore, female employment can also be affected by the possibility of apparel production moving to nearshore markets in the long run. The adoption of technology, such as automated cutting machines and SewBots in destination markets such as China, Europe and the US in the process of production nearshoring, if proven to be more economical than sourcing from off-shore garment producing countries in Asia, has the potential to displace routine jobs performed by low-skilled female workers in Asia.[14]

At the same time, the impact of 4IR technology in changing apparel production processes, if managed effectively, do also present an opportunity for women to progress towards better quality, higher paid employment in the future.

Technology can result in both job destruction and job creation, with technologies replacing certain tasks and not entire occupations. The 4IR is expected to benefit high-skilled workers

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6 International Labour Organisation. (2014). *Wages and working hours in the textiles, clothing, leather and footwear industries: Issues paper for discussion at the global dialogue forum on wages and working hours in the textiles, clothing, leather and footwear industries.* Retrieved from https://www.ilo.org/wcmsp5/groups/public/@ed_dialogue/@sector/documents/publication/wcms_300463.pdf

7 *Ibid.*

8 BSR. (2017). *Empowering female workers in the apparel Industry: Three areas for business action.* Retrieved from https://www.bsr.org/reports/BSR_Empowering_Female_Workers_in_the_Apparel_Industry.pdf

9 The Lab – Market Systems Development for Decent Work, International Labour Organisation. (2017). *From obligation to opportunity.A market systems analysis of working conditions in Asia's garment export industry.* Retrieved https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/documents/meetingdocument/wcms_579468.pdf

10 International Growth Centre. (2014). *Female empowerment in the Bangladeshi garment industry.* Retrieved https://www.theigc.org/blog/female-empowerment-in-the-bangladeshi-garment-industry/

11 Chang, Jae-Hee., & Phu, Huynh. (2016). *The future of jobs at risk of automation.* International Labour Organisation, Bureau for Employers' Activities Working Paper No. 9. Retrieved from https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---act_emp/documents/publication/wcms_579554.pdf

12 McKinsey Apparel, Fashion & Luxury Group. (2018). *Is apparel manufacturing coming home? : Nearshoring, automation, and sustainability – Establishing a demand-focused apparel value chain.* Retrieved from https://www.mckinsey.com/~/media/mckinsey/industries/retail/our%20insights/is%20apparel%20manufacturing%20coming%20home/is-apparel-manufacturing-coming-home_vf.ashx

13 ETCIO.com (2016). *Raymonds to replace 10,000 jobs with robots in next 3 years.* Retrieved from https://cio.economictimes.indiatimes.com/news/strategy-and-management/raymonds-to-replace-10000-jobs-with-robots-in-next-3-years/54359470

14 International Labour Organisation. (2016). *ASEAN in transformation. textiles, clothing and footwear: Refashioning the future.* Retrieved from https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---act_emp/documents/publication/wcms_579560.pdf

with a high degree of flexibility, creativity, and strong problem-solving and interpersonal skills, while low and medium skilled workers performing routine jobs are likely to be outcompeted by technology.[15] Moreover, technology will also lead to creating new tasks in the future, that require new skills.[16]

Similar trends may apply in the apparel sector. While certain tasks in the apparel process are likely to be automated, other tasks can evolve in the future.

Historically, the garment industry has remained a low-skilled, labour intensive industry, with a majority of the clothing industry workforce consisting of young women with relatively low skills. However, the adoption of 4IR technology in apparel production is changing the apparel industry (Box 14.1). Such transformative changes call for better skilled workers who can guide and operate technologically driven production processes.

Thus, contrary to the typical low-paying routine work performed by women in the apparel sector, these transformations have the possibility to offer better-quality occupations for apparel sector female workers in the future. Further, the technological transformation will also create new job opportunities for high-skilled workers, such as technicians, software developers and tech engineers,[17] which are needed for developing and maintaining automated production processes. However, capitalising on such opportunities will depend on the ability of women to transition into these new roles with the relevant skills.

14.4 4IR and Implications for Sri Lanka's Apparel Industry Workers

In absolute numbers, Sri Lanka's apparel industry provides direct and indirect employment of around 300,000 and 600,000, respectively.[18] Women account for around 78 per cent of the industry workforce,[19] while other estimates suggest that the share of women in the garment sector is as



[15] United Nations Department of Economic and Social Affairs. (2017). *The impact of the technological revolution on labour markets and income distribution.* Retrieved from https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/publication/2017_Aug_Frontier-Issues-1.pdf

[16] World Economic Forum. (2018). *The future of jobs report 2018.* Retrieved from http://www3.weforum.org/docs/WEF_Future_of_Jobs_2018.pdf

[17] The Brookings Institution. (2019). *Robots kill jobs. But they create jobs, too.* Retrieved from https://www.brookings.edu/blog/up-front/2019/03/18/robots-kill-jobs-but-they-create-jobs-too/

[18] Export Development Board. (2017). *Industry capability report: Sri Lankan apparel industry.* Retrieved from http://www.srilankabusiness.com/pdf/industry_capability_reports/apparel-new.pdf

[19] Asia Floor Wage Alliance. (2014). *National people's tribunals on living wage for garment workers in Asia.* Retrieved from https://asia.floorwage.org/resources/tribunal-verdicts/synthesis-report-of-all-the-national-peoples-tribunals

Box 14.1
The Use of 4IR Technologies in the Apparel Sector

The adoption of 4IR technology is transforming the apparel industry by introducing new ways in which garments are made and sold. For instance, new technology enables a move into mass customisation, where garments are customised in-store according to customer requirements, replacing the past industry practice of assembly line workers making garments according to fixed sizes. The US based apparel company 'Ministry of Supply' is working towards launching an in-store mass customisation experience, where a robotic machine using a heat gun will personalise sweaters for customers in a matter of minutes within stores. Moreover, the use of new technology to produce sew-free fabric and garments using adhesives, where glue is used instead of stitches to adorn garments, and the production of sustainable fabrics by producers such as Orange Fiber – the first brand to produce sustainable fabric using citrus juice byproducts – are examples of ways in which technology is reshaping the apparel industry.

Sri Lanka's apparel industry too is undergoing changes owing to technological innovation. Examples include the production of smart textiles by the Sri Lanka Institute of Nanotechnology (SLINTEC). These include the introduction of stimuli-responsive materials which are responsive to photo energy, electric energy and moisture; the introduction of stimuli responsive yarn that can reduce its length through an increase in surface temperature; and the development of an advanced coating system – an invention where a thin coating helps materials to manage moisture, warmth and odour.

Local producers have also started to invest in innovation. For instance, MAS Holdings has invested in innovative startups such as 'Thinx' that uses signature technology for producing washable period-proof underwear and 'Wearable X' that produces smart yoga pants that produce guided vibrations. Other examples include a USD 70 million investment of MAS Holdings in setting up the largest automated knitting plant in South Asia in its Thulhiriya fabric park, and Textprint Lanka – a fully owned operation of MAS Holdings that provides among its product offerings, the latest technology in high speed digital printing.

Sources: FastCompany. (2018). *Ministry of supply will tailor this sweater to your body while you wait*. Retrieved from https://www.fastcompany.com/90281007/ministry-of-supply-will-tailor-this-sweater-to-your-body-in-minutes; Orange Fiber. (2015). Orange fiber: *Sustainable fabrics from citrus juice by-products.* Retrieved from http://orangefiber.it/en/; MAS Twinery. (2019). *MAS twinery.* Retrieved from http://www.masholdings.com/innovation.html#innovation-overview; MAS Holdings. (2018). *Fabrics and accessories.* Retrieved from http://www.masholdings.com/fabrics-and-accessories.html#fabric-page-services

high as 87 per cent.[20] Female employment is seen to be concentrated mostly in routine categories of work; for instance, the highest proportion of female recruitments during 2015 to mid-2017, accounting for nearly a half of total female recruitments, has been in the category of 'sewing machine operators'.[21] Thus, despite the adoption of technologies being crucial for long-term business competitiveness, it can have significant impacts on female employment in Sri Lanka. as the apparel industry has a high concentration of female labour, particularly in routine categories of work that are prone to automation.

Technological upgrading can help alleviate labour shortages facing Sri Lanka's apparel industry. Changing career aspirations of young women in opting for computer-based jobs with higher social status and flexibility, competition from other sectors of work with higher wages and pleasant working conditions have been noted as some of the causes behind the labour shortage faced by the industry.[22] Not surprisingly, the occupational category of 'sewing machine operators' was reported to be the most difficult-to-fill occupation in the 'Labour Demand Survey of 2017' conducted by the Department of Census and Statistics (DCS).[23] Thus, changing job profiles of garment factory workers towards technology driven production processes in the future can be an opportunity for female garment workers who are looking to progress into better quality occupations and social status.

However, female workers employed in the apparel industry across Sri Lanka and Asia, are mostly from poor backgrounds with lower levels of education,[24] and might find it challenging to transition into different job roles in the future. Moreover, most educated women seem to be employed in other industries compared to the apparel sector (with the exception of agriculture sector workers),[25] whereas tasks carried out by women in the apparel sector is concentrated

New jobs in the apparel sector needed for developing and maintaining automated production processes, demand higher skill levels.

[20] Kelegama, S. (2009). Ready-made garment exports from Sri Lanka. *Journal of Contemporary Asia.*

[21] Department of Census and Statistics. (2017). *Sri Lanka labour demand survey 2017.* Retrieved from http://www.statistics.gov.lk/industry/Labour_Demand_Survey_2017_Report.pdf

[22] Madurawala, S. (2017). *The dwindling stitching hands: Labour shortages in the apparel industry in Sri Lanka.* Retrieved from http://www.ips.lk/talkingeconomics/2017/04/03/the-dwindling-stitching-hands-labour-shortages-in-the-apparel-industry-in-sri-lanka/

[23] Department of Census and Statistics. (2017). *Sri Lanka labour demand survey 2017.* Retrieved from http://www.statistics.gov.lk/industry/Labour_Demand_Survey_2017_Report.pdf

[24] Asia Floor Wage Alliance. (2014). *National people's tribunals on living wage for garment workers in Asia.* Retrieved from https://asia.floorwage.org/resources/tribunal-verdicts/synthesis-report-of-all-the-national-peoples-tribunals

[25] International Labour Organisation. (2014). *Wages and working hours in the textiles, clothing, leather and footwear industries: issues paper for discussion at the global dialogue forum on wages and working hours in the textiles, clothing, leather and footwear industries.* Retrieved https://www.ilo.org/wcmsp5/groups/public/@ed_dialogue/@sector/documents/publication/wcms_300463.pdf

mostly in entry level low-skilled work.[26] New jobs in the apparel sector, such as technicians, software developers and tech engineers who are needed for developing and maintaining automated production processes, demand higher skill levels. Thus, skills development is essential to prepare women for a smooth transition into the future of work.

14.5 Preparing for Change: Investing in Education and Training

As the future of work will require more analytical and problem-solving skills, transformational 4IR technology calls for a reskilling of the workforce.[27] Greater focus on science, technology, engineering and math (STEM) education is a requirement for new technologies and early exposure to computer science, entrepreneurship and interpersonal skills can help prepare the next generation of workers.[28] However, women are underrepresented in STEM education globally, with women accounting for 35 per cent of all students enrolled in STEM related fields of study in higher education.[29]

Similarly, in Sri Lanka, women's involvement in STEM related fields of study is limited compared to men at both secondary and tertiary levels of education, with gender gaps being wider for certain STEM related fields such as mathematics and engineering, compared to science and technology.[30] For instance, boys accounted for a share of 65 per cent of those following the mathematics stream in grade 12-13 advanced

Greater focus on science, technology, engineering and math (STEM) education is a requirement for new technologies.

Women are under-represented in STEM education globally.

[26] The Lab – Market Systems Development for Decent Work. International Labour Organisation. (2017). *From obligation to opportunity. A market systems analysis of working conditions in Asia's garment export industry.* Retrieved https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/documents/meetingdocument/wcms_579468.pdf

[27] World Economic Forum. (2018). *The future of jobs report 2018.* Retrieved from http://www3.weforum.org/docs/WEF_Future_of_Jobs_2018.pdf

[28] United Nations Department of Economic and Social Affairs. (2017). *The impact of the technological revolution on labour markets and income distribution.* Retrieved from https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/publication/2017_Aug_Frontier-Issues-1.pdf

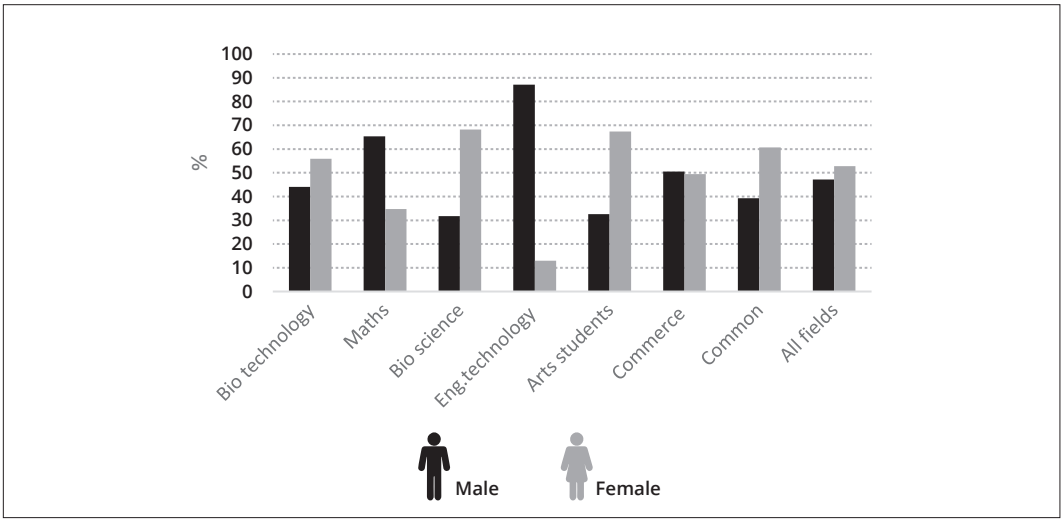
[29] United Nations Educational, Scientific and Cultural Organisation. (2017). *Cracking the code: Girls' and women's education in science, technology, engineering and mathematics (STEM).* Retrieved from https://en.unesco.org/sites/default/files/unesco-gc39-stem-event-concept-note-en.pdf

[30] See Chapter 6 of this report on "The Future of Sri Lanka's Education in the 4IR".

level classes in national schools, compared to 35 per cent of girls in the same cohort (Figure 14.1). Meanwhile, females accounted for only around 24 per cent of those enrolled in engineering courses in higher education institutions, while the share of males is over 75 per cent (Figure 14.2). Nevertheless, it is encouraging to observe a narrower gender gap in science and IT fields, indicating that women are already somewhat represented in certain areas of STEM education.

systems are gender-biased, with a gender segregation observed in course selection. Similarly, women's involvement in TVET in Sri Lanka, although marking an upward trend over time, remains below that of males as seen in Table 1.1, and is limited to a few subjects such as ICT, personal and community development and textile and garments (T&G). On the contrary, men's TVET involvement is broader, and range across several areas including light engineering,

Figure 14.1
Students in National Schools 2017, Advanced Level Grades 12-13, by Stream, by Gender



Source: Ministry of Education. (2017). *Data management portal.* Retrieved from https://dmb.moe.gov.lk/edu-stat-2017

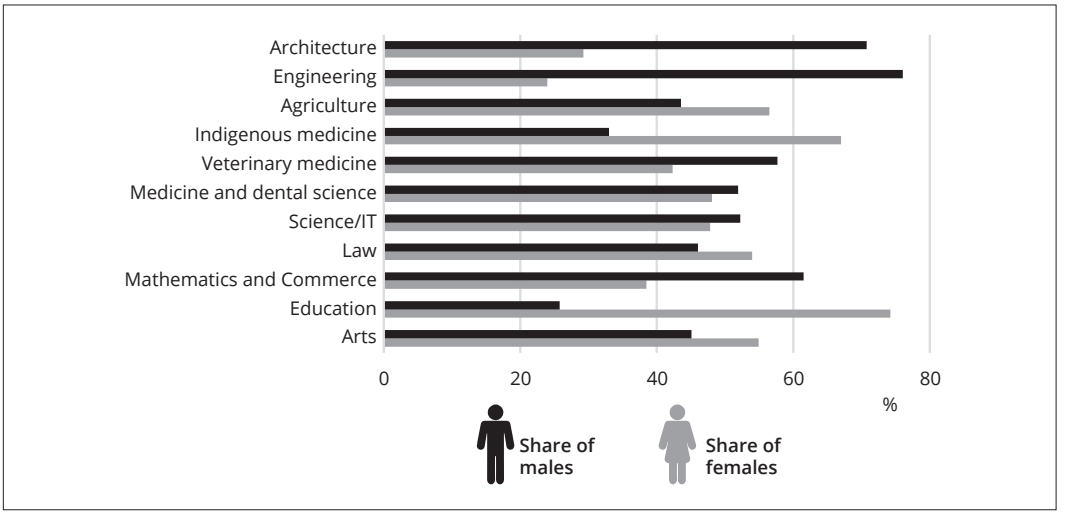
To cater to STEM related skills such as analytical and problem-solving, efforts to improve and broaden women's skills across areas of technical and vocational education and training (TVET) is also important. While estimates highlight that women account for around 44 per cent of worldwide TVET students,[31] globally, TVET

electronics and telecommunication.[32] Efforts should be taken to assess the capability of TVET courses in catering to future needs, while identifying ways of filling gender gaps in TVET. For instance, improving the range of TVET courses offered in rural TVET centers can expand women's choice in TVET, as female course

[31] UNESCO-UNEVOC International Centre. (2016). *Promoting learning for the world of work: TVET for gender equality.* Retrieved from https://unevoc.unesco.org/go.php?q=TVET%20for%20gender%20equality

[32] Asian Development Bank. (2018). T*racer study: Sri Lanka public training institutions in 2016.* Retrieved from https://www.adb.org/sites/default/files/publication/479096/sri-lanka-public-training-institutions-2016.pdf

Figure 14.2
Postgraduate Student Enrolment of Higher Educational Institutions, by Academic Programme, 2017



Source: University Grants Commission. (2019). *Sri Lanka university statistics 2017.* Retrieved from http://www.ugc ac.lk/en/component/content/article/2029-sri-lanka-university-statistics-2017.html

selection is restricted due to limited availability of TVET courses in rural areas and preference of women to enroll in TVET centres nearest to them.[33]

Collaboration between the government and businesses to facilitate training opportunities can also help bridge relevant skills gaps. Examples include the joint effort of Brandix Lanka Ltd, and Vocational Training Authority to introduce a national vocational qualification (NVQ) level 5 equivalent qualification for garment technicians.[34] Investing early in improving women's access to skills that will be demanded the most in the future in line with technological developments, will be crucial in securing the place of women in the future of work.

Table 14.1
Percentage of NVQ Certificate Holders

Year	Male	Female
2012	67.8	32.2
2013	64.5	35.5
2014	59.3	40.7
2015	62.5	37.5
2016	61.6	38.4
2017	0.3	39.7

Source: Compiled based on Tertiary and Vocational Education Commission. (2017). *National skills development report 2016/2017.*

[33] *Ibid.*

[34] Brandix Lanka Ltd. (2018). *VTA signs ground-breaking MoU with Brandix for skills development in Sri Lanka's apparel sector.* Retrieved from http://brandix.com/news?year=2018

15. 4IR and Intellectual Property Rights

15.1 Introduction

The fourth industrial revolution (4IR) is identified as the technological revolution represented by the internet of things (IoT), big data and artificial intelligence (AI), amongst others.[1] It is based on a 'digital revolution' where development in technological spheres combines human abilities in an unprecedented way using self-learning algorithms, autonomously operated cars, big data analytics etc.[2]

Successive industrial revolutions have resulted in human and technological progress, alongside the development of comprehensive legal systems, inclusive of intellectual property (IP) protection.[3] In the international arena, IP started to develop with the enactment of the Trade Related Intellectual Property Rights (TRIPs) Agreement of the World Trade Organisation (WTO) in 1995. This far-reaching international instrument on intellectual property rights (IPRs) establishes universal standards for patents, copyrights, trademarks, industrial designs, geographical indications, trade secrets and lay-out designs of integrated circuits. Member countries are obliged to ensure that their laws meet the minimum standards laid down in the TRIPs agreement. However, it also allows member countries to determine appropriate methods to implement provisions of the TRIPs Agreement within their respective legal systems and practices.[4]

In the 4IR, unlike in the three preceding revolutions, technology and innovation can play a greater role in wealth creation and to sustain socio-political stability. A strong IPR protection regime is critical in this endeavour, allowing innovators a share of benefits of their creative activities, to further encourage innovation and creativity. However, some concerns persist with regards to IPR protection in the 4IR. Presently, the IPR provides protection for physical objects, devices, structures, physical outputs, physical systems, physical connections, etc. With the implementation of the 4IR, the focus of protection expands into intangible items such as methodologies, data ownership, configuration of virtual systems, processing algorithms, brand recognition, etc.[5] Thus, current IP regimes may

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1 World Intellectual Property Organisation. (2019). *Technology trends 2019 - Artificial intelligence*. Geneva, Switzerland: World Intellectual Property Organisation.

2 Schäfer, M. (2018). *The fourth industrial revolution:* How the EU can lead it, European view. *17*(1), :5– 12. Brussels, Belgium: Marten Center for European Studies.

3 Tamimi, A. (2018). *Innovation & IP at the core of the 4th industrial revolution.* Retreived from https://www.tamimi.com/law-update-articles/innovation-ip-at-the-core-of-the-4th-industrial-revolution/

4 World Trade Organisation. (n.d.). *The TRIPs agreement.* Retrieved from https://www.wto.org/english/tratop_e/trips_e/intel2_e.htm

5 Soares, M.N. (2018). *Intellectual property law in the fourth industrial revolution: Trade secrets risks and opportunities.* Retrieved from https://www.cigionline.org/sites/default/.../intellectual_property_rights_program_0.pdf

In the 4IR, unlike in the three preceding revolutions, technology and innovation can play a greater role in wealth creation and to sustain socio-political stability. A strong IPR protection regime is critical in this endeavour, allowing innovators a share of benefits of their creative activities, to further encourage innovation and creativity.

be unable to provide protection for technology and innovation as encompassed in the 4IR. This policy brief examines some of these issues, focusing on the Sri Lankan context.

15.2 IPR Systems and the 4IR: Opportunities and Challenges

The 41R carries a combination of several factors such as software applications which provide direct links to customers, sensors. Latter allow AI to analyse various aspects, networks which help to enhance communication, memory units to store information, online purchasing and marketing, etc.[6] With these, connections between humans and machines change; machines can make decisions in various areas with very little human intervention. This means that innovation and creativity are moving from traditional engineering technologies to automated computerised methods. According to the European Patent Office (EPO) data on AI application, the top industries are transportation (15 per cent), telecommunications (15 per cent) and life and medical sciences (12 per cent).[7] Growing industries in the 4IR are identified as transportation, agriculture, and computing with annual growth rates of at least 30 per cent between 2013 and 2016.[8]

The TRIPs agreement encourages technological innovation for many reasons. A well-built IP system stimulates innovation by attracting investments, rewarding inventors, encouraging inventors to develop their ideas and ensure that their newly

[6] Schäfer, M. (2018). *The fourth industrial revolution*: How the EU can lead it, European view. *17*(1): 5– 12. Brussels, Belgium: Marten Center for European Studies.

[7] World Intellectual Property Organisation. (2019). *Technology trends 2019 - Artificial intelligence.* Geneva, Switzerland: World Intellectual Property Organisation.

[8] *Ibid.*

Innovation and creativity are moving from traditional engineering technologies to automated computerised methods.

acquired knowledge is protected. Moreover, strong IPR protection can encourage technology transfer through increased trade, foreign direct investment (FDI), technology licensing and joint ventures. Therefore, as specified under Article 7 of the TRIPs Agreement, a key objective is to promote technological innovation and transfer and dissemination of technology through IPRs.

Further, patents, copyrights, trademarks and trade secrets can be used to protect innovation. Patents play a pivotal role as it provides an exclusive right to an inventor. Furthermore, to obtain a patent, the inventor needs to disclose the patented invention to the public. This allows others to use and develop the technology further. Therefore, the patent system is created to balance the interests of both the inventors and general public.[9]

A well-built IP system stimulates innovation by attracting investments, rewarding inventors, encouraging inventors to develop their ideas and ensure that their newly acquired knowledge is protected.

[9] Daily FT. (2017, April 26). *Role of IPRs in stimulating inventions.* Retrieved from http://www.ft.lk/article/611400/Role-of-IPRs-in-stimulating-innovations

Copyrights are also important to protect creative artistic work, and in the present digital era a substantial number of software are released on copyright licenses. Article 10 of the TRIPs Agreement on 'Computer Programmes and Compilations of Data' specifies that computer programmes could be protected as literacy work under copyrights. However, copyrights only protect both the idea of the innovation and not implementation in source codes of software. Patent licenses protect both the idea itself and implementation source codes of software. Trademarks and trade secrets can help protect innovations related to marketing.

Article 66 of the TRIPs Agreement focuses on technology transfer from developed countries to least developed countries. It states that "developed country members shall provide incentives to enterprises and institutions in their territories for the purpose of promoting and encouraging technology transfer to least developed country members in order to enable them to create a sound and viable technological base."

In the 4IR, most inventions relate to the IoT which consists of smart objects and operate autonomously with AI and big data. There are increasing numbers of inventions that use software to combine technologies of information processing and networking which can be used across diverse technological platforms. Thus, 4IR technologies pose challenges to many existing IP protection systems, technology transfer and commercialisation strategies.

Patenting of computer implemented inventions remains a challenge. In 4IR, a higher percentage of innovations are based on software and data. Providing protection for intangible assets like software is not easy. It is made difficult also because different elements of software are likely to be developed by different people, in different regions of the world. As such, identifying ownership is more challenging under these existing IP systems. Copyrights do not provide protection for codes and/or the functional behaviour (algorithm) of the software. Thus, it could be easily reproduced using the codes and functions. However, some countries have bypassed this hurdle through their IP regime by allowing patenting of software. Nevertheless, in most countries, software programmes are excluded from patenting.[10]

In the 4IR, big data plays a major role. Big data means not only the data, but also 'data-analysis techniques' and 'business models'. However, there is no proper mechanism to gain ownership of data. Some countries have developed strategies to protect data using IPRs. For instance, the European Union (EU) has introduced 'sui generis' data protection systems to protect substantial parts of databases. Some of the strategies adopted by different countries in the world in terms of protecting AI, big data and IoT are set out in Box 15.1.

[10] Seuba, X., Geiger, C., & Penin, J. (2018). (Eds.). *Intellectual property and digital trade in the age of artificial intelligence and big data.* Strasbourg, France: International Center for Trade and Sustainable Development, Switzerland and Center for International Intellectual Property Studies.

Box 15.1
International Best Practices in Protecting AI, Big Data and IoT

European Union (EU)

At the EPO, the growth of 4IR patent applications has increased rapidly in recent years, by an increase of 54 per cent in the last three years (WIPO, 2019).[11] The highest 4IR patent applications have been submitted from the Samsung Group, LG Group, Sony Corporation, Nokia Corporation Huawei Technologies, etc. Notably, most applicants are located in South Korea, China, Japan, Europe and the US. Further, most of these applications represent the manufacture of computer, electronic, optical products, electrical equipment, and transport equipment.

A major step in the EU's response to the 4IR is the development of a strategy similar to the US' Artificial Intelligence Strategy (US Government 2016). EPO has issued new guidelines for the patentability of AI and machine learning (ML) inventions.[12]

The EU has also adopted a 'sui generis' system to protect databases. The EPO has also invested heavily on recruiting appropriate patent examiners to address the multidisciplinary nature of the 4IR. The EU also recently implemented the General Data Protection Regulation (GDPR).

Japan

In protecting big data, Japan has established guidelines to deal with the authorisation of data utilisation. It has also identified ways to ensure appropriate protection of data and rules of contract based on the actual state of data utilisation and contracts on data between companies.

Moreover, Japan protects data under the Unfair Competition Prevention Act of 2015. In addition, it has implemented a few strategies such as improving the environment in which patents can be steadily obtained and utilised, checking the examination guidelines on software-related inventions, collecting the use cases of patented business-related inventions, utilising newly created patent classification for IoT-related inventions, establishing cross-sectoral examination groups to respond to initiatives on new technologies to IoT technology, etc.

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[11] World Intellectual Property Organisation. (2019). *Technology trends 2019 - Artificial intelligence.* Geneva, Switzerland: World Intellectual Property Organisation.

[12] The National Law Review. (n.d.). *Key strategies obtaining patents under EPO's-new AI guidelines.* Retrieved from https://www.natlawreview.com/article/key-strategies-obtaining-patents-under-epo-s-new-ai-guidelines

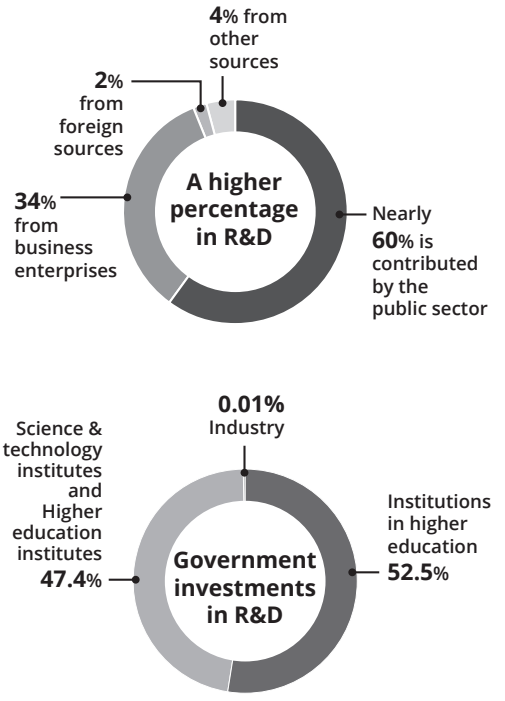
United Arab Emirates (UAE)	India
In 2017, the UAE formed the UAE Fourth Industrial Revolution Council (FIRC). It is responsible for the UAE's strategy to adopt new technologies and develop the digital and knowledge-based economy in the country. The main goals of the Council are segregated into education, health and medical industry, economic security, and urban planning and defense sectors. The FIRC emphasises the need to establish a national environment that encourages the development of new technologies and incubates the innovative efforts and initiatives of the younger generation in the UAE. It also highlights the importance of IP value of innovations and the development of an advanced patent protection regime to secure the rights to such innovations. The FIRC will consider and evaluate the existing laws in the UAE as it relates to attracting talent, stimulating research and development (R&D), protection, commercialisation and deployment of IP and innovation, and to understand as to what refinements may be required. This could include education and talent placement policies, tax incentives for R&D, infrastructure policies, regulatory licensing, competition and consumer protection legislation, commercial and insolvency legislation, labour laws, public procurement rules, technology transfer and IP legislation.[13]	While India has taken initiatives to strengthen its IP regime, challenges still remain, especially in respect of applying stringent and narrowly focused patent laws to AI applications – given the unique nature of AI solution development. The importance of data to development of useful models is one such example. To tackle these issues, the establishment of IP facilitation centres help to bridge the gap between practitioners and AI developers, and adequate training of IP granting authorities, judiciary and tribunals is proposed to the government. India has also set up a joint task force, with the Ministry of Corporate Affairs and Department of Industrial Policy and Promotion (DIPP). One of the main objectives is to examine and effect appropriate modifications to the IP regulatory regime pertaining to AI.

[13] The National Institution for Transforming India. (2018). *National strategy for artificial intelligence.* Retrieved from https://niti.gov.in/writereaddata/files/document_publication/NationalStrategy-for-AI-Discussion-Paper.pdf

15.3 Where Does Sri Lanka Stand?

According to the global innovation index (GII) 2018, Sri Lanka ranks at a relatively weak 90th position out of 126 countries.[14] Several factors affect a country's generation of innovations. Amongst them, the most important are the level of R&D initiatives in place, the stock of human capital and strategies of commercialisation of new knowledge. An effective IPR system stimulates almost all these factors and creates an environment which provides incentives for innovations. For example, strong IPRs systems can overcome the issue of private investments in R&D by facilitating effective protection for investors. It also encourages engagement of people in innovations by providing credibility for inventors and promoting commercialisation of innovations.

The expenditure on R&D is one of the main indicators to identify a country's support for innovation. In Sri Lanka, gross expenditure on R&D (GERD) as a percentage of GDP was 0.11 per cent in 2015.[15] A higher percentage in R&D (nearly 60 per cent) is contributed by the public sector, 34 per cent from business enterprises, 2 per cent from foreign sources and 4 per cent from other sources. In most developing countries, the government sector provides for a higher percentage of country's total investments. When markets fail as a result of the difficulty in assuring profits for investors, public investment is essential in R&D. In Sri Lanka, 99.9 per cent of government investments in R&D are made towards institutions in higher education (52.5 per cent) and science and technology (47.4 per cent), and a mere 0.01 per cent to the industry (Figure 15.1).



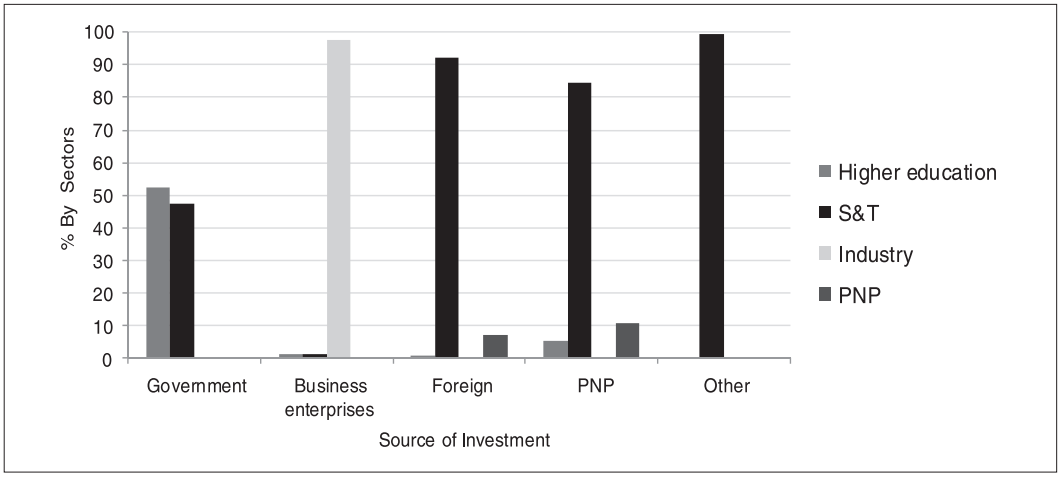
As shown in Figure 15.2, the number of innovations developed by the business enterprise sector is greater than those of other two sectors, namely higher education and government. Remarkably, the higher education sector has not engaged in any commercialisation activities, and is minimal in the government sector, according to the latest data available. This highlights the fact that Sri Lanka is not only lagging behind in the number of innovations, but also in the transferring and commercialisation of innovations. Until recently,

[14] GII is an annual ranking of countries by their capacity for, and success in innovation, published by the World Economic Forum.

[15] National Science Foundation. (2015). *Sri Lanka Science, Technology and Innovation Handbook.* Colombo, Sri Lanka: National Science Foundation.

Sri Lankan universities and government research institutes mainly focused on teaching and reported very low levels of R&D. This may be the main reason for the limited numbers in innovation developed in universities and government research institutes.

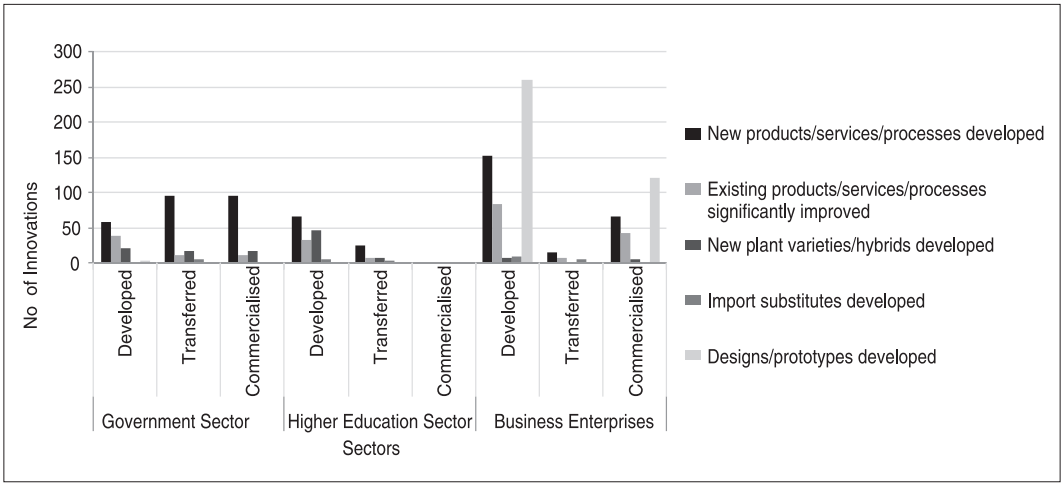
Figure 15.1
National Gross Investment on R&D in Different Sectors in 2015



Source: National Science Foundation. (2015). *Sri Lanka Science, Technology and Innovation Handbook.* Colombo, Sri Lanka: National Science Foundation.

Note: * PNP denotes private nonprofit agencies.

Figure 15.2
Number of Innovations Developed, Transferred and Commercialised in 2015



Source: National Science Foundation. (2015). *Sri Lanka Science, Technology and Innovation Handbook.* Colombo, Sri Lanka: National Science Foundation.

The number of patents registered in a country is another indicator to measure the level of innovation and development in technology. Since 2011, there is an upward trend in patent registration in Sri Lanka, in the case of both residents and non-residents. The highest number of patents is recorded in chemical production, drugs, cosmetics, process technologies, etc (Table 15.1).

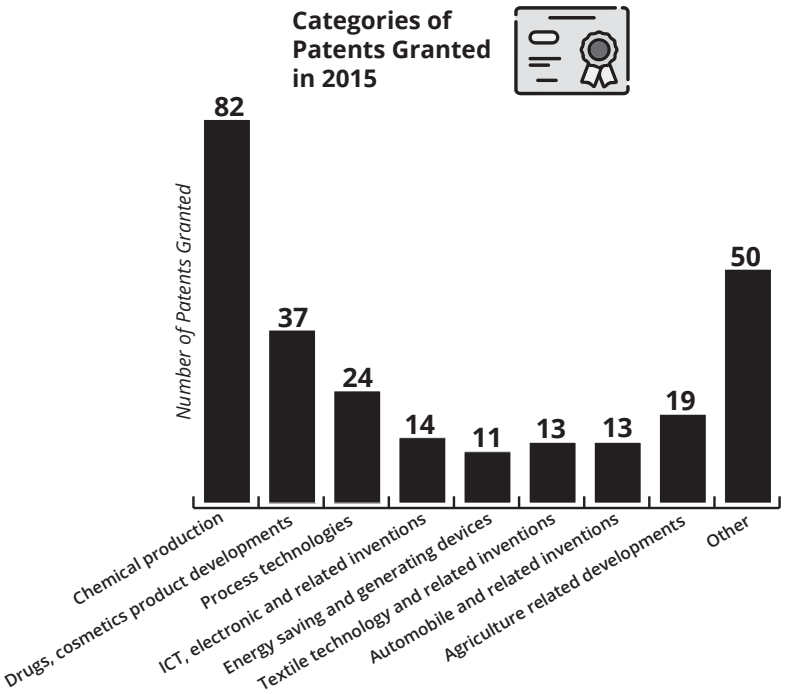


Table 15.1
Categories of Patents Granted from 2013-2015

Patent Categories	2013	2014	2015
Chemical production and related findings	73	78	82
Drugs, cosmetics and other related product developments	30	26	37
Process technologies	38	35	24
ICT, electronic and related inventions	16	20	14
Energy saving and generating devices	16	16	11
Textile technology and related inventions	04	12	13
Automobile and related inventions	08	12	13
Agriculture related developments	12	12	19
Other	39	51	50

Source: National Science Foundation. (2015). *Sri Lanka Science,Technology and Innovation Handbook.* Colombo, Sri Lanka: National Science Foundation.

Table 15.2
Methods Used by Industries to Protect IPs

Method	2010	2014	2015
Patents	23.3	8.0	9.0
Trademarks	74.1	85.0	71.0
Copyrights	20.6	28.1	21.0
Trade secret	67.2	70.0	17.0
Complexity of design	31.2	30.3	9.0
Other	1.1	0.0	0.0

Source: National Science Foundation. (2015). *Sri Lanka Science,Technology and Innovation Handbook.* Colombo, Sri Lanka: National Science Foundation.

With the implementation of the TRIPs Agreement in 2003, Sri Lanka too provides IPR protection. Several methods are used to safeguard innovations, while the protection method depends on the type of invention. Table 15.2 indicates trademarks and trade secrets are the most popular IP protection methods in Sri Lanka.

Some of the well known 4IR technologies featured in Sri Lanka include several interconnected digital technologies, smart agriculture, smart classrooms, smart technologies, etc. However, some other technologies such as IoTs, robotics, aero science, etc., are still relatively new. To reap the benefits of the 4IR, government and industries need to take several initiatives as a whole.

15.4 Way Forward

Sri Lanka is positioned at the middle of the 4IR. To gain its benefits, the government has to play a major role as a catalyst in fostering innovation, supporting partnerships for technology transfer and commercialisation, and providing access to infrastructure, etc. To drive the wave of innovation, Sri Lanka must have a robust IP system in place too.

To drive the wave of innovation, Sri Lanka must have a robust IP system in place.

To effectively use IPRs as means of stimulating innovation, Sri Lanka should explore alternatives such as integrating with regional patenting organisations, sharing information and fostering conducive relationships with other national patenting offices, as a solution to sharing the high cost of patenting. Simultaneously, it is important to create public awareness of IPR services. Especially in patenting, insights on how patents can support and encourage inventors by providing recognition and rewards, and also how to convert inventors' knowledge into tradable assets are valuable.

Furthermore, international best practices suggest that merely being a signatory to TRIPs agreement is insufficient; the most important step is national enforcement. Effective enforcement of the existing IPR policy and also effective management of IP is also crucial. It is also important to provide IPR policy management for research institutes, universities and other higher education facilities, especially in the areas of commercialisation, research collaboration, and ownership of innovation. Modernising the existing IPR regime to address issues arising from new technology applications from the IoT, AIs and big data is needed. These include means to patent software, protect new plant varieties, strategies or guidelines to protect big data etc. Such efforts should be complemented by capacity building in the form of technically sound IP examiners (especially in patents and trademarks) to explore IP applications based on IoT and AI.

16. Privacy and Data Protection in the 4IR

16.1 Introduction

Each day, a vast amount of information is transmitted, stored, and collected across the globe, enabled by the rise of computing and communication power. Technologies and innovation have increased the need for privacy regulation, whilst requiring existing privacy regulations to adapt to these new advancements. The emergence of cloud computing, the internet of things (IoT), 5G networks and big data analytics present new challenges to the field of data protection and privacy.

In Sri Lanka, online social, economic and financial activities have been facilitated largely through mobile phone uptake and greater internet connectivity. As more economic and social activity moves online, the urgent need for data protection and privacy regulation has been recognised. This policy brief examines the growing need for privacy and data protection legislation, approaches to privacy legislation and the potential concerns that need to be considered when drafting privacy legislation.

16.2 A Growing Need for Privacy in the 4IR

In a rapidly digitising world, the need for comprehensive data protection regulation has become an urgent issue. Data protection is placed high on political agendas globally; In 2015, the United Nations (UN) appointed a special rapporteur on the right to privacy,[1] the European Union (EU) ratified its new privacy legislation in 2016, data protection is now included in many trade agreements, whilst data protection is also a key concern in several high profile court cases in relation to national surveillance issues.[2] Some key technologies that necessitate these adaptations are cloud computing, IoT, big data analytics and 5G networks.

Cloud computing which entails the renting of computing capacity from vendors has seen a tremendous growth, and is poised to grow even more in the future. In 2018, over 80 per cent of server shipments were to cloud service providers,

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[1] United Nations Human Rights. (2015). *Special rapporteur on the right to privacy.* Retrieved from http://www.ohchr.org/EN/Issues/Privacy/SR/Pages/SRPrivacyIndex.aspx

[2] United Nations Conference on Trade and Development. (2016). *Data protection regulations and international data flows.* Retrieved from https://unctad.org/en/PublicationsLibrary/dtlstict2016d1_en.pdf

and over 80 per cent of computer storage capacity was deployed in the cloud.[3] Privacy concerns around cloud computing include misuse of data and leakage. Moreover, cloud services present challenges to data protection in relation to cross-border data transfers and surveillance, where cloud services provided by private sector firms have become a mechanism for accessing personal data by national security agencies.[4]

Internet of things (IoT)is a term used to describe the devices that are connected to the internet which send and receive data.[5] The IoT include health and fitness monitors, home security devices, connected cars and other household appliances that are connected to the internet. This is a rapidly developing area across the world with between 20-50 billion connected devices by 2020,[6] with a forecasted economic impact of between USD 3.9 and USD 11.1 trillion per year by 2025.[7] This is also an area where data protection laws have struggled to keep up.

Big data analytics (BDA) is another area that bring up a host of privacy issues. BDA is typically carried out on large data sets to reveal patterns, trends and associations.[8] This is a rapidly growing area in the digitalising world with significant implications for the future of marketing, forecasting and research. For instance, core revenue streams for Alphabet (Google's parent company) – one of the world's top five companies by market capitalisation – come from data analytics and targeting of advertising following such analytics. The rapid rise of data centric services (e.g. the use of Uber for mobility) have also led to the proliferation and growth in data being used for analysis. This vast amount of data, much of it personally identifiable, lends itself to misuse, provides organisations with the ability to not only drive consumer behaviour, but also serves as a basis for discrimination and a target for malicious actors.[9] The analysis of such large sets aimed at understanding and influencing consumer behaviour for commercial purposes requires a legislative framework to protect the interests of people and inhibit exploitation.

As 5G networks take hold, and as adoption of mobile devices grows, there will be an increased volume of data being transmitted. By definition, usage of the 5G network requires certain personal data including identity, position and private content. Many networks use this information to tailor their service to different clients and needs.[10] New standards and technologies must be developed to ensure that data privacy can be maintained and can cope with the vast amount of

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3 Elumalai, A., Starikova, I., & Tandon, S. (2016). *IT as a service from build to consume.* McKinsey & Company. Retrieved from https://www.mckinsey.com/industries/high-tech/our-insights/it-as-a-service-from-build-to-consume

4 United Nations Conference on Trade and Development. (2016). *Data protection regulations and international data flows.* Retrieved from https://unctad.org/en/PublicationsLibrary/dtlstict2016d1_en.pdf

5 *Ibid.*

6 McKinsey & Company. (2015). *The internet of things: Mapping the value beyond the hype*. Retrieved from http://www.mckinsey.com/business-functions/business-technology/our-insights/the-internet-of-things-the-value-ofdigitizing-the-physical-world

7 Woodside Capital Partners. (2015). *The internet of things:"Smart" products demand a smart strategy using M&A for a competitive edge.* Retrieved from http://www.woodsidecap.com/wp-content/uploads/2015/03/WCPIOT- M_and_A-STUDY-2015-3.pdf

8 United Nations Conference on Trade and Development. (2016). *Data protection regulations and international data flows.* Retrieved from https://unctad.org/en/PublicationsLibrary/dtlstict2016d1_en.pdf

9 Federal Trade Commission. (2014). *Big data a tool for inclusion for exclusion?* Retrieved from https://www.ftc.gov/system/files/documents/public_events/313371/bigdata-workshopslides-9_15_14.pdf

10 Huawei. (2015). *5G security forward thinking Huawei white paper.* Retrieved from https://www.huawei.com/minisite/5g/img/5G_Security_Whitepaper_en.pdf

By definition, usage of the 5G network requires certain personal data including identity, position and private content. Many networks use this information to tailor their service to different clients and needs.

data that 5G connectivity will produce, including better identity management, authentication mechanisms, and policies on acceptable data usage.

The growing threat of cybercrime reinforces the need for adequate data protection and data privacy measures. In 2018 alone, cyberattacks, including those on systemically important industries like financial services have increased fivefold,[11] and new estimates put the estimated global costs of cyberattacks at USD 8 trillion over the next five years.[12] A large proportion of cyberattacks result in unauthorised access to sensitive data, including that of personal nature, in turn creating data privacy concerns. Some estimates suggest that several billion datasets are breached every year, with some attacks and data losses taking months to detect.[13]



Global costs of cyberattacks at USD 8 trillion over the next five years

[11] Murgia, M., & Megaw,N. (2019). *Cyber-attacks on financial services sector rise fivefold in 2018.* Retrieved from https://www.ft.com/content/6a2d9d76-3692-11e9-bd3a-8b2a211d90d5

[12] The World Economic Forum. (2018). *The global risks report 2018.* Retrieved from http://www3.weforum.org/docs/WEF_GRR18_Report.pdf

[13] McKinsey & Company. (2018). *Digital and risk a new posture cyberrisk in a networked world.* Retrieved from https://www.mckinsey.com/de/~/media/mckinsey/locations/europe%20and%20middle%20east/deutschland/publikationen/2018%20compendium/a%20new%20posture%20for%20cybersecurity%20in%20a%20networked%20world/kompendium_03_cyberrisk-2.ashx

16.3 Implications of Insufficient Data Protection and Privacy

Data misuse and leakage, especially that of a materially nonpublic nature or publicly identifiable nature can have severe consequences for all parties involved. The implications of data misuse and leakage can range from financial loss, increased fraud, as well as influences on driving national policy. This section will look at some consequences of data misuses.



Data, typically linked to financial institutions and records, have been a target for malicious actors and once such data has been exposed, led directly to an increase in fraud. One notable case is that of Equifax, a major credit rating agency. Large quantities of data on US and EU residents, which included all identifiable data (e.g. addresses and social security numbers) and financial data (e.g. credit card numbers) were exposed by Equifax. This data was then used to perpetrate fraud through malicious actors opening credit accounts in the individual's names,[14] and through selling of credit card details on the 'dark web'. The cost to Equifax itself is estimated at over USD 400 million.[15]

Another growing concern is the impact of data breaches on national elections. As part of the most recent US elections and the UK's Brexit vote, a large amount of data was harvested without the consent of data subjects, to be used illegally for profiling and campaign targeting purposes. The firm behind the big data analytics, Cambridge Analytica, is alleged to have leveraged data on almost 80 million individuals from their Facebook profiles to psychologically profile and tailor campaign communication.[16] This practice is not only illegal in several jurisdictions, but is deemed responsible for the outcomes of many of these polls.

Data leakage and lack of data privacy has implications not only for the subjects in the data, but also for the companies handling the data. Loss of data has led to loss of key intellectual property (IP), and the loss of competitive advantages. One estimate puts the likelihood for

[14] Hsu, T. (2017). *Data breach victims talk of initial terror, then vigilance.* Retrieved from https://www.nytimes.com/2017/09/09/business/equifax-data-breach-identity-theft-victims.html

[15] McCrank, J., & Finkle, J. (2018). *Equifax breach could be most costly in corporate history.* Retrieved from https://www.pymnts.com/news/security-and-risk/2018/equifax-cost-275m/

[16] The Guardian. (2018). *Revealed: The ties that bound vote leave's data firm to controversial Cambridge Analytica.* Retrieved from https://www.theguardian.com/uk-news/2018/mar/24/aggregateiq-data-firm-link-raises-leave-group-questions

One estimate puts the likelihood for financial damage from loss of IP worth USD 150 million to be almost USD 3.2 billion, most of it in the form of future lost earnings.

financial damage from loss of IP worth USD 150 million to be almost USD 3.2 billion, most of it in the form of future lost earnings.[17]

Data privacy failures can also have implications for the most sensitive of data. A notable example is the loss of key state secrets around communication surveillance programmes executed by the intelligence services of the 'five eyes' nations.[18] Another example is the alleged loss of protected design information for the US' newest jet fighter, allowing rivals to leverage the technologies in their own designs.[19] Both of these leaks have led to these countries having to actively shift defense strategies.

In view of such developments, data privacy management is vital. Data protection laws date back to the 1970s, reflecting concerns about the advent of computer and communication technologies, with their ability to process remotely large volumes of data.[20] The principles around such legislation include having a legitimate reason for any processing activity, obtained either through consent or other justification, designed to acknowledge competing private and public interests. Privacy regulation is designed to protect against deliberate acts of misuse as well as accidental loss of or destruction of data.

With the rise in usage and generation of data, legislation governing its use has not necessarily kept up. Given this, a number of countries/ regions are in the process of updating regulation regarding data privacy. The EU has been at the

[17] Mossburg, E., Fancher, J.F., & Gelinne, J. (2016). *The hidden costs of an IP breach.* Retrieved from https://www2.deloitte.com/content/dam/insights/us/articles/loss-of-intellectual-property-ip-breach/DR19_TheHiddenCostsOfAnIPBreach.pdf

[18] Gellman, B. (2013). *Edward Snowden, after months of NSA revelations, says his mission's accomplished.* Retrieved from https://www.washingtonpost.com/world/national-security/edward-snowden-after-months-of-nsa-revelations-says-his-missions-accomplished/2013/12/23/49fc36de-6c1c-11e3-a523-fe73f0ff6b8d_story.html

[19] Japan Times. (2015). *China stole F-35 blueprints from Lockheed, Snowden data appears to show.* Retrieved from https://www.japantimes.co.jp/news/2015/01/19/national/china-stole-f-35-blueprints-lockheed-snowden-data-appears-show/

[20] United Nations Conference on Trade and Development. (2016). *Data protection regulations and international data flows.* Retrieved from https://unctad.org/en/PublicationsLibrary/dtlstict2016d1_en.pdf

forefront of data protection and privacy regulation with the new general data protection regulation (GDPR) ratified in 2016, and in force from 2018 (Box 16.1). [21] [22]

Box 16.1
GDPR – The EUs New Data Privacy Legislation

The General Data Protection Regulation (GDPR) is one of the most advanced data protection legislation in force. The legislation aligns existing data protection protocols, while increasing the levels of protection for individuals. The legislation takes the form of several key principles, with a distinction made for sensitive personal data.

The several key principles are:

1. Lawfulness – Data should only be processed when there is a lawful basis for this processing.
2. Fairness – The data processor should provide data subjects (who the data is about) with information on and means to exercise their rights.
3. Transparency – Consent and the rationale behind data collection and processing should be clear to data subjects (and not as part of legal terms and conditions).
4. Minimalism – Only necessary data should be collected and processed, and this data can only be used for the specific, explicit purpose.
5. Accuracy – Data must be maintained to be up to date and accurate.
6. Storage – Data should be kept in a format that does not permit personal identification any longer than is necessary.
7. Security – Data should be protected from tampering, unlawful processing, accidental loss, damage and destruction.

There are significant penalties for non-compliance to GDPR, including those that are scaled by revenue of the data controller, ensuring that data privacy is not an afterthought but a core business decision.

GDPR fundamentally alters how data should be managed and data controllers and processors are provided with a two-year window, following ratification, to ensure compliance with the legislation. Although most data entities are now compliant, there were a number of significant barriers to achieving compliance.

Source: United Nations Human Rights. (2015). *Special rapporteur on the right to privacy.* Retrieved from http://www.ohchr.org/EN/Issues/Privacy/SR/Pages/SRPrivacyIndex.aspx

[21] Publications Office of the European Union. (2016). *Regulations.* Retrieved from https://publications.europa.eu/en/publication-detail/-/publication/3e485e15-11bd-11e6-ba9a-01aa75ed71a1/language-en

[22] Mayers, C. (2018). *Three major GDPR obstacles facing British businesses.* Retrieved from https://www.citrix.com/blogs/2017/09/06/three-major-gdpr-obstacles-facing-british-businesses/

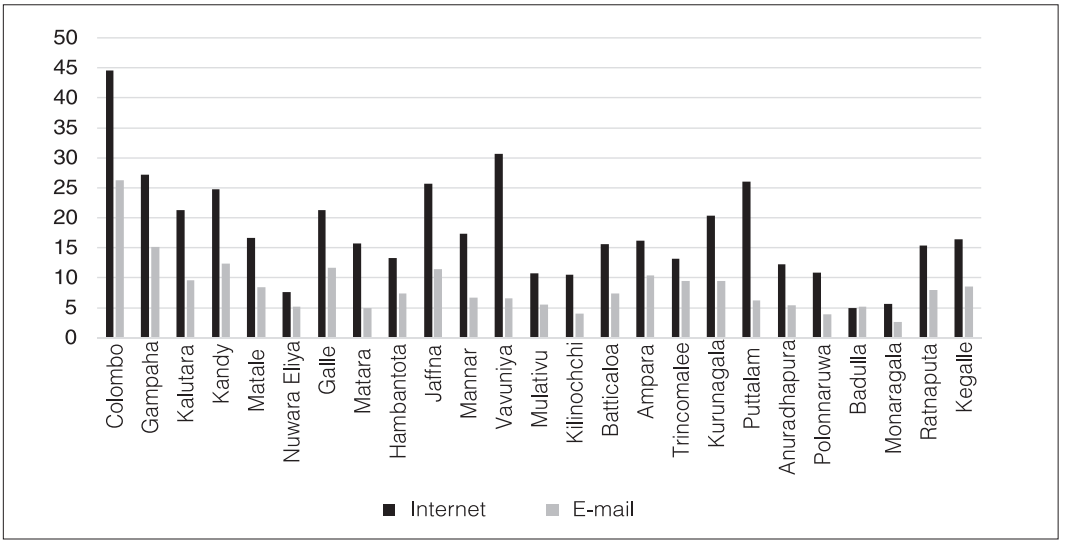
16.4 Why Data Protection is Necessary for Sri Lanka

Data protection is increasingly becoming more relevant to Sri Lanka with the rapid rise in digitalisation and digital connectivity. By early 2017, Sri Lanka had more active mobile phone subscriptions than people, with 124 subscriptions per 100 persons. As of 2017, over 75 per cent of the 6.2 million internet users in Sri Lanka were estimated to access the internet through smart phone devices.[23] This continued rise in digitalisation generates more and more data, and heightens the requirement for data protection and privacy laws.

A breakdown of internet and email use by district for 2017 is shown in Figure 16.1. The highest usage of both email and internet is from the Colombo district, while the lowest in terms of email usage is in the Moneragala district with 2.6 per cent, and the lowest internet usage is reported from the Badulla district at 4.9 per cent.[24]

Figure 16.2 shows the rise in both fixed and mobile broadband subscriptions in Sri Lanka from 1996 to 2018. There were 5,733,062 mobile broadband subscriptions and 1,530,099 fixed broadband subscriptions in 2018.[25]

Figure 16.1
Percentage Distribution of Internet and Email Usage of Household Population Aged Between 5-69, 2017



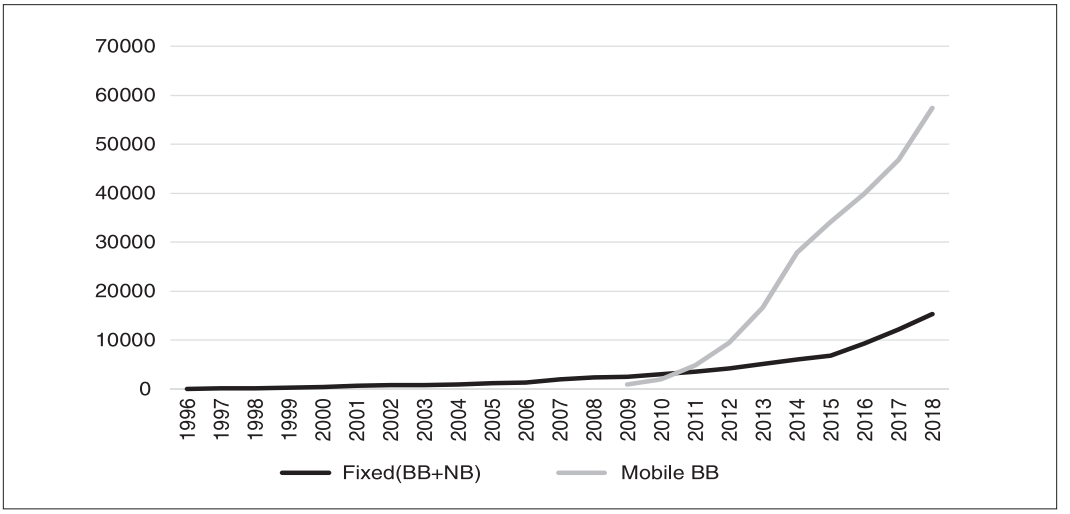
Source: Telecommunications Regulatory Commission of Sri Lanka. (2018). *Statistics, quarter 2018*. Retrieved from http://www.trc.gov.lk/2014-05-13-03-56-46/statistics.html

[23] Gunawardene, N. (2017). *Digital transformation in Sri Lanka.* Retrieved from http://www.rticommission.lk/web/images/pdf/DigitalTransformationinSriLankareport-FINAL-30Nov2017.pdf

[24] Department of Census and Statistics. (2017). *Computer literacy statistics 2017.* Retrieved from http://www.statistics.gov.lk/education/ComputerLiteracy/ComputerLiteracy-2017Q1-Q2-final.pdf

[25] Telecommunications Regulatory Commission of Sri Lanka. (2018). *Statistics, quarter 2018*. Retrieved from http://www.trc.gov.lk/2014-05-13-03-56-46/statistics.html

Figure 16.2
Fixed Broadband, Narrowband and Mobile Subscriptions in Sri Lanka, 1996-2018



Source: Telecommunications Regulatory Commission of Sri Lanka. (2018). *Statistics, quarter 2018.* Retrieved from http://www.trc.gov.lk/2014-05-13-03-56-46/statistics.html

Within Sri Lanka, there is also an increasing reliance on digital and cloud services, all of which collect data. For example, transportation applications such as Uber and PickMe both collect data for offline analysis. In addition, there is an increased usage of social media platforms and cloud communication platforms for email and calendar management (e.g. Google mail and Calendar). These systems, being the primary means of communication, collect large amounts of data daily and then target advertisements based on these collected data.

Furthermore, the use of Virtual Private Networks (VPN) also brings in privacy concerns. In certain cases, applications providing this VPN service for free, sell consumer internet activity data to advertisement targeting agencies. Given the fact that VPNs can capture all data that are being transmitted or received by a device, the amount of information captured can be very detailed (e.g. unencrypted messaging services, location, contact information, app usage) and this information can easily be personally identifiable in nature.

As Sri Lanka is set to enable 5G transmission in 2020, the need for comprehensive privacy legislation is heightened. A large amount of data sent over current mobile networks is not encrypted or if it is, with leverages outdated and easily by-passable encryption methods and are therefore susceptible to interception.[26]

The need for cyber security and data protection becomes increasingly urgent with the onset of e-government services in Sri Lanka. The risk of fraud and identity theft increase along with a heightened risk for cyberattacks. The government is in the process of digitising many services and

[26] Gendrullis, T., Novotny, Martin., & Rupp, Andy. (n.d.). *A real-world attack breaking A5/1 within hours.* Retrieved from https://eprint.iacr.org/2008/147.pdf

Given the fact that VPNs can capture all data that are being transmitted or received by a device, the amount of information captured can be very detailed (e.g. unencrypted messaging services, location, contact information, app usage) and this information can easily be personally identifiable in nature.

have already digitised some services including online visa forms, electronic customs processes and the acceptance of e-signatures in 2017. [27]

Sri Lanka's e-commerce industry is projected to reach USD 400 million by 2020.[28] As businesses venture on to digital platforms, it is vital for sufficient privacy laws to be in force to secure data as well as to improve business and consumer confidence. Insufficient data protection can create negative market effects by reducing consumer confidence where consumers are unlikely to disclose personal information including financial information.[29]

In addition, information and communication technology (ICT) related services including software has become one of the key service sector exports of Sri Lanka. These service exports include automated application testing, infrastructure outsourcing, high end research and development (R&D), enterprise resource planning (ERP), cloud technology and mobile applications.[30] While some of the exports will be subject to compliance with foreign privacy legislation such as the GDPR, national data protection will further reduce the threat of loss of IP.

Additionally, foreign investors will also be concerned about any gaps in data protection laws in the country and a comprehensive yet internationally compatible privacy laws could

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[27] Ceylon Chamber of Commerce, Verité Research. (2017). *Accepting e-documents with e-signatures: A small step for the govt., a giant leap for the country.* Retrieved from http://www.ft.lk/article/620947/Accepting-e-documents-with-e-signatures--A-small-step-for-the-Govt---a-giant-leap-for-the-country

[28] Daily News. (2018). *SL e-commerce to hit US$ 400 mn by 2022.* Retrieved from http://www.dailynews.lk/2018/09/07/business/161894/sl-e-commerce-hit-us-400-mn-2022

[29] United Nations Human Rights. (2015). *Special rapporteur on the right to privacy.* Retrieved from http://www.ohchr.org/EN/Issues/Privacy/SR/Pages/SRPrivacyIndex.aspx

[30] Sri Lanka Export Development Board. (n.d.). *ICT services overview.* Retrieved from http://www.srilankabusiness.com/export-services/ict/

help attract foreign direct investment (FDI) to the nation.[31]

16.5 Data Privacy Legislation in Sri Lanka

Although there is legislation around electronic transactions, consumer protection and cybercrime, no specific laws are currently in place for privacy and data protection in Sri Lanka.[32] According to the mapping of data protection and privacy conducted by the United Nations Conference on Trade and Development (UNCTAD) in 2019, out of 107 countries mapped, 21 per cent have no legislation around privacy and data protection of which Sri Lanka falls under. More than 58 per cent have legislation in place, while 10 per cent of countries mapped have draft legislation.[33]

In 2019, out of 107 countries mapped, 21 per cent have no legislation around privacy and data protection of which Sri Lanka falls under.

A 'Data Protection Bill' for Sri Lanka is currently being drafted with an expert committee set in place by the Ministry of Digital Infrastructure and Information Technology. The Bill is being drafted with the aim of covering the fundamental principles of privacy and data protection modelled after legislation in place by similar countries.[34]

The Computer Crimes Act of 2007 covers legislation for the identification of computer crimes and the investigation of such crimes. The law criminalises attempts at unauthorised access to a computer, computer programme, as well as data or information stored in computer

[31] The Morning. (2019). *Data protection bill draft in two months.* Retrieved from http://www.themorning.lk/biz-pg-1-2-data-protection-bill-draft-in-two-months/

[32] United Nations Conference on Trade and Development. (2019). *Data protection and privacy legislation worldwide.* Retrieved from https://unctad.org/en/Pages/DTL/STI_and_ICTs/ICT4D-Legislation/eCom-Data-Protection-Laws.aspx

[33] *Ibid.*

[34] The Morning. (2019). *Data protection bill draft in two months.* Retrieved from http://www.themorning.lk/biz-pg-1-2-data-protection-bill-draft-in-two-months/

systems. It also contains a provision to deal with the unauthorised use of computers regardless of whether the offender had authority to access the computer.[35] Although this addresses data privacy to some extent, it is not considered to be a sufficient framework for data protection.

The amendment to the Electronic Transaction Act in 2017, harmonises Sri Lanka's electronic transaction legislation with the UN Electronic Communications Convention (ECC), which is the international standard for e-commerce legislation.[36] Although the existing Electronic Transaction Act and the Computer Crimes Act facilitate e-commerce, they do not provide for sufficient privacy and data protection.

16.6 Potential Concerns

Although data protection and privacy are vital in an increasingly digitising and information society, there are some concerns around it, and debates on how best to structure it. These factors have to be kept in mind when drafting legislation around data protection.

One key concern is that it may unduly restrict business activities by increasing the administrative burden on businesses in order to comply with multiple stringent data regulation policies.[37] This is a concern, especially in relation to small and medium enterprise (SME) businesses, and may even act as a barrier to trade and restrict innovation. Compliance and adoption of new privacy requirements tend to be somewhat costly, and is an additional burden on businesses.

One key concern is that data protection may unduly restrict business activities by increasing the administrative burden on businesses in order to comply with multiple stringent data regulation policies.

[35] Parliament of the Democratic Socialist Republic of Sri Lanka. (2007). *Computer crime act, no. 24 of 2007.* Retrieved from http://www.slcert.gov.lk/Downloads/Acts/Computer_Crimes_Act_No_24_of_2007(E).pdf

[36] Daily FT. (2017). *Major boost with Sri Lanka harmonising e-commerce legislation with new amendment.* Retrieved from http://www.ft.lk/front-page/Majorboost- with-Sri-Lanka-harmonisinge-commerce-legislation-with-newamendment/44-641819

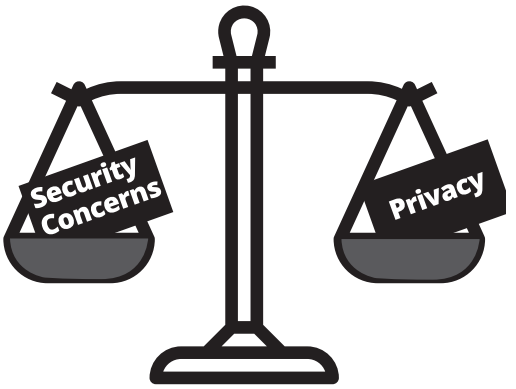
[37] United Nations Human Rights. (2015). *Special rapporteur on the right to privacy.* Retrieved from http://www.ohchr.org/EN/Issues/Privacy/SR/Pages/SRPrivacyIndex.aspx

Furthermore, data regulation that acts as a barrier to trade will affect market competition adversely, creating monopolies.

At the aggregate, global trade and investment can be impacted by a lack of international compatibility on regulatory approaches, where data protection laws can hinder developing countries in particular. The World Trade Organisation's (WTO) General Agreement on Trade and Services (GATS) permits cross boarder restrictions that enable "the protection of the privacy of individuals in relation to the processing and dissemination of personal data and protection of confidentiality of individual records and accounts". However, the mandate specifies that "such measures are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where like conditions prevail, or a disguised restriction on trade in services".[38]

Thus, privacy laws need to take into consideration the global nature and scope of their application and foster compatibility with other frameworks as global trade flows are increasingly reliant on the internet.

Another concerns the balance between surveillance for national security purposes and privacy. The rise of mass surveillance also poses significant threats to data privacy. Currently, a number of governments collect communication and internet data for analysis, to identify threats to national security. Although these programmes balance privacy needs against security concerns, reservations on these arise from the large amount of personally identifiable data that is collected (often most internet data within a nation).[39] Although this data is generally scanned in aggregate and in an algorithmic manner, there are concerns on data leakage from such screening programmes.



16.7 Way Forward

At present, there is no consensus for a single model for data protection laws. However, compatibility is the stated objective of many global and regional data protection initiatives. Sri Lanka's data protection laws need to be drafted with international compatibility in mind to facilitate the smooth cross border transfer of data. For countries without relevant laws in place, the UNCTAD recommends that governments should aim for greater coverage.[40]

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[38] World Trade Organisation. (n.d.). *General agreement on trade in services.* Retrieved from https://www.wto.org/english/docs_e/legal_e/legal_e.htm#services

[39] The Guardian. (2013). *GCHQ taps fibre-optic cables for secret access to world's communications.* Retrieved from https://www.theguardian.com/uk/2013/jun/21/gchq-cables-secret-world-communications-nsa

[40] United Nations Human Rights. (2015). *Special rapporteur on the right to privacy.* Retrieved from http://www.ohchr.org/EN/Issues/Privacy/SR/Pages/SRPrivacyIndex.aspx

Data protection laws need to keep up with new advancements in technologies in order to be effective. Gaps in coverage need to addressed while striking a balance between surveillance and privacy. Moreover, while there are lost business opportunities due to lack of domestic legal protection, overly restrictive protection can act as a barrier to trade. Businesses' compliance burden should be managed with assistance provided for them to overcome any such barriers to adoption.

As Sri Lanka embraces new technologies and enters the information society of the 4IR, privacy and data protection are of utmost importance. With the right policies and legislation in place, the economy will be better positioned to reap the benefits offered by the 4IR while mitigating any adverse impacts.

17. Role of Data in the 4IR

17.1 Introduction

New breakthroughs and advancements in technologies under the fourth industrial revolution (4IR) – in artificial intelligence (AI), cloud computing, the internet of things (IoT), etc., – are generating large volumes of information and the means to analyse them more easily. Technologies that allow the development of three-dimensional solid objects from a digital file, or changes in the genetic makeup of an organism, amongst others, have already started to transform the way people live, work and relate to one another.

These advanced technologies are now reaching the doorsteps of developing countries like Sri Lanka as well. For example, banks track and collect all sorts of data on consumers, such as what they buy, how they buy them and do their shopping, etc., when purchases are made through credit cards and other such bank cards. Smart phones allow information to be gathered on online shopping, use of media and even track the location of the person using them. Data generated from telecommunication networks, allow to identify preferences for various TV channels/ programmes, etc., without the need for special surveys or any other forms of data collection.

Amidst all this information however, it may not be possible to measure and monitor everything related to people- especially their living standards, nutritional status, income and expenditure patterns, incidence of poverty, status of their health, participation in the labour force, etc., without conducting the normal household surveys. These traditional forms of information gathering too need to adapt to collect new data on the types of emerging employment opportunities and skills in demand along with technological advancements. Against this backdrop, this policy brief takes a broad look at the role of data in the 4IR, the importance of sharing data, and as to why it is essential to formulate a strong and effective data policy to build trust in the data system, among the users and providers of data.

17.2 Data Policies and Building Trust

Big data is expected to play a pivotal role in the 4IR and are already being used in industrialised countries, in various areas, such as health care, education, business, banking, insurance, industries, government services, etc. To get the maximum benefit, big data and all other types of data need to be used, as much as possible. For this to be a reality, data generated through various processes or collected by various actors need to be shared.

Most government, semi-government and private sector organisations in Sri Lanka are reluctant to share their data with other agencies, mainly due to the possibility of abuse or misuse of personal data. If big data or any other type of data available are not shared, the possibility to generate new information more accurately through 4IR technologies is lost. As such, the reluctance

to share data need to be addressed, through attitudinal changes as well as efforts to secure data privacy. If big data generated through routine operations of public and private organisations are to be shared amongst many stakeholders, numerous data security issues that usually arise need to be handled carefully.

Most government, semi-government and private sector organisations in Sri Lanka are reluctant to share their data with other agencies, mainly due to the possibility of abuse or misuse of personal data.

The reluctance to share data need to be addressed, through attitudinal changes as well as efforts to secure data privacy.

Mishandling or abuse of data, especially sensitive personal data, can lead to loss of confidence and trust and pave the way towards making cooperative efforts difficult. A strong coordinating mechanism for public-private cooperation, and strong data policies and rules to prevent any misuse of data are critical. For this, data policies to prevent the misuse of sensitive data, and means of developing a robust system which can win the trust of all stakeholders are key issues.[1]

[1] *Data policy in the fourth industrial revolution: Insights on personal data.* (2018). Retrieved from https://www.weforum.org/whitepapers/data-policy-in-the-fourth-industrial-revolution-insights-on-personal-data

Data policies to prevent the misuse of sensitive data, and means of developing a robust system which can win the trust of all stakeholders are key issues.

Regulators around the world are experimenting new approaches to data policy, struggling on how to address recent technologies that fall beyond existing regulatory frameworks. The pace of technological advances means that existing laws and regulations can quickly become obsolete, frustrating both customers and businesses seeking to access new innovations. However, individuals can also become concerned if they feel governments are not sufficiently protecting them from new risks associated with data and technology.

New approaches are needed to formulate effective data policies which can address complex issues, including the importance of privacy. Founder and Chairman, World Economic Forum, Klaus Schwab states that, "One of the greatest individual challenges posed by new information technologies is privacy. We instinctively understand why it is so essential, yet the tracking and sharing of information about us is a crucial part of the new connectivity. Debates about fundamental issues such as the inner lives and loss of control over our data will only intensify in the years ahead." [2]

If data policies are not formulated properly, loopholes will allow users to abuse data. Clarity on how to balance complex and competing interests, with transparency, trust and accountability, are some essential elements to ensure sustainability of the entire data system. In this context, a range of issues and concerns frame the modern privacy debate, which raise ethical, technological, legal, economic, cultural and even philosophical

[2] Schwab, K. (2016). *Global agenda, the fourth industrial revolution: What it means, how to respond*. Geneva, Switzerland: World Economic Forum.

questions. This means the solutions are unlikely to be simple and straightforward. The confusion and tension surrounding the issue of privacy arise from a number of directions as listed under the 'Fair Information Practice Principles (FIPPs).[3]

- Collection limitation: there should be limits to the collection of personal data relative to its use.
- Data quality: personal data should be relevant to the purposes for which it is to be used, and should be accurate and up to date.
- Purpose specification: the purpose for which personal data is collected should be specified at the time of collection, and its use should be consistent with the stated purpose.
- Use limitation: personal data should not be used or shared for purposes other than those specified in accordance with the purpose for which it was collected, except with consent or as required by law.
- Security: personal data should be protected by reasonable security safeguards.
- Openness: there should be a general policy of openness about developments, practices and policies with respect to personal data.
- Individual participation: an individual should have the right to know what data about them is held by a data controller and to update or remove such information, subject to reasonable restrictions.
- Accountability: a data controller should be accountable for complying with measures that give effect to the principles above.

A barrier that may hinder the rapid adoption of 4IR technologies is widening of the 'trust gap', across the world. Security breaches, identity theft and fraud; concerns from individuals and organisations about the accuracy and use of personal data; organisations are confused about what they can do and cannot; and increasing attention and sanctions from regulators are just some of the indicators. The extent to which a country can maintain an effective, predictable and efficient data protection system will be evaluated by all stakeholders. In these circumstances, trust is essential for a sustainable, inclusive, innovative and credible digital ecosystem to emerge; trust is difficult to gain and easy to lose. Six essential principles for ensuring a trustworthy data system– all highly interconnected and each bringing a unique set of opportunities for policy makers – has been identified as a start.[4] These include, security, accountability, transparency, auditability, fairness and ethics.

- Security: Operating on shared technical infrastructure, the confidentiality, integrity and availability of both data at rest and data in motion are critical, given their increasingly granular, real-time and valuable nature.
- Accountability: The use of data (and the platform which uses it) must function as promised; stakeholders must comply with legal requirements and agreed-upon processes and be held responsible in the event of system failures.

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[3] *Data policy in the fourth industrial revolution: Insights on personal data.* (2018). Retrieved from https://www.weforum.org/whitepapers/data-policy-in-the-fourth-industrial-revolution-insights-on-personal-data

[4] World Economic Forum. (2019). *Data collaboration for the common good enabling trust and innovation through public-private partnerships.* (Insight report produced in Collaboration with McKinsey & Company).

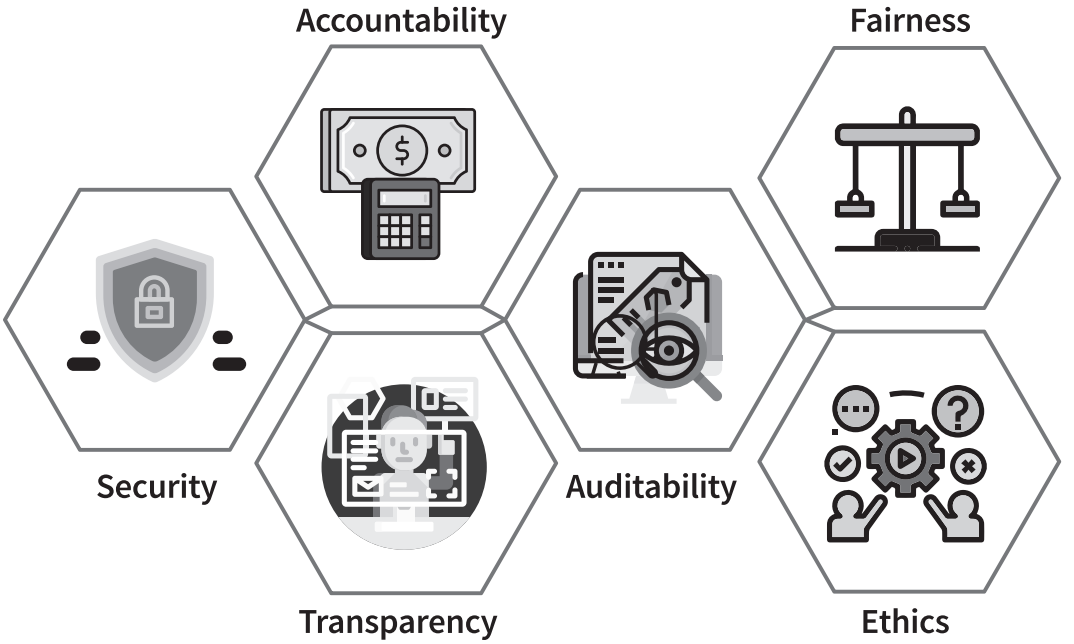
- Transparency: Individuals need meaningful ways to understand and decide on how their data are to be collected, stored, processed and shared. They also need to have a functional and active relationship with the entities that hold and process their data so that the intent and desired outcomes of these entities can be better understood.

- Auditability: The systems that use data must have the capacity to be externally audited and verified, and policy makers in many instances lack the robust means to audit data regulations given the velocity, global nature and complexity of the underlying technical architectures.

- Fairness: Regulators and data-protection authorities need to be increasingly vigilant about both privacy abuses and an array of other harms (economic, social and political).

- Ethics: Unethical (or even illegal) use of data can permanently damage trust among stakeholders.

Six essential principles for ensuring a trustworthy data system



Policy makers face an unprecedented set of known and unknown emerging risks in the face of rapidly growing data volumes, increasing transborder data flows, the granular and real-time nature of connected device data, the inscrutable nature of AI systems, and growing concentration of global platforms. Data policy makers need to embrace this complexity and invest in resources to understand and manage it, and not to ignore it. They must understand the full range of benefits, risks, desired outcomes and potential unintended consequences of a given framework. Decisions in either direction should be fully informed, carefully crafted and deliberated. There should be clearly defined rules, which can simplify compliance in terms of what are permissible and what are prohibited.

Such rules should be designed in a manner not to constrain innovation, but to prevent adverse consequences. In other words, too many restrictions will discourage innovations, as there could be limitations to the use of data. On the other hand, without proper data policies and strict rules, there are risks of data misuse which can lead to loss of trust. As a start, making public-sector information available can be means of encouraging public engagement and supporting innovative uses of data. This represents transformation from a logic of government transparency and freedom of information, to that of enabling analytical uses of data.

17.3 Assessing Risks: The Importance of Context

It is difficult to adequately assess the sensitivity of a given data element or dataset without considering its context. A more nuanced way to think about the issues of data policy requires a contextual mindset based on the origin of data collection, data sensitivity and intended uses. When focusing on the contextual dependencies of data, a number of concerns need to be addressed. These include concerns such as how the shared rights, responsibilities and appropriate permissions can be established for data to flow in ways, that both the integrity of a given context and balance the interests of relevant stakeholders can be ensured.

Assessing risk requires policy makers to consider the context in which data is collected and processed. The relevant considerations include:

- Source of information: information can be collected directly from the individual/ entity or obtained from publicly available sources.

- Collection method: information can be acquired from sensors inside an individual's home, from closed circuit television (CCTV) in public places, DNA from bio samples, to health conditions from wearable health monitors.

- Private or public facts: information may have been made available, shared or publicly posted by the individual or the information may have been intended to remain private.

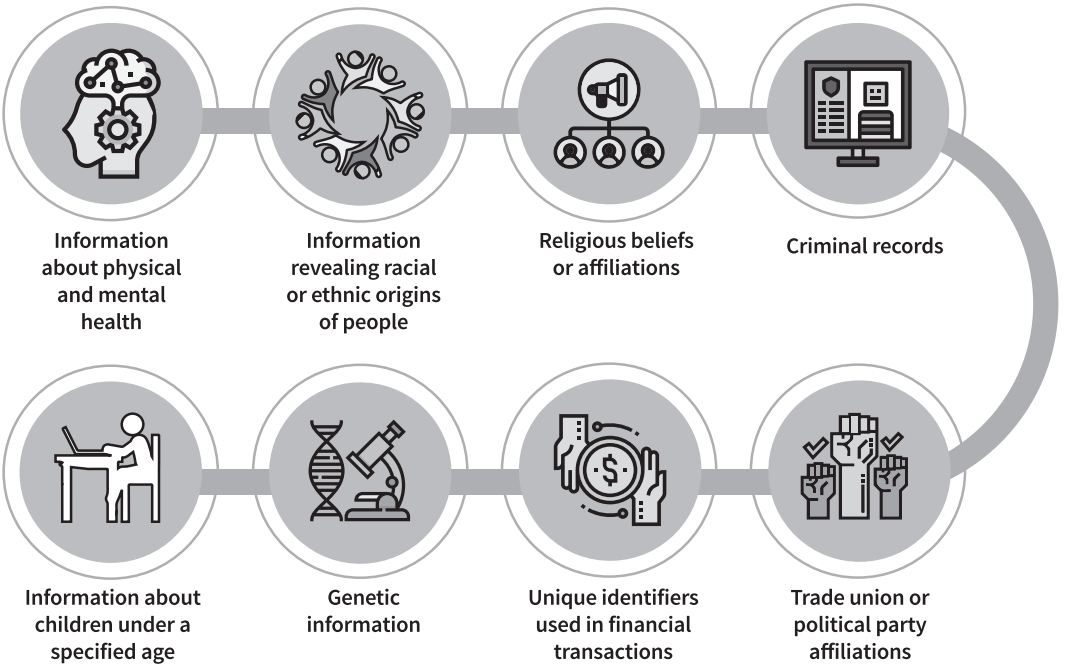
- Entity collecting the data: the entity may be government or a law enforcement agency, a commercial unit, a charity or an educational or medical institution.

Identifying and setting specific rules for various categories of sensitive data is extremely important for any type of data protection framework. As

such, it is necessary to define sensitive data or classified special categories of personal data, as different elements of data can pose different levels of risk to individuals. What is more important is not whether a given data set is labelled as personal or not, but the potential risk of adverse consequences or malicious harm to the individuals by processing such data.

Another concern is security issues. As such, it is necessary to identify the implications of allowing access to sensitive data. High standards regarding the consent, security and legitimate use of sensitive personal data need to be ensured. In some cases, the collection and use of certain sensitive information may need to be prohibited. Common categories of sensitive data include:

Common categories of sensitive data include



Vulnerable and voiceless populations may face a greater risk of adverse consequences of data breaches than others. It is therefore necessary to provide a higher level of protection for such people, within the data protection framework. It is also desirable to identify the possible adverse consequences and data related harms to various communities and different population groups, and give due consideration to them when developing data policies.

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The following are some adverse consequences related to data, but fall outside the data policy framework:

All countries will have to plan in advance on how to cope with these new and complex challenges emerging from rapidly changing new technologies. While developed countries will adopt new technologies at faster rates (adoption rates faster), developing countries are likely to do so at different rates, depending on cultural norms, state of economic development and different development goals of the respective country. Indeed, data policy frameworks of the 4IR must be flexible enough to accommodate differences in values and norms as an enabler of technology innovation.[5] While there is no best single approach that will suit all stakeholders alike, the following areas can be taken into further consideration:

- Provide policy makers with uniform, comparable information on data protection frameworks that will give them insights into when and how a proposed framework may diverge from other frameworks, ensuring that fully informed decisions are made, before a data protection framework is implemented.

- Address the distinction between privacy and security.

- Develop a common understanding and set of criteria for concepts related to identifiability and what is necessary and sufficient to ensure that data is appropriately de-identified.

[5] World Economic Forum. (2019). *Data collaboration for the common good enabling trust and innovation through public-private partnerships.* (Insight report produced in Collaboration with McKinsey & Company).

Some adverse consequences related to data, but fall outside the data policy framework



- Offer an analysis of vulnerable populations, to assist policy makers in providing consistent levels of protection to vulnerable populations.

- Conduct a comprehensive analysis of sensitive categories of personal data to identify those areas that are most commonly considered sensitive.

17.4 Why Data Matters in the 4IR

Preparing the workforce to meet requirements of the 4IR is the most critical need.[6] If not, many will be left behind due to inadequate skills to meet the future demands of the labour market. Required work skills in the 4IR are placed into five distinct categories: physical and manual; basic cognitive; higher cognitive; social and emotional; and technological.[7] The workers use a range of these capabilities in their employment activities. The physical and manual skills are being used to perform relatively unskilled labour, such as drivers and assembly line workers as well as skilled workers, including nurses, electricians, craftworkers, etc. Cognitive abilities like basic literacy and numeracy are needed by workers such as cashiers, customer service staff and those involved in lower-level data input and processing, such as typists and clerks. It is mainly workers with these two skills sets who are likely to suffer the most, although not in every profession.

Different sectors will experience different skill shifts. For example, health care services will have a higher demand for physical skills, even as the demand for physical skills will decline in manufacturing and other sectors.[8] Countries like Sri Lanka too will face shifting demand for skills and as such, it is important to plan ahead and accordingly prepare the workforce for the 4IR. A continuous monitoring of the rapidly changing types of skills which are in demand, and those showing a diminishing demand is needed, to take appropriate action to minimise the skills gap.

Sri Lanka currently relies on the quarterly labour force surveys (QLFS) conducted by the Department of Census and Statistics (DCS) to capture employment and labour market developments in the economy. Such surveys need to adapt to changes that occur continuously, to generate better data to help policy makers prepare for the impacts of the 4IR. For instance, more details on educational attainment and skills such as: (i) school education by stream (science/ commerce/arts); (ii) higher levels of education (with the field of education); (iii) professional qualifications/technical qualifications; (iv) those having different types of professional / technical training / specific types of high skills, etc., are some points of interest. In addition to the QLFS, labour demand surveys to ascertain the demand for different type of jobs, types of skills sought by employers, etc., need to be consistently identified. These types of information are essential to address the growing mismatch between available youth skills and employer needs, especially in view of the changes expected in the job market arising from the 4IR.

Although the sample used at present by the DCS for the QLFS and the labour demand surveys may be too small or limited to obtain precise estimates, it is still possible to study trends to

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[6] See Chapter 5 of this report on "4IR and the Future of Work in Sri Lanka".

[7] Barleys Corporate Education. (2018). *Shifting skills: Automation and future of the workforce.* Retrieved from https://corped.berkeley.edu/shifting-skills-automation-and-the-future-of-the-workforce/

[8] Mckinsey Global Institute. (2018). *Skill shift: Automation and the future of the workforce.* Retrieved from https://www.mckinsey.com/featured-insights/future-of-work/skill-shift-automation-and-the-future-of-the-workforce

identify changes in the job market, available skills and types of jobs for which the demand will decline or grow with the adoption of new technology. Such information is critical to plan suitable strategies to develop the skills sets as the entire education system, from school to technical education and universities, which need to be modified systematically to prepare the future workforce required for the 4IR.

At the same time, better data will help policy makers to meet the challenges faced by workers with inadequate skills. Even with reskilling or continuous learning – some workers may not have the capacity to improve their skills to a desired level, even if an attempt is made to develop their skills – there are risks of job displacement. The living standards of such people and their families may further deteriorate as a result, as they slip into lower income levels or in some cases even to poverty. Income inequality may also further increase. As such, it is also necessary to continuously monitor changes in living standards with adequate datasets such as the Household Income and Expenditure Surveys (HIESs).

17.5 Summary of Recommendations

Data, including big data, will play a leading role in the 4IR and the ability to utilise and analyse data is bound to be one of the biggest drivers of effective policy responses in future. If the vast amount of data generated by different organisations, both government and private sectors and other actors are handled properly, it will be possible to develop an efficient data system which will benefit all. Due consideration needs to be given to protect the rights of all those who provide data.

Gaining the trust of all stakeholders is essential for better collection and usage of data. One of the most important requirements for this is a sound data policy which can build the trust of all stakeholders, especially the individuals whose personal data is expected to be used by governments and other agencies. For these outcomes to become a reality, the following broad steps are outlined:

- Formulate a strong data policy, which will encourage the sharing of available data (big data/data, generated through routine operations/data collected through national surveys/censuses, to the extent possible) from different sources, and to take the maximum use of such data, for the benefit of all. It should ensure the security and legitimate use of sensitive personal data, as privacy needs to be given the highest priority, for the data system to be trusted by all, and for it be sustainable. There should not be any discrimination to anyone or any group or groups.

- Need to share the data, and use public-private cooperation/coordination to do so, in order to derive the maximum benefit from data in the 4IR.

- Regularly monitor the types of jobs/skills that are in demand and those for which demand is diminishing, so that appropriate action can be taken to minimise the skills gap. National datasets such as the QLFS need to be further improved to be comprehensive, in order to obtain details on the levels of skills of the workforce and trends in demand for jobs/skills. Labour demand surveys should be conducted at least once in three years,

to ascertain the types of skill needs of the employers so that the education system too can be restructured accordingly.

- Other datasets such as the HIES should be continuously analysed in-depth to monitor changes in living standards as people with low skills and their families may get affected, due to inadequate work or loss of jobs.

Regularly monitoring the types of jobs/skills that are in demand and those for which demand is diminishing, so that appropriate action can be taken to minimise the skills gap, is important.

Themes of the "Sri Lanka: State of the Economy Reports"

1992	Macroeconomic Policy
1993	Export Sector
1994	Agriculture Sector
1995	Poverty Alleviation
1996	Workers' Charter
1997	Private Sector Expansion
1998	Demographic Change and Social Safety Nets
1999	Free Trade in South Asia
2000	Plantation Sector
2001	Competition Policy and Regulations
2002	Agriculture Sector
2003	Garment Sector
2004	Land Policy
2005	Post-Tsunami Economic Issues
2006	Agriculture Reforms: Irrigation Water Charges and Land Policy
2007	Empowerment of the Poor
2008	Political Economy Dilemma of Reforms
2009	The Global Economic Crisis: Issues, Impacts and Outlook
2010	Growth and Stability in Post-conflict Economic Recovery
2011	Post-Conflict Growth and Recovery
2012	Keeping Sri Lanka on the Growth Expressway
2013	The Transition to a Middle-Income Economy
2014	Rising Asia: Opportunities and Challenges for Sri Lanka
2015	Economic Reforms: Political Economy and Institutional Challenges
2016	Fiscal Policy for Growth: Sustainable Financing for Development
2017	Demographic, Labour Markets and Growth
2018	Climate Change, Food Security and Disaster Risk Management
2019	Transforming Sri Lanka's Economy in the Fourth Industrial Revolution (4IR)

Sri Lanka: State of the Economy 2019
Transforming Sri Lanka's Economy in the Fourth Industrial Revolution (4IR)

The IPS' annual flagship report *Sri Lanka: State of the Economy* provides a critical assessment of the country's economic performance and near term outlook for growth and macroeconomic stability. Each year, the report also examines crucial medium term policy priorities to achieve sustained growth and strengthen socio-economic development outcomes for the country.

The Sri Lankan economy is making a slow recovery after a series of setbacks – a devastating terror attack in April 2019, preceded by a political crisis in the third quarter of 2018. With sluggish GDP growth of around 3 per cent and high foreign debt settlements, the overall positioning of the economy in 2019 is weak. This is despite significant gains from macro reform measures in fiscal, monetary and exchange rate policy management from mid-2016.

As Sri Lanka prepares the groundwork for a fresh phase of economic growth and development on the back of decisive elections in 2019-2020, new tools to assess and understand competitiveness must be heeded. Transformative technologies such as artificial intelligence (AI), robotics, and 3D printing – under the banner of the Fourth Industrial Revolution (4IR) – are proving to be invasive, complex and disruptive. For countries with ageing populations like Sri Lanka, that must rely on productivity as a key driver of future growth, the challenges need to be understood and opportunities grasped.

This year's *Sri Lanka: State of the Economy 2019* report on the theme of 'Transforming Sri Lanka's Economy in the Fourth Industrial Revolution (4IR)' examines the many areas of the Sri Lankan economy – world of work, education, migration, gender, health, financial inclusion, trade, agriculture, and climate change, amongst others – where 4IR technologies will come into play as defining features of the country's future economic progress.

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ISBN978-955-7397-18-4