UNLOCKING INVESTMENT FOR DIGITAL INFRASTRUCTURE AND SMART CITIES

04

This chapter discusses the extent of dispersion and gaps in digital infrastructure among Commonwealth countries. The discussion will then proceed with investigating the presence of digital infrastructure enablers that help transform the economy into 'smart cities'. The last section concludes with a discussion of the regulatory and governance framework necessary to support digital infrastructure investments moving forward.

4.1 Overview of digital infrastructure

This section maps the digital infrastructure landscape in the Commonwealth, comparing progress in developing digital infrastructure across Commonwealth countries. We distinguish between basic, intermediate and advanced digital infrastructure in the discussion below, while Table 4.1 summarises indicators under each category.

Basic digital infrastructure refers to internet infrastructure, cable networks etc. captured by proxy variables related to ICT access and affordability. On average, the Commonwealth performs less well than non-Commonwealth countries in access to basic digital infrastructure. On average, 89 per cent of the population in low-income Commonwealth countries is covered by a mobile-cellular network, but only 16 per cent of the population in these countries has access to the internet; and the average proportion of households in Commonwealth LICs with access to computers and internet is between 5 and 10 per cent. The lower access to basic technologies in LICs may be explained by the higher cost of the internet: it costs roughly US$66, on average, to acquire a fixed broadband internet connection in these countries.

On average, Commonwealth countries reached 48 per cent internet penetration in 2017. Brunei, United Kingdom, Canada and New Zealand rank the highest within the Commonwealth, with more than 90 per cent of the population having internet access, while more than half (28) of the Commonwealth member states fall below the world average on this measure (Figure 4.1). In Kiribati, Malawi, Sierra Leone, Solomon Islands and PNG, less than 15 per cent of the population are connected to the internet. Box 4.1 highlights some of the recent initiatives undertaken in PNG to improvise access to basic digital infrastructure.

Globally, mobile connectivity is an increasingly important way for individuals to access the internet. This is no different in the Commonwealth, where mobile phones are a widely used technology for online activities. However, the digital infrastructure supporting mobile connectivity varies significantly across the Commonwealth. Digital divides in mobile connectivity remain significant among members. According to the GSMA mobile connectivity index (MCI, see Table 4.2),[1] Australia ranks the top country in the world, with a MCI score of 88.4 in 2018. Singapore ranks second, with a MCI score of 86.6, and New Zealand is third with a MCI score of 85.2. At the other end of the spectrum, a number of Commonwealth African countries (Eswatini, The Gambia, Malawi, Sierra Leone and Zambia), along with Pakistan and Solomon Islands, perform poorly on the MCI, suggesting key enablers of mobile connectivity are deficient in these countries.

On average, Commonwealth countries reached 48 per cent internet penetration in 2017. Canada, Australia, New Zealand and The Bahamas rank the highest within the Commonwealth, with more than 90 per cent of the population having internet access, while more than half (28) of the Commonwealth member states fall below the world average on this measure (Figure 4.1). In Kiribati, Malawi, Sierra Leone, Solomon Islands and Papua New Guinea, less than 15 per cent of the population are connected to the internet.

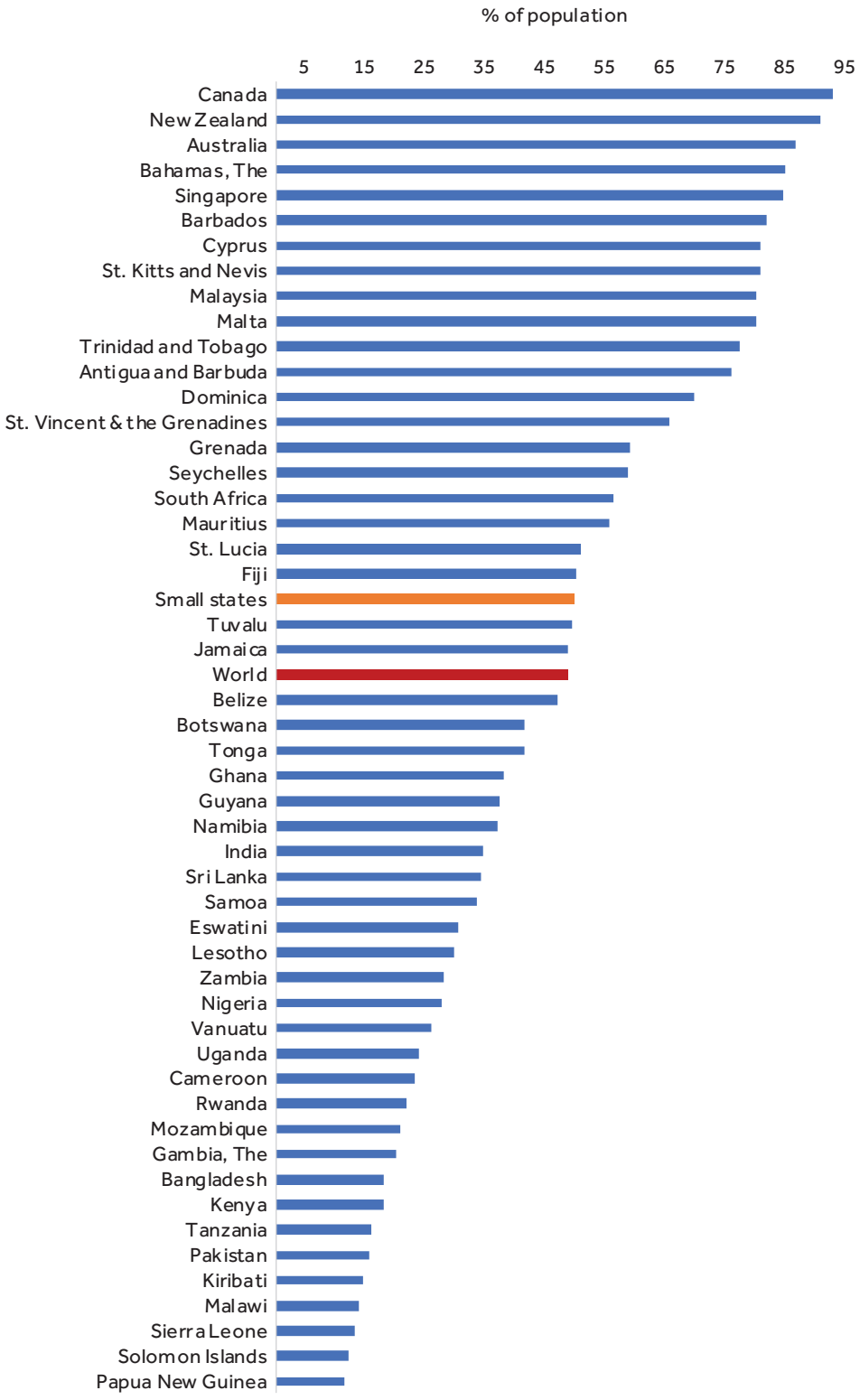
For intermediate digital infrastructure, Table 4.1 uses indicators to capture the quality of internet – such as internet bandwidth and 3G mobile penetration – and shows that Commonwealth countries are lagging behind their non-Commonwealth counterparts. In Commonwealth countries, on average, 63 per cent of the LIC population is covered by at least a 3G network, but the international bandwidth per internet user is roughly 40 times lower compared to Commonwealth HICs. Across regions, international

Table 4.1 Digital infrastructure in the Commonwealth, by income level, 2015–17

	Common-Wealth	Non-Common-wealth	Commonwealth			
			High income	Upper middle income	Lower middle income	Low income
Basic digital infrastructure						
Access to electricity (% of population)	78.07	86.89	100.00	91.99	63.35	27.86
Percentage of the pop ulation covered by a mobile-cellular network	91.69	93.87	99.32	91.60	85.26	89.56
Fixed-telephone subscriptions per 100 inhabitants	14.61	19.75	34.74	14.68	1.45	0.52
Mobile-cellular subscriptions per 100 inhabitants	100.45	109.95	130.08	105.36	77.75	73.94
Fixed broadband subscriptions per 100 inhabitants	10.37	14.93	26.53	8.49	0.71	0.52
Internet users (% of population)	45.15	54.32	80.15	47.29	21.46	16.10
Estimated proportion of households with internet access at home	40.65	51.33	76.19	42.68	18.99	10.12
Estimated proportion of households with a computer	37.63	48.63	77.29	39.89	11.85	5.82
Connection fee for residential telephone service (US$)	42.60	89.00	73.80	37.54	31.41	21.21
Mobile-cellular prepaid connection charge (US$)	3.74	14.69	7.16	3.71	1.50	0.45
Mobile-cellular prepaid price of a one-minute local call (peak; on-net) (US$)	0.15	0.41	0.23	0.16	0.10	0.08
Installation fee for business telephone service (US$)	46.98	258.73	70.15	41.75	35.10	17.40
Fixed broadband internet connection charge (US$)	39.37	39.03	53.36	24.89	34.73	66.69
Intermediate digital infrastructure						
Secure internet servers (per 1 million people)	3,290.51	3,683.10	11,088.56	909.09	44.40	9.66
Percentage of the population covered by at least a 3G mobile network	77.05	81.23	96.13	80.81	60.66	63.07
International internet bandwidth; in Mbit/s	830,659.14	1,077,280.83	2,318,801.00	116,977.30	619,893.80	16,233.26
International internet bandwidth per internet user	80,255.45	172,371.92	217,973.30	45,674.60	17,488.66	5,507.49
Advanced digital infrastructure						
Robot shipments	**data available only for limited countries*					
UNCTAD Business-to-Consumer E-Commerce Index score (2016)	53.00	54.35	88.26	57.25	33.90	28.00

Source: Authors' computations based on ITU, IFR and UNCTAD data. Averages are unweighted.

Figure 4.1 Internet penetration rates (%) in the Commonwealth, 2017



Source: Authors (constructed graph based on World Bank data).

Notes: Internet penetration is measured as % of population with access to the internet.

Box 4.1 Improving access to basic digital infrastructure in PNG

In the area of infrastructure PNG has taken decisive action to increase the quantity and quality of data transmission as well as improve access to the service. First, internet speed and reliability are expected to increase substantially once the two main cables connecting PNG with China and Australia are operational. This is expected to occur at the end of 2019. Once these cables are operational, PNG will have the capability to receive more than 20 terabytes per second of data – 20 times its current capability. Frequently, operators tend to limit the upload speed with the aim of maximizing the download speed. As the interaction with online services requires a bi-directional exchange of data, their operation suffers when the upload speed is limited. The new cables will allow companies based in PNG to operate internet-based services (e.g. data cloud) and the online and almost immediate synchronization of financial operations among others as a result of the improvement of the bi-directional exchange of data. Second, the price of internet access has declined significantly. Whilst the cost of accessing the internet had been falling over the last few years, data prices were still quite high. Earlier in 2019, one gigabyte of data cost around 20 Kinas (USD 5.9). Recently, however, the government-owned operator (although only capturing 10 per cent of the market) has slashed its prices offering one gigabyte for 5 Kina (USD 1.5). This constitutes a reduction between 70 and 80 per cent. Unfortunately, the reduction in prices has been too recent to be observed in data related to the use of internet.

Nevertheless, it is expected that the declining cost will intensify the use of the internet by existing users rather than constituting a decisive factor in the expansion of accessibility. This is driven largely by two elements. On the one side, although PNG is working towards improving last mile access, encouraging operators to build the necessary infrastructure, only 26 per cent of the population has access to 4G connectivity. The Universal Access Programme funds the expansion with a levy to support direct investment by NICTA. However, a lack of access to the energy grid in many parts of the country significantly increases investment and operational costs associated with mobile antennas as a result of requiring electric generators or solar cells. At the same time, only 15 per cent (1 million) of the population has smartphones that can make effective use of the internet. High tariffs and duties (40 per cent) applied to smartphones make these essential devices unaffordable to most of the population. The importance of smartphones is critical as mobile internet is the dominant form of access to internet. Fixed broadband subscriptions total around 50,000.

Source: Authors, based on stakeholder consultations in PNG.

internet bandwidth (IIB) available per user is much more limited in countries in Commonwealth Africa (14 kilobyte per second per user) (Figure 4.2). The high IIB per user among the three European countries in the Commonwealth is driven by Malta, a small state, with 1,179kb/s per user compared with the 356kb/s rate among European countries. IIB can be deployed either by satellite or by submarine or land optical fibre, and thus limited economies of scale and/or remoteness may have restricted

Table 4.2 Commonwealth countries' performance on the mobile connectivity index

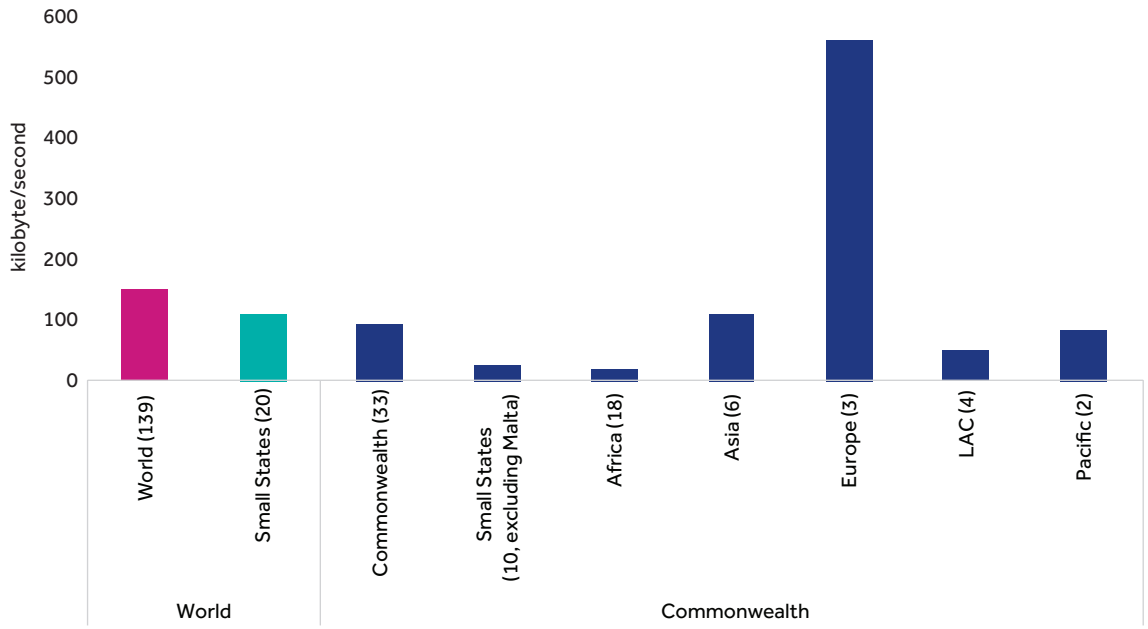
Countries	Mobile connectivity index score	Countries	Mobile connectivity index score
Australia	88.4	Sri Lanka	54.3
Singapore	86.6	Ghana	51.2
New Zealand	85.2	Kenya	50.8
United Kingdom	83.1	Vanuatu	50.5
Canada	82.2	Botswana	49.4
Bahamas	70.3	Bangladesh	48.0
Barbados	67.9	Nigeria	47.7
Malaysia	67.4	PNG	47.0
Trinidad and Tobago	67.4	Namibia	45.2
Brunei Darussalam	67.3	Rwanda	43.0
Mauritius	65.5	Senegal	41.7
Jamaica	59.6	Tanzania	41.0
South Africa	59.5	Uganda	40.0
Dominican Republic	57.6	Pakistan	39.8
Fiji	57.5	Sierra Leone	37.9
Samoa	57.2	Solomon Islands	37.5
Saint Lucia	57.2	Eswatini	35.9
India	55.6	Zambia	33.8
Tonga	55.0	The Gambia	32.7
Guyana	54.9	Malawi	25.4

Source: GSMA 2018.

the bandwidth available in small states. The ten Commonwealth small states (excluding Malta) in the sample only have an average of 27kb/s per user. With many African and small state members, the Commonwealth as a group fell below the world average IIB per user in 2018.

We categorise advanced digital infrastructure as that embedded in actual production (e.g., automation in manufacturing) and business transactions made and settled in digital platforms. While there is good coverage of Commonwealth countries on proxy indicators for basic and intermediate digital infrastructure, proxy indicators on advanced digital infrastructure – such as the use of robotics or e-commerce – suffer from some data gaps. The UNCTAD Business-to-Consumer E-Commerce Index reflects the processes in an online shopping B2C transaction, comprising an enabling digital platform (i.e., web presence) to place an order, electronic payment method (e.g., mobile banking, credit card) and postal delivery of digital products (UNCTAD 2017). Based on 2016 data, 20 out of 31 Commonwealth countries in the sample fell below the world average index score of 54 (Figure 4.3). Out of these 20 Commonwealth countries, 15 are in Africa, and 15 are LICs or LMICs. Only Commonwealth HICs and UMICs were able to

Figure 4.2 International internet bandwidth (kb/s per user, 2016)



Source: Authors' calculations based on WEF data.

Notes: Figures in parentheses indicate number of countries included in the group.

obtain e-commerce indices above the world average index.

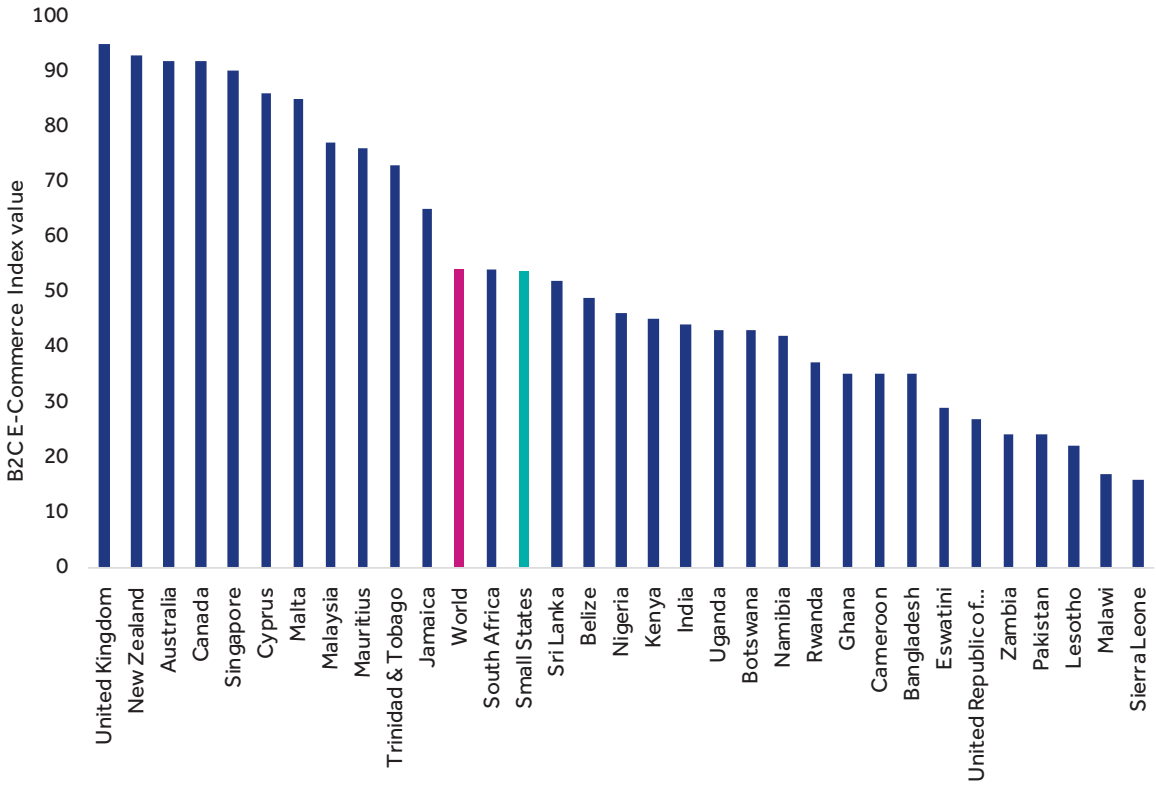
'Robotisation' of production illustrates countries' absorption of high-technology smart machines to increase productivity and further upscale outputs. Among Commonwealth countries with available data,[2] the strongest growth in robot unit shipments in the period 2013-2017 was recorded in Singapore (an increase of 281 per cent to 4,559 units), while on the opposite pole, robot shipments to South Africa contracted by 50 per cent (to 451 units) (Figure 4.4). According to the latest IFR data, 68 per cent of the 381,640 robot units sold worldwide in 2017 went to Southeast Asia, wherein more than a third of the total supply (36 per cent) were shipped to China, 12 per cent to Japan and 10 per cent to Korea.

Among the sample of eight Commonwealth countries,[3] digitalisation via robotics is more intensive in the manufacturing sector – with all countries utilising the robots procured in 2017 in manufacturing industries, except in Canada where a small number of robots (27 units) were used for education and R&D (based on IFR data). In terms of robot density (i.e., units of industrial robots installed per 10,000 employees in the manufacturing industry), only Singapore, Canada and Australia have robot density above the world average (74 units). India's manufacturing sector stands to be the least digitalised with only 3 robots installed per 10,000 employees, followed by South Africa with robot density of 28 (Figure 4.5).

4.2 Where and how to improve digital infrastructure in the Commonwealth

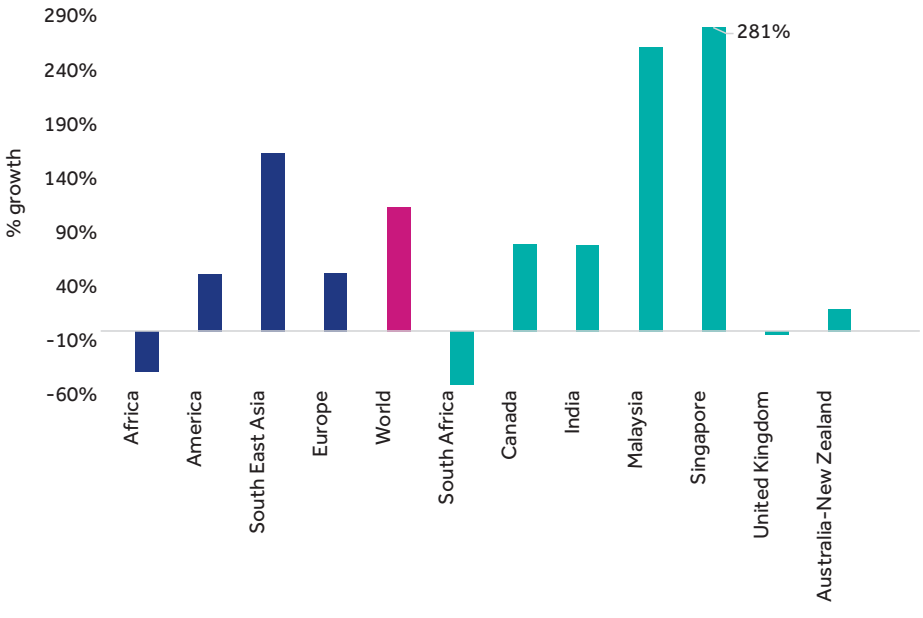
The previous sub-section provided a picture of the Commonwealth's progression in terms of digital infrastructure and highlighted the persistent divide between high income and lower income Commonwealth countries. The heatmap of the WEF Networked Readiness Index (NRI) below

Figure 4.3 Business-to-Consumer E-Commerce Index Value, 2016

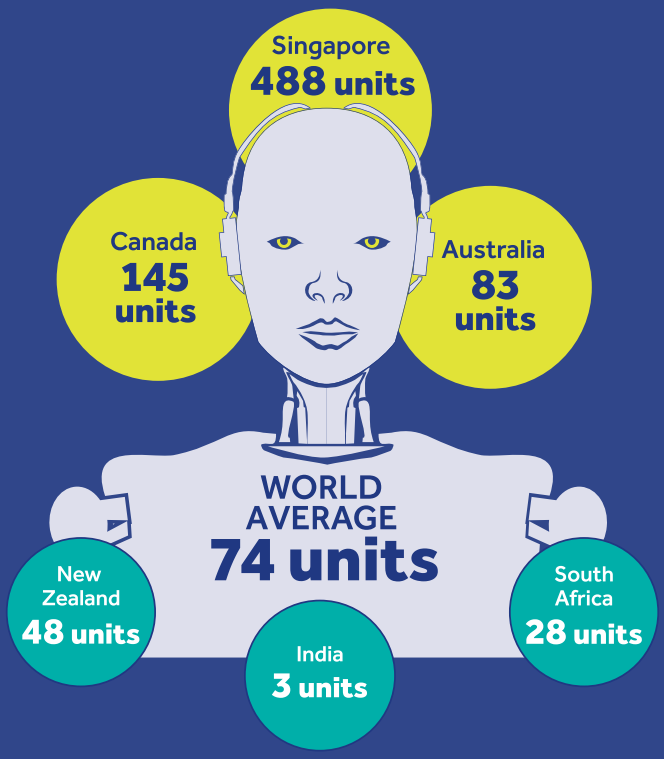


Source: Authors (constructed graph based on UNCTAD data).

Figure 4.4 Robot unit shipments



Notes: Percentage growth rate from 2014 to 2017.



The number of **industrial robots** installed per 10,000 employees in the manufacturing industry is above the world average (**74**) in Singapore (**488**), Canada (**145**) and Australia (**83**), but lower in New Zealand (**48**), South Africa (**28**) and India (**3**)

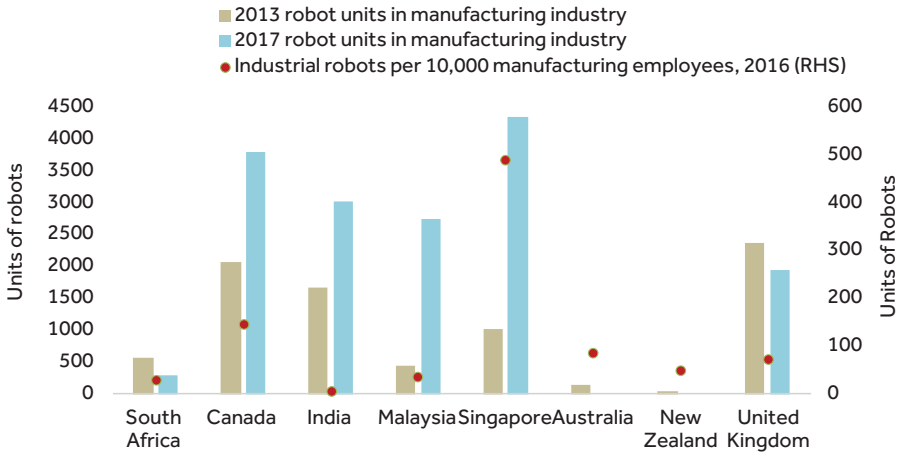
HIGH INCOME Commonwealth Countries

85% of the population has access to the internet

18% of the population has access to the internet

LOW INCOME Commonwealth Countries

Figure 4.5 Units of robots in manufacturing



(Table 4.3) shows the digital preparedness of 33 Commonwealth countries, with indices ranging from 1 to 7 (7 as best/most prepared). NRIs in darkest red indicate the lowest scores across indicators and among Commonwealth countries (i.e., 1.11 score for infrastructure in Cameroon), median scores shaded in yellow, and the highest scores in darkest green (6.96 index for infrastructure in Australia and Canada).

The heatmap affirms the divide between HICs and LICs that we observed in individual digital infrastructure indicators, and further highlights that among the 10 composite indices of digital preparedness, digital infrastructure together with digital penetration are the biggest hurdles for Commonwealth LICs and countries in Africa.

For example, the heatmap shows that even if Rwanda has a conducive regulatory environment and high government digital usage comparable to Australia, the limited digital infrastructure coupled with the low level of digital penetration – a common challenge among Commonwealth LICs – may restrict the economic gains from digitalisation. This resonates with the conclusion of a World Bank study (Qiang et al. 2009), where a 10 percentage point increase in fixed broadband penetration has the potential to increase the GDP of developing countries by 1.35 per cent.

Additionally, even if digital access is more affordable on average in South Asia (Bangladesh, India, Pakistan and Sri Lanka) than European and Caribbean Commonwealth countries, the region is heavily constrained by the lack of digital infrastructure for development and use of digital platforms. For example, based on WEF data for 2016, fixed broadband internet tariffs in Bangladesh (at 12.8PPP$/min) are lower than in the UK (14.12PPP$/min) and Canada (37.5 PPP$/min). However, the lower price can be utilised by only the 9.6 per cent of Bangladesh's population that has access to the internet. In terms of internet quality, only 6.6kb/s international internet bandwidth is available per user in Bangladesh, compared with 129.2kb/s per user in Canada and 429.8kb/s per user in United Kingdom.

The speed of global digitalisation is putting pressure on economies to catch up and fulfil the facilitating conditions for digital transformation. However, Table 4.3 highlights the critical need to address basic digital infrastructure needs in relation to access to electricity before LICs can access, absorb and participate in basic aspects of the digital economy. Additionally, it is tempting to focus on areas where improvements can be made easily – such as in the case of the digital regulatory environment in Rwanda or affordability of internet access in Bangladesh. However, the Commonwealth countries that consistently perform relatively better in terms of digital infrastructure (e.g., Singapore, the UK, Canada, Australia and Malaysia) are also

Table 4.3 WEF Networked Readiness Index sub-components for Commonwealth countries, 2016

Country	Income Level	Region	Political & regulatory environment	Business & innovation environment	Infrastrue ture	Affordability	Skills	Individual usage	Business usage	Government usage	Economic impacts	Social impacts
Gambia	Low	Africa	4.16	3.45	2.71	2.96	3.25	2.58	3.48	3.70	2.86	3.55
Malawi	Low	Africa	3.46	3.36	2.66	1.97	2.66	1.53	3.14	2.80	2.45	2.72
Mozambique	Low	Africa	3.21	3.48	1.87	4.78	2.11	1.90	3.18	3.28	2.72	3.15
Rwanda	Low	Africa	5.41	4.36	2.83	3.59	3.48	1.94	3.69	5.30	2.89	4.83
Tanzania	Low	Africa	3.62	3.37	2.55	2.32	2.94	1.72	3.08	3.40	2.35	3.26
Uganda	Low	Africa	3.74	3.62	2.66	3.31	2.90	1.90	3.27	3.43	2.60	3.12
Cameroon	Lower middle	Africa	3.27	3.67	1.11	2.77	3.79	1.97	3.56	3.29	2.95	2.98
Eswatini	Lower middle	Africa	3.19	3.45	2.50	2.21	4.18	2.35	3.15	2.65	2.32	2.69
Ghana	Lower middle	Africa	3.96	4.01	2.22	4.19	4.10	3.46	3.51	3.41	2.65	3.50
Kenya	Lower middle	Africa	3.71	4.00	3.07	4.31	4.24	2.61	3.86	4.40	3.43	4.47
Lesotho	Lower middle	Africa	3.97	3.88	2.42	5.01	3.78	2.10	3.09	2.91	2.40	3.08
Nigeria	Lower middle	Africa	3.16	3.69	2.61	4.34	2.41	2.51	3.47	3.25	2.94	3.02
Zambia	Lower middle	Africa	3.87	4.78	1.96	2.54	3.62	1.97	3.58	3.33	2.69	3.31
Botswana	Upper middle	Africa	4.12	4.06	3.11	2.92	4.61	3.17	3.41	3.58	2.78	3.43
Mauritius	Upper middle	Africa	4.56	4.74	4.27	5.50	5.33	4.26	3.77	4.31	3.21	4.23
Namibia	Upper middle	Africa	4.48	3.86	3.91	3.17	3.77	2.99	3.73	3.52	2.89	3.49
South Africa	Upper middle	Africa	4.99	4.33	4.88	5.20	4.37	3.90	4.20	3.32	3.40	3.30
Bangladesh	Lower middle	Asia	2.51	3.73	2.75	6.42	3.14	2.13	3.09	3.76	2.84	3.38
India	middle	Asia	3.69	3.70	2.61	6.60	4.12	2.15	3.55	4.05	3.12	4.12
Malaysia	Upper middle	Asia	5.09	5.21	4.18	4.68	5.44	5.05	4.73	5.48	4.08	5.21
Pakistan	Lower middle	Asia	2.96	3.93	2.09	6.92	2.84	2.09	3.23	3.33	2.83	3.41
Sri Lanka	Upper middle	Asia	3.79	4.10	3.00	6.02	5.67	2.83	3.87	5.04	3.20	4.70
Guyana	Upper middle	LAC	3.59	4.12	2.93	4.22	4.94	2.70	3.54	3.40	2.91	3.66
Jamaica	Upper middle	LAC	4.02	4.40	3.15	5.37	4.62	3.54	3.66	3.62	3.14	3.52
Seychelles	High	Africa	3.90	3.94	4.75	4.50	5.01	4.35	3.59	3.68	3.15	3.77
Singapore	High	Asia	5.93	5.97	6.57	5.29	6.48	6.36	5.42	6.26	5.89	6.25
Cyprus	High	Europe	3.94	4.83	5.47	6.31	5.95	4.95	3.77	3.73	3.60	4.11
Malta	High	Europe	4.48	4.49	6.30	4.80	5.46	5.92	3.97	4.31	4.03	4.89
United Kingdom	High	Europe	5.73	5.48	6.32	5.69	5.80	6.64	5.18	5.40	5.31	5.91
Canada	High	LAC	5.38	5.48	6.96	5.55	6.06	5.73	4.88	5.10	5.19	5.60
Trinidad and Tobago	High	LAC	3.28	4.14	5.22	5.87	5.47	4.73	3.52	3.48	3.13	3.67
Australia	High	Pacific	5.40	5.09	6.96	5.59	5.98	6.33	4.79	5.03	4.66	5.67
New Zealand	High	Pacific	5.86	5.43	6.85	4.55	6.19	6.11	4.98	5.36	4.59	5.45
World Average			**3.93**	**4.31**	**4.17**	**4.97**	**4.73**	**4.13**	**3.85**	**3.96**	**3.48**	**4.15**

Note: The darkest red represents the lowest score across ten components and among countries, yellow is the median score, and the darkest red is the highest score.

the countries that have high NRI scores across all digital preparedness indicators in Table 4.2. This highlights the importance of broadly addressing digital preparatory needs across the regulatory and business environment, infrastructure, affordability and skills for countries to fully utilise and harness the gains from basic to advanced digital infrastructure.

It is important to note that the digital infrastructure divide among Commonwealth countries may emanate from access to electricity – a basic prerequisite for the functioning of digital devices and equipment – wherein only 28 per cent of the Commonwealth LIC population, on average, have access to electricity, as seen from Table 4.1.

4.3 Digitalisation and smart cities

The impact of digitalisation affects a range of economic activities with implications for the overall functioning of cities and the well-being of their populations. There is no universal definition of a 'smart city' in the literature. However, the European Commission (2019a) defines a smart city as 'a place where traditional networks and services are made more efficient with the use of digital and telecommunication technologies for the benefit of its inhabitants and business'. Meanwhile, McKinsey (2018) identifies three layers that make up a smart city: (i) 'technology base', which includes a critical mass of smartphones and other sensors connected by high-speed communication networks, as well as open data portals; (ii) 'specific applications', which translate raw data into alerts, insight and action; and (iii) 'public usage' that can lead to better decisions and behavioural change. In the sections that follow, we explore the intersection of digital progress and smart cities as indicators (or proxy indicators) that enable the emergence of smart cities in Commonwealth countries.

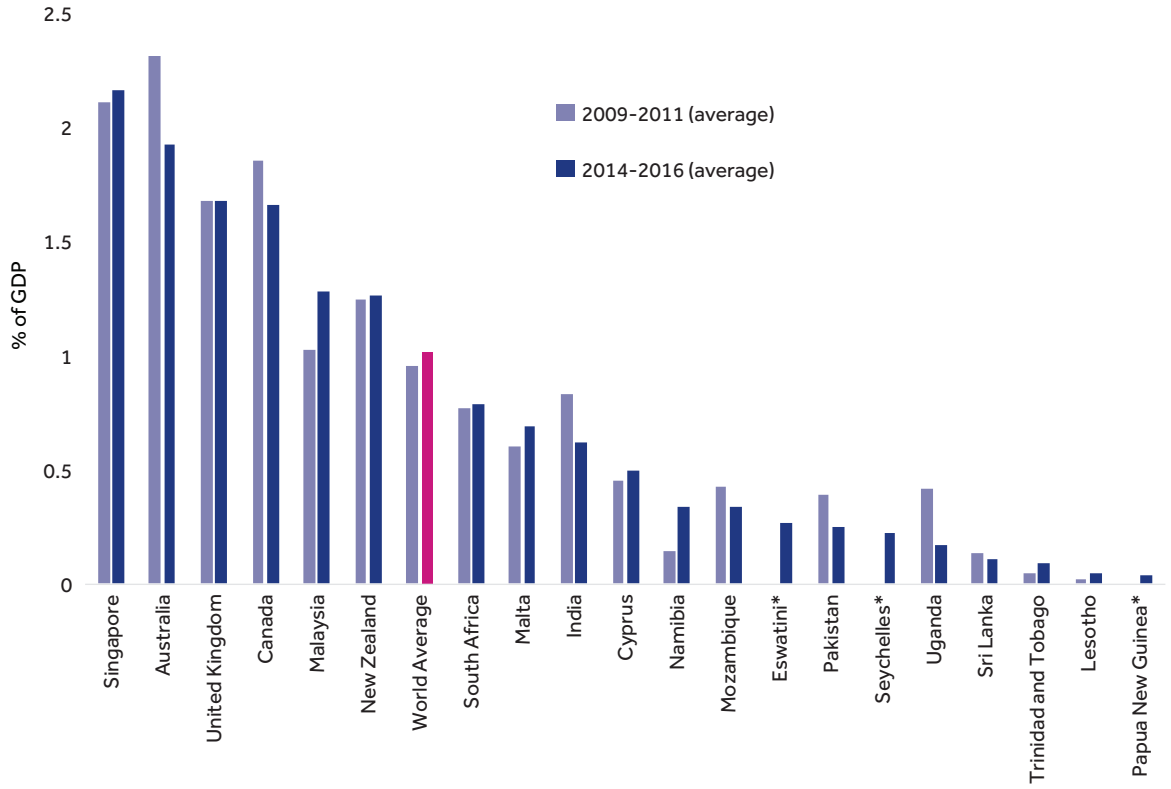
4.3.1 Smart economy

R&D can make a significant contribution in revolutionising digitalisation of business models, value chains, services and product portfolios (Strategy& and PWC 2016). At the same time, digitalisation (e.g., extracting data from raw material to prototype phase, Big Data analysis) can also make firms' R&D processes more efficient and affordable (ibid). For example, Huawei's (in China) strategy focusing on local R&D and reverse engineering, and Samsung's (in the Republic of Korea) shift from importing knowledge to building in-house design competencies, helped these companies become global leaders in the production of smartphones (cited by Mayer 2018 from Kang 2015, and Yoo and Kim 2015).

As a proxy for innovative capacity in the digital economy, we look at countries' overall R&D expenditure as a share of GDP. Figure 4.6 shows that Commonwealth HICs (Singapore, Australia, the UK, Canada and New Zealand) and Malaysia (UMIC) have continued to be the highest R&D spenders since 2009. Among 21 Commonwealth countries with available data from 2014 to 2016, more than half fell below the world average, and five countries (India, Mozambique, Pakistan, Uganda and Sri Lanka) experienced a contraction in average R&D spending in 2014–16 compared to 2009–11 levels.

Patents that give exclusive rights for an invention or a new technical solution (WIPO 2019) represent a traditional output measure of innovation (WEF 2016). As of 2016, the World Intellectual Property Organization (WIPO) reported that the highest share of published patent applications worldwide was recorded in computer technology (7.5%), electrical machinery, apparatus, energy (7%) and digital communications (5.1%). Among Commonwealth countries, Singapore has the highest ICT patent penetration, with 60 ICT-related patent applications filed under the Patent Cooperation Treaty (PCT) per 1 million people, followed by Canada, the UK, Australia and New Zealand. Meanwhile, HIC small states in the Commonwealth (Seychelles and Malta) recorded an increase in ICT patent penetration in 2016 (Figure 4.7). However, among 33 Commonwealth countries with 2016 data, 10 countries had less than one ICT patent application

Figure 4.6 Research and development expenditure (% of GDP)



Source: Authors' calculations based on World Bank data.

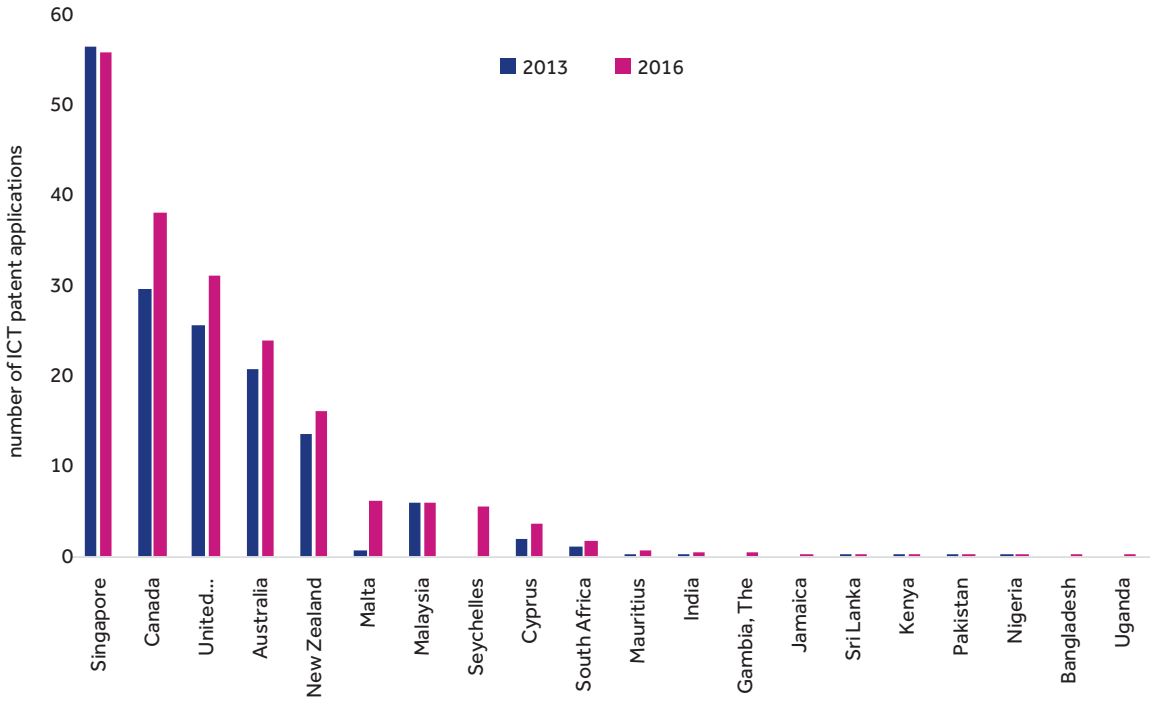
Notes: No available 2009–11 data for eSwatini, Seychelles and Papua New Guinea.

per one million people, and 13 countries reported zero patent penetration in 2016. While there are several factors affecting the emergence of patents, the almost null patent penetration in lower-income Commonwealth countries may be related to cost and scale challenges as cited by Mayer (2018) – since patent applications are generally costly, developed country firms usually apply for patents in jurisdictions that cover large economies.

A friendly ecosystem for start-ups is also a key feature of a smart city. A World Bank study (Mulas et. al. 2015) suggests that a rise of ICT start-ups in cities creates new business and employment categories that are becoming new sources of employment and economic growth. Mulas et. al. (2015) observed, through various World Bank studies, that creating and supporting a community of tech entrepreneurs (e.g., assets and mentoring), providing incentives to kickstart the ecosystem (e.g., competition, challenges) and providing skills programmes often leads to a growing and sustainable technology innovation ecosystem.

For Commonwealth countries, we use the WEF indicator of availability of venture capital and the speed of starting businesses as a proxy for the conduciveness of the ecosystem for technology start-ups and innovation in general. Figure 4.8 shows that higher availability of venture capital and fewer days required to start a business are common features in Singapore, Australia, Canada, the UK, New Zealand and Malaysia, although LIC Rwanda is performing on par with Australia. More generally, countries with higher venture capital availability also have faster processing times to start a business.

Figure 4.7 ICT PCT patent applications per 1 million people



Source: Authors (constructed graph culled from World Bank data based on WEF reports).

However, there are a number of variations among countries. For example, among UMICs, starting a business usually takes 66 days in Namibia, while it only takes four days in Malaysia and three days in Jamaica.

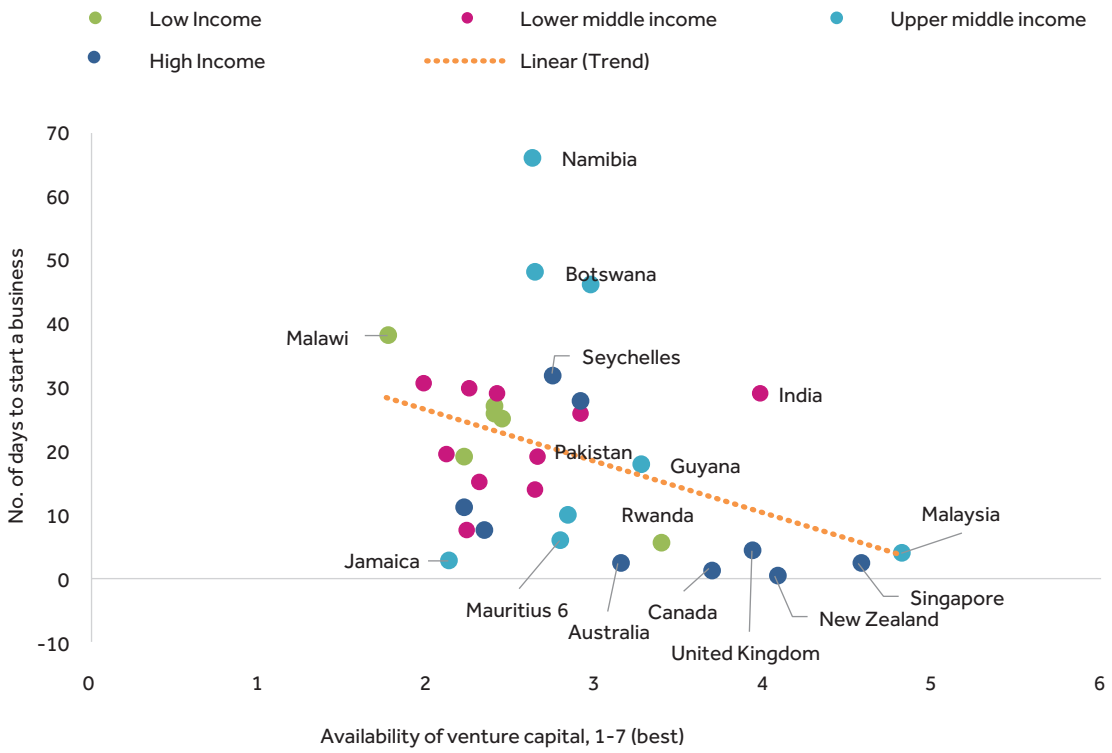
The availability of accessible and widely adopted smart applications can change the nature of city dwelling, which may translate into improvements in well-being. McKinsey (2018) looked at relevant smart applications in cities up to 2025 across many quality-of-life dimensions, such as for security (e.g., real time crime mapping), healthcare (e.g., first aid alerts), mobility (e.g., private and pooled e-hailing), energy (e.g., smart streetlights), water (e.g., leakage detection and control), waste (e.g., digital payment for waste disposal), economic development and housing (e.g., digital business tax filing, peer-to-peer accommodation platforms), and community engagement (e.g., local civic engagement platforms). They found that smart applications can improve quality-of-life dimensions by 10–30 per cent and noted that about half of the applications affect more than one aspect of the quality of life.

For Commonwealth countries, we examine mobile money service penetration as an indicator of availability and adoption of smart applications. Figure 4.9 shows that while the HICs lead the Commonwealth countries in this financial technology service, Kenya, India and Uganda have made significant progress in increasing mobile money service penetration – by about 40 percentage points from 2011 to 2017.

4.3.2 Smart governance

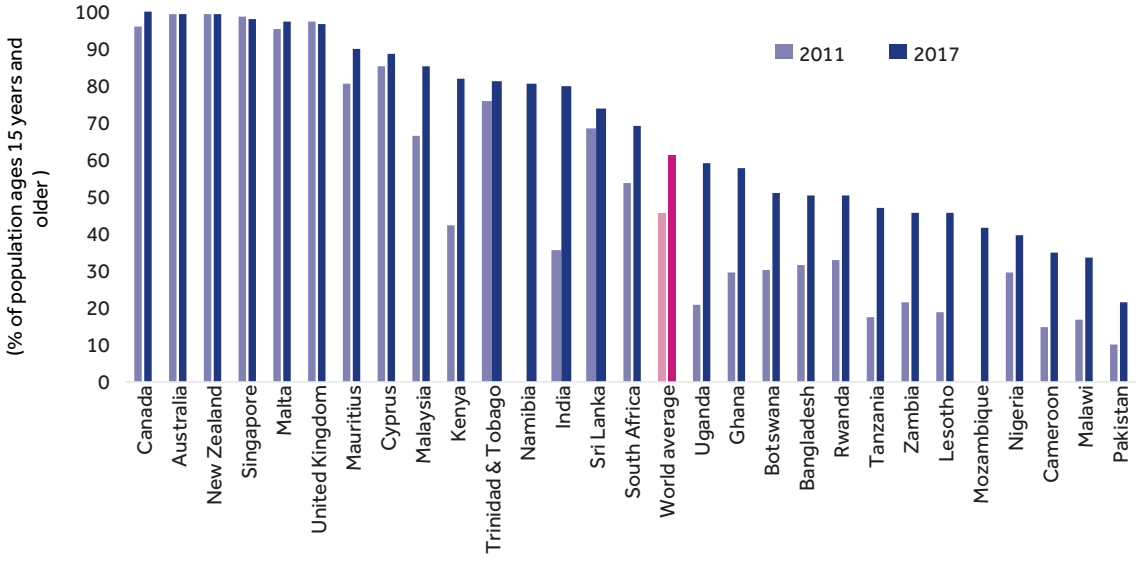
The availability of digital technology provides an opportunity for governments to improve efficiency and increase the reach of public services, as well as facilitate citizens' participation in public discussions/feedback and civic duty compliance

Figure 4.8 Business and venture capital support



Source: Authors' calculations based on 2016 WEF data.

Figure 4.9 Account ownership at a financial institution or with a mobile-money service provider (% of population ages 15+)



Source: Authors' calculations based on World Bank data. No 2011 data available for Namibia.

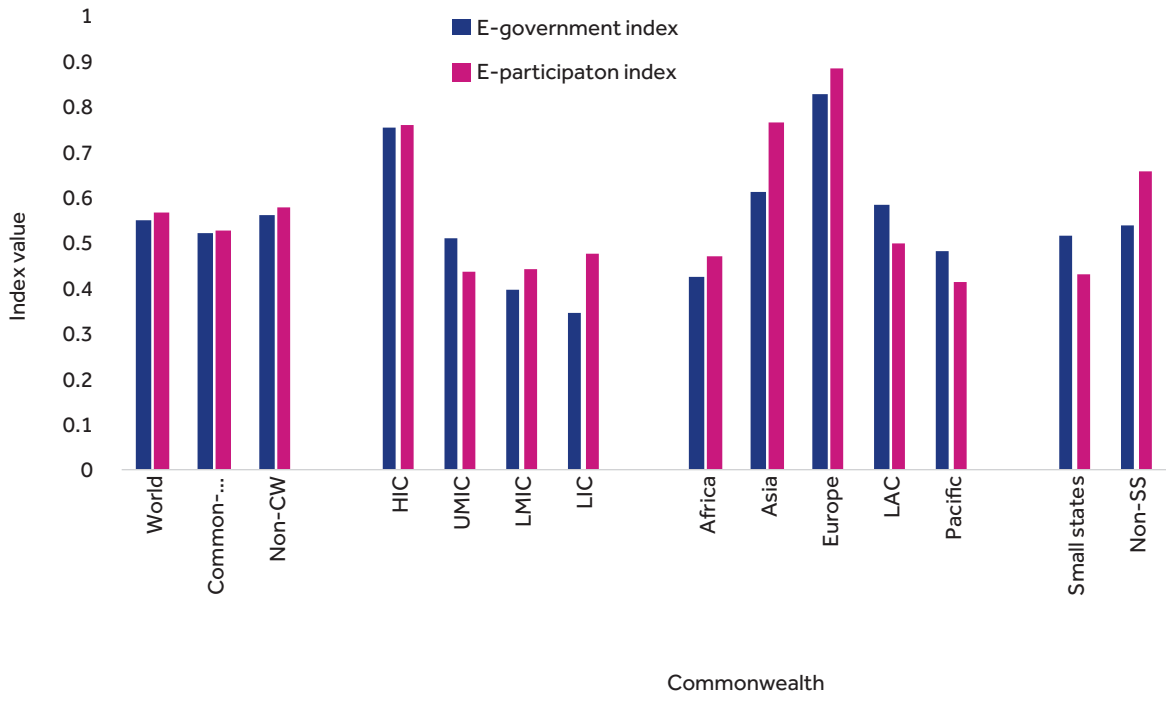
(e.g., digital business permit application, tax payments). We utilise the 2018 UN E-Government Survey e-government development index (EDGI) and e-participation index (EPI), which cover all 53 Commonwealth countries. The EDGI assesses the capacity and preparedness (e.g., in terms of human capital, telecommunication infrastructure and online services) of national agencies to leverage ICT in the delivery of public services. Meanwhile, the EPI assesses the availability of online information, online public consultation and involvement in decision processes.

Figure 4.10 shows that while the Commonwealth performs on par with the world and non-Commonwealth country averages in e-governance, variances exist among Commonwealth countries by income, region and size. LICs and countries in Africa and the Pacific have the lowest EDGI and EPI scores, while e-governance and e-participation is relatively less developed among Commonwealth small states. This mirrors the digital divide risk flagged by the 2018 UN E-Government Survey, wherein it cited that while online use increases opportunity for e-inclusion, it also risks creating a new digital divide due to the lack of digital infrastructure in LICs (United Nations, 2018). This is consistent with the Commonwealth HIC–LIC divide we observed in earlier sub-sections.

4.3.3 Smart transport and logistics

An integrated and digitally tractable public transport system is a key feature of smart cities. An intelligent transport system applies ICT to make passenger and freight transport safer, more efficient and sustainable (European Commission 2019b). The London Transport System, for instance, exemplifies integrated digital payments through bank cards, mobile phones and Oystercards for train and bus fares. Similarly, in the city of Mysuru in Karnataka, India, a GPS-enabled Intelligent Transport System (ITS) is being employed to monitor speed and co-ordinates of more than 400 city buses

Figure 4.10 E-government and citizens' public engagement through ICT



Source: Authors' calculations based on UN data.

(World Bank 2017). Through the ITS, passengers can track the arrival time of buses online or through mobile phones. More generally, by using smart applications, commuting times in cities are expected to be cut by 15–20 per cent (Mckinsey 2018).

In the absence of data directly measuring smart transport indicators for Commonwealth countries, we use proxy indicators such as the trade logistics and facilitation indicators from the World Integrated Trade Solutions (WITS) database covering postal services, international shipment and customs. Table 4.4 shows that Commonwealth HICs and countries in Asia and Europe have all performed above the world average across all indicators. Conversely, all Commonwealth LMICs and LICs, and countries in Africa, performed worse than the Commonwealth and world averages across indicators. Except for postal service penetration and customs export clearance, Commonwealth small states have performed worse than the average across all indicators. Of the 30 Commonwealth small states in the sample, 20 are located in either the Caribbean or the Pacific, reinforcing the reality that logistics and trade facilitation performance is especially challenging for relatively small and remote Commonwealth countries.

4.4 Regulatory and governance framework

To bridge the digital divide across and within Commonwealth countries, there is a need for a supportive regulatory and governance framework targeting improvements and investments in digital infrastructure.

Standard challenges – such as poor trade logistics, unreliable electricity and inadequate road infrastructure – continue to present obstacles

Table 4.4 Logistics and trade facilitation

	(1) Percent of population having mail delivered at home – UPU Database	(2) Postal reliability index – UPU Database	(3) Percent of the population without postal services – UPU Database	(4) LPI international shipments score	(5) LPI tracing and tracking score	(6) LPI timeliness score	(7) Days to clear direct exports through customs – Enterprise Survey	(8) Burden of customs procedures – World Economic Forum
World	63.35	50.15	11.16	2.87	2.86	3.27	7.71	4.06
Commonwealth (CW)	49.41	41.85	13.10	2.87	2.87	3.26	7.95	4.11
Non-CW	68.33	53.34	10.47	2.87	2.86	3.27	7.62	4.05
By income								
CW HIC	87.96	56.74	0.94	3.14	3.21	3.58	6.60	4.84
CW UMIC	47.07	41.12	3.20	2.86	2.90	3.28	7.59	4.20
CW LMIC	27.36	32.48	25.86	2.61	2.61	3.00	8.05	3.50
CW LIC	21.44	32.51	33.13	2.86	2.70	3.15	9.85	3.93
By region								
CW Africa	25.73	38.23	24.68	2.75	2.70	3.15	8.61	3.81
CW Asia	96.14	59.69	0.71	3.24	3.24	3.56	7.62	4.42
CW Europe	99.30	74.13	0.00	3.22	3.26	3.91	(no data)	4.83
CW LAC	58.25	36.55	0.93	2.75	2.86	3.10	7.25	3.83
CW Pacific*	31.69	33.10	21.13	2.62	2.67	2.97	7.65	5.50
By size								
CW small states	46.01	31.31	8.75	2.58	2.54	3.06	7.06	3.97
CW non-small states	53.40	54.69	18.21	3.04	3.07	3.39	9.16	4.19

Source: Authors' calculations based on WITS data. Green circles represent better than world average performance/score and red circles represent below world average performance/score.

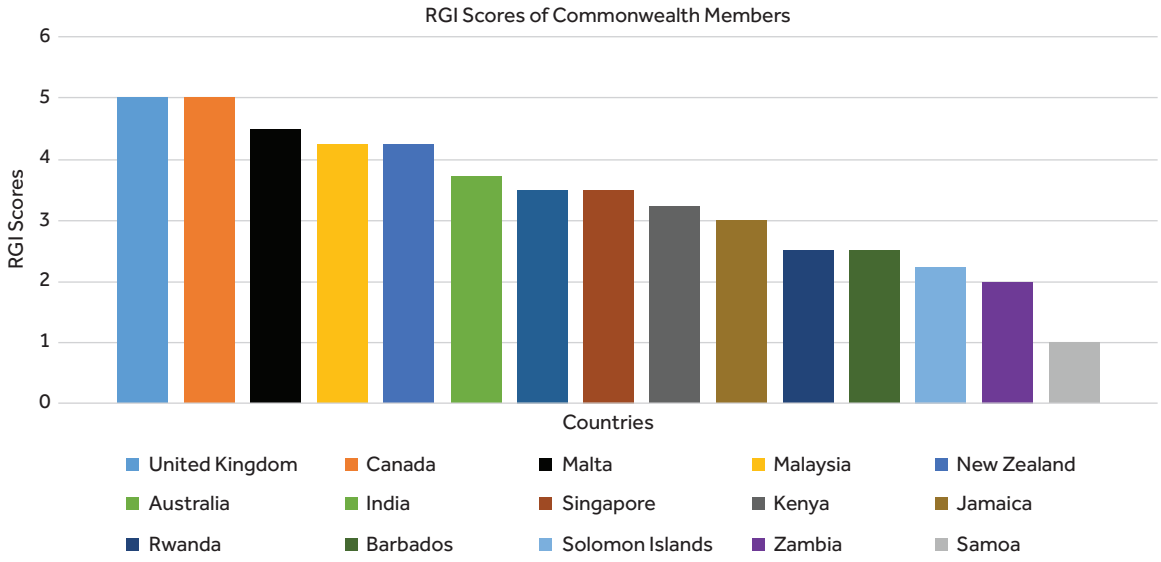
Note: That in indicators (3) and (8), lower than world average percentage and days mean better performance than world average.

for leveraging digitalisation in less-developed Commonwealth countries. Nigeria, for example, has an international broadband backbone by terabytes of data-laden cables at the country's shores – typically in Lagos – but there remains a significant connectivity gap inland due to a lack of wider adoption of infrastructure sharing. As per the World Bank's Ease of Doing Business indicators, many Commonwealth countries (38 out of 51 countries in the sample) also continue to lag behind the world median Ease of Doing Business index score, reflecting the challenges faced by lower-income countries and small states that largely comprise the Commonwealth. In comparison, Rwanda, Kenya and India have significantly increased their Doing Business scores since 2016 and are now performing above the world median.

According to the regulatory governance index (RGI) for Commonwealth member countries, it is evident that each of the countries is at a different stage of regulatory performance. Figure 4.11 shows the RGI scores for a selection of Commonwealth member countries. Variation in the RGI reflects differences in the development of quality and effective regulations. The RGI scores among the Commonwealth member states vary significantly. Member countries such as the UK, Canada, Malta, Malaysia and New Zealand have RGI scores between 4 and 5. For these countries, the processes adopted for the development of quality regulations are better and more transparent than those for the other member countries. There countries are in the upper quartile for RGI scores and thus for good regulatory practices (GRPs). Countries that are in the middle quartile are those with RGI scores between 3 to 3.75. These include Australia (3.75), India (3.5), Singapore (3.5), Kenya (3.25), and Jamaica (3). The rest of the Commonwealth member countries have RGI scores of below 3. These include countries such as Barbados, Rwanda, Solomon Islands, Zambia, Samoa and Seychelles.

In addition to general investment in physical infrastructure and creating a supportive business environment, targeted investments are needed in the Commonwealth to build digital infrastructure. First, there is a need to improve access to good quality internet across developing Commonwealth countries. To make internet more affordable in Commonwealth countries, policies need to target public-access solutions including through free

Figure 4.11 Regulatory governance index among Commonwealth countries



Source: https://rulemaking.worldbank.org and authors' own compilation.

or subsidised access to public/open areas such as educational institutions, local and community centres, and public WiFi; close digital urban-rural divides through, for example, reductions in taxes on ICT services and equipment supplied to rural areas; provide incentives to network operators to expand coverage to marginal areas; and reduce import duties for local content suppliers. One country that has significantly improved its internet affordability is Botswana through rules enabling technology and service neutrality, without restricting operators from holding several types of licenses such as network and services licenses (Alliance for Affordable Internet 2017). The Botswana government has also used its Universal Access Fund (USAF) to increase the number of public WiFi hotspots in hospitals, bus stops and shopping malls across seven towns.

On top of the higher cost of capital in these economies, the cost of financing also remains an obstacle to digital transformation, often as a result of market and co-ordination failure. In the case of Kenya, for instance, Kenya Association of Manufacturers (2018) confirms that there is limited access to technology among Kenyan manufacturing industries due to the high cost of financing innovation and digital technologies, particularly in the textiles and apparel industry, where the cost of financing manufacturing investments and trade financing is very high compared to global rates. Box 4.2 highlights successful initiatives taken by the Kenyan government to increase access to the internet, which include targeted digital investments, improvements in the ease of doing business and 'digital infrastructure sharing' with India (see Box 4.2).

Second, there is a need to build data infrastructure in the Commonwealth to support member states to collect, process and analyse data. UNCTAD (2018) highlights Rwanda's pioneering National Data Revolution Policy (2017), from which important principles can be adopted and adapted in other Commonwealth countries. Rwanda's data revolution policy focuses on: (i) classification of data into sensitive and non-sensitive sets, following which sensitive data is protected; (ii) national data sovereignty, whereby Rwanda retains exclusive sovereign rights on national data but is open to hosting its data in local or international data centres as per Rwandan laws; (iii) increasing access to non-sensitive data by public consolidation and publication of data with granularity, completeness, accuracy and open licensing; (iv) recognition of the author of data, as per data intellectual property rights (IPRs); and (v) PPPs as an investment model in the data industry.

Thirdly, support from the government needs to be extended to digital manufacturing and services start-ups and also to ecosystem enablers such as technological and innovation hubs. Policies launched by the Indian government under Startup India, a flagship initiative under the wider Digital India programme, can provide useful insights into how start-ups, particularly digital start-ups, can be promoted. The Startup India initiative offers tax exemptions, exemptions from inspection requirements (such as those related to the labour environment), a roughly 80 per cent reduction in patent costs, easier regulations for businesses and procedures for licenses, easier exit (within 90 days) and funding support. It is also important to focus support on the development of hubs that can provide a manufacturing ecosystem in the form of technical support (internet and ICT services), manufacturing maker-space (manufacturing equipment and shared spaces), skills development (training in hardware engineering, coding, digital fabrication, IoT and blockchains), and at the same time act as incubators (support for product formation, conceptualisation of ideas, business development, networking and funding support). Good examples of initiatives in this area include the government's susAso Villa Demo Day in Nigeria, and corporate initiatives by EcoBank and GE Garage, which fund and integrate innovations into the economy. Effective public-private collaboration is needed to support such technological and innovative hubs. Box 4.3 summarises some important policies and lessons that can be drawn from across Commonwealth countries in building digital infrastructure.

Box 4.2 Digital transformation in Kenya

A number of initiatives have been taken by the Kenyan Government to catapult Kenya into being a digital leader in Sub-Saharan Africa. In recent years, *Kenya has invested in an enabling environment* by moving towards a more open trade regime, targeting increased overseas market access for Kenyan services and further global integration. These policy objectives have been pursued through regional and bilateral trade negotiations, particularly with other African countries, and also through Kenya's participation at the World Trade Organization (WTO). Kenya has undertaken many steps to improve the investment climate and to become more attractive for foreign investors. The World Bank Group's Doing Business (2017) assessment ranks Kenya as the third most reformed country – it has moved up 21 places to reach 92nd position out of 190 economies on the overall ease of doing business. In the last 5-6 years, important reforms have been made in the following areas: starting a business, access to electricity, registration of property, protecting minority investors and resolving insolvency. The Kenyan Investment Authority (KenyaInvest) and the Business Environment Delivery Unit also continue to make progress in reducing bureaucracy and simplifying the process of registering a business in Kenya, while recent laws such as the Bribery Act (2016) and the Access to Information Act (2016) are targeted towards fighting corruption and improving transparency in business.

Kenya has also made a number of targeted digital investments. It has opted for a national fibre backbone that connects different towns and leverages alternative service providers such as the network available from Kenya Power and Lighting Company. The Kenya Economic Survey (2018) records significant improvements in Kenya's digital economy: the value of ICT output increased by 12.9 per cent between 2017-2018, while ICT value added rose by 6.6 per cent over the same period. The number of internet service providers (ISPs) increased by 17.4 per cent from 219 in 2017 to 257 in 2018, partly attributed to demand for fibre optic cable in most parts of the country that created the need to supply internet to businesses and residential buildings. In addition, Kenya has invested in digital infrastructure sharing by granting Mobile Virtual Network Operating (MVNO) Licenses. These MVNOs do not have their own infrastructure, but rather practice 'infrastructure sharing' with already established telecom providers, who have excess network capacity. Each MVNO then sells services, such as data for accessing the internet, at its own price. Kenya has granted MVNO licenses to three companies offering mobile money and data services, and all three MVNOs depend on infrastructure supplied by Airtel, an Indian telecommunications company (Kenyan Wall Street 2018).

Source: Authors.

Box 4.3 Building digital infrastructure: lessons from the Commonwealth

Rwanda: Key digital infrastructure was put in place in the country between 2006–2011, including the national fibre optic backbone, the Kigali Metropolitan Network and the Tier-III National Data Centre. The government also launched a Broadband Policy to increase the accessibility, affordability, reliability and usage of broadband services throughout Rwanda. Since then, the government has entered into a joint venture with Korea Telecom to provide an open-access wholesale 4G-LTE network, the first in Africa. The Rwanda Utilities Regulatory Authority was set up an as autonomous regulatory body overseeing internet governance. The Rwanda Internet Community and Technology Alliance is now working on the Rwanda Web Hosting project to support local hosting of local content through engagement across stakeholders.

India is pioneering a digital identity infrastructure, Aadhar, and has issued IDs to over 1.15 billion residents. It is one of the world's largest biometric-based digital identity systems, creating opportunities for the government and the private sector to transform citizen-centric services, and to provide innovative platforms for digital transactions. Biometric data collection needs collaboration between the government and various ecosystem partners (including state governments, registrars, enrolment agencies, authentication service providers, user agencies, logistics provider and project management units) to be successfully rolled out, and the establishment of an enabling legal and regulatory framework recognising digital identity, data privacy and other important elements at the start of the programme.

Singapore has expanded its broadband infrastructure, with 100 per cent of homes connected (up to up to 10 bytes) and a 150 per cent device penetration rate. It has adopted an open innovation model through partnerships, which includes engaging and incentivizing start-ups in the innovation process and creating a collaboration model (e.g. open key performance indicators). It has upgraded internal capabilities to align with new technologies and hired externally from other sectors.

Source: WEF (2017).

References

Alliance For Affordable Internet (2017), *2017 Affordability Report*, available at: http://1e8q3q16vyc81g8l3h3md6q5f5e.wpengine.netdna-cdn.com/wp-content/uploads/2017/02/A4AI-2017-Affordability-Report.pdf (accessed September 2019).

European Commission (2019a), *Smart Cities*, available at: https://ec.europa.eu/info/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities_en (accessed August 2019).

European Commission (2019b), *Intelligent Transport Systems*, available at: https://ec.europa.eu/transport/themes/its_en (accessed September 2019).

GSMA (2018), 'Mobile Connectivity Index', available at: http://www.mobileconnectivityindex.com/.

Kenya Association of Manufacturers (2018), 'Manufacturing in Kenya Under the 'Big 4 Agenda':

A Sector Deep-dive Report', KAM, Nairobi, available at: http://kam.co.ke/kam/wpcontent/uploads/2018/10/KAM-Manufacturing-Deep-Dive-Report-2018.pdf.

Kenyan Wall Street (2018), 'Equitel: Kenya's First & Most Successful MVNO', available at: https://kenyanwallstreet.com/equitel-kenyas-first-most-successful-mvno/.

Mayer, J (2018), 'Digitalization and industrialization: friends or foes?', UNCTAD Research Paper No. 25, available at: https://unctad.org/en/PublicationsLibrary/ser-rp-2018d7_en.pdf

McKinsey & Company (2018), *Smart cities: Digital solutions for a more liveable future*, McKinsey Global Institute, available at: https://www.mckinsey.com/~/media/McKinsey/Industries/Capital%20Projects%20and%20Infrastructure/Our%20Insights/Smart%20cities%20Digital%20solutions%20for%20a%20more%20livable%20future/MGI-Smart-Cities-Full-Report.ashx.

Mulas, V, M Minges and H Applebaum (2015), 'Boosting Tech Innovation Ecosystems in Cities: A framework for growth and sustainability of urban tech innovation ecosystems', World Bank Working Paper 100899.

Qiang, CZ-W, C Rossotto and K Kimura (2009), 'Economic Impacts of Broadband', in *Information and Communications for Development*, World Bank, Washington DC, available at: http://siteresources.worldbank.org/EXTIC4D/Resources/IC4D_Broadband_35_50.pdf.

Strategy& and PWC (2016), *Research and Development 4.0. The mutual benefits of digitization and R+D*, available at: https://www.pwc.nl/nl/assets/documents/pwc-research-and-development-strategyand.pdf.

United Nations (2018), *E-Government Survey 2018: Gearing E-Government to Support Transformation towards Sustainable and Resilient Societies*, United Nations, New York, available at: https://publicadministration.un.org/egovkb/Portals/egovkb/Documents/un/2018-Survey/E-Government%20Survey%202018_FINAL%20for%20web.pdf.

UNCTAD (2018), *Trade and Development Report 2018: Power, Platforms and The Free Trade Delusion*, UNCTAD, Geneva, available at: https://unctad.org/en/PublicationsLibrary/tdr2018_en.pdf.

UNCTAD (2017), *UNCTAD B2C E-Commerce Index 2017*, UNCTAD Technical Notes for Development, available at: https://unctad.org/en/PublicationsLibrary/tn_unctad_ict4d09_en.pdf.

World Bank (2017), 'India: Mysuru's Smart Public Bus Transport for Livable Cities WBx Talks', World Bank Group Open Learning Campus, available at: https://olc.worldbank.org/content/india-mysurus-smart-public-bus-transport-livable-cities.

WEF (World Economic Forum) (2017), 'Digital Policy Playbook 2017: Approaches to National Digital Governance', White Paper, September 2017, available at: http://www3.weforum.org/docs/White_Paper_Digital_Policy_Playbook_Approaches_National_Digital_Governance_report_2017.pdf.

WEF (2016), 'The Networked Readiness Index 2016', available at: http://www3.weforum.org/docs/GITR2016/WEF_GITR_Chapter1.1_2016.pdf.

World Intellectual Property Organization (2019) 'Patents', available at https://wipo.int/patents/en/faq_patents.html (accessed August 2019).

End Notes

1 The overall MCI score is made up of four enablers representing – what are commonly agreed to be – the key determinants of mobile internet access and usage: infrastructure, affordability, content and services, and consumer readiness. These are themselves built upon 35 discrete indicators.

2 Includes Australia-New Zealand (combined), Canada, India, Malaysia, Singapore, South Africa and United Kingdom.

3 Includes Australia, Canada, India, Malaysia, New Zealand, Singapore, South Africa and United Kingdom.