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The Digital Infrastructure Divide in the Commonwealth

Radika Kumar and Niels Strazdins

The Commonwealth

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By Radika Kumar and Niels Strazdins.

Radika Kumar is Adviser for Infrastructure Policy and Niels Strazdins is Trade Specialist at the Commonwealth Secretariat.

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Abstract

This paper assesses infrastructure using various parameters including access, affordability and performance. It considers the hard/soft infrastructure divide, which includes literacy as a human capital investment in the digital economy. Furthermore, it assesses the gender digital divide in relation to digital infrastructure for sustainable and inclusive development. The COVID-19 pandemic has highlighted the importance of sound digital infrastructure for economic sustainability in Commonwealth member countries. It has also resulted in a major digital infrastructure divide that has affected economic activities across the Commonwealth.

The Physical Connectivity Cluster of the Commonwealth Connectivity Agenda, led by The Gambia, has developed the 'Agreed Principles on Sustainable Investment in Digital Infrastructure' which identify six core areas of infrastructure development. This paper provides further technical analysis of infrastructure – including digital infrastructure – as a core component to accelerate economic recovery. It finds that a digital divide exists within and across the Commonwealth, at different levels. It asserts that digital infrastructure gaps must be addressed through effective and targeted interventions as Commonwealth countries further develop their economies.

JEL Classifications: I15, O10, O30

Keywords: digital infrastructure, economic development, digital economy, COVID-19, Commonwealth

Contents

1. Introduction

Infrastructure is a vital conduit for the effective functioning of economies. A well-functioning infrastructure ecosystem acts as an enabler for economic development, contributes to the competitiveness of economies, and facilitates trade and investment. The productive use of infrastructure can reduce the global infrastructure bill by 40 per cent, equivalent to US$1 trillion annually, creating savings that could boost economic growth by about 3 per cent or more than US$3 trillion by 2030[1] (Bailey et al. 2014). One of the largest constraints to economic development has been inadequate infrastructure in developing countries. For developing countries in Asia Pacific, US$22.6 trillion in infrastructure investment will be needed from 2016 to 2030, equating to US$1.5 trillion per year, if the region is to maintain growth and eradicate poverty. This figure would increase to US$26 trillion if additional investment of US$1.7 trillion per year was included for climate change mitigation costs[2] (Department of Foreign Affairs & Trade 2020).

There exist major gaps in relation to the access, quality and affordability of infrastructure across the Commonwealth. Factors such as increases in population, urbanisation, health and safety concerns, environmental considerations, financing capacity, international trade, and the rise in digital technology affect access to, affordability and quality of infrastructure (Global Infrastructure Hub 2020).

Sustainable Development Goal 9 (SDG 9) further accentuates the important role infrastructure plays in sustainable and inclusive development. It identifies that inclusive and sustainable industrialisation, along with innovation and infrastructure, can unleash dynamic and competitive economic forces that generate employment and income[3] (United Nations 2015).

Infrastructure can be defined in several ways. To begin with, infrastructure can be used to describe the interconnectedness of organisation structures that underpin society, thereby enabling it to function effectively.[4] Furthermore, infrastructure is also defined as the total of all material, institutional, personal and data infrastructure, which is available to economic agents and which contributes to the realisation and the equalisation of the remuneration of comparable inputs. (Jochimsen, 1966). Infrastructure using three sub-categorical terms includes institutional infrastructure, personal infrastructure and material infrastructure. Institutional infrastructure is provided by the government and comprises the rules and procedures for implementing and activating the economic potentialities of economic agents. Personal infrastructure is represented by the number and the properties of the working population that influence the economic potentialities of the economic agents. Material infrastructure refers to capital stock that serves the function of mobilising the economic potential of agents (Buhr 2003).

For the purpose of analysis, this paper focuses on 'hard' and 'soft' infrastructure. Hard infrastructure includes the physical systems that are required to run a nation. These include basic and critical infrastructure such as roads, highways, bridges, telecommunications and energy, among others. The hard infrastructure component also comprises the information technology (IT) and digital infrastructure that enables the reach to last mile users (the end users) Soft infrastructure includes human capital that is used to deliver services and complements hard infrastructure.

The Physical Connectivity Cluster of the Commonwealth Connectivity Agenda has developed the overarching 'Principles of Sustainable Investment in Digital Infrastructure'. These comprise six core principles for member states of the Commonwealth to implement in order to contribute to the achievement of a US$2 trillion of trade and investment target by 2030. However, with COVID-19 and the resulting global economic recession, trade and investment around the world have been severely impacted. According to a recent Commonwealth survey on the economic response to COVID-19, infrastructure will be a critical component for the economic recovery of Commonwealth member countries following the pandemic. (Commonwealth Secretariat 2021).

COVID-19 has underscored the importance of the deeper digitalisation, highlighting the core issue of providing sound and conducive digital infrastructure to enable Commonwealth

economies to accelerate their economic recovery. Closing the digital infrastructure divide and focusing on the development dimension of infrastructure needs, through effective policy imperatives, will be key to the economic recovery of Commonwealth member states.

Against this backdrop, the paper aims to provide technical analysis to member states on the role of infrastructure – including digital infrastructure – as a core component to accelerate their economic recovery. In undertaking the analysis, assessment of the digital divide in relation to infrastructure is important if member states are to understand their position and develop effective targeted policies for intervention.

The paper is structured as follows: Section 2 discusses the nexus between infrastructure and sustainable economic development; Section 3 outlines the synergy between basic infrastructure and digital infrastructure as complements to digitalisation; Section 4 discusses the digital divide in relation to the infrastructure gaps that exist between Commonwealth countries; and, finally, Section 5 provides conclusions and policy recommendations.

2. Infrastructure and sustainable economic development

Infrastructure is a component of capital investment in overall gross domestic product, which is either funded by the government or the private sector, depending on whether the financed infrastructure is a public or a private good. Soft infrastructure investment, such as education and training, is a part of government and private sector investments aside from the accumulated capital investments in hard infrastructure. Investment in infrastructure is likely to increase during periods of high economic growth and recovery, as opposed to when economies are in recession. However, evidence suggests that investment in infrastructure for economic recovery leads to higher levels of economic growth and improved levels of competitiveness for countries. Infrastructure enables businesses to generate additional production capacity and reduces the cost of inputs and transaction costs. Furthermore, investment in soft infrastructure increases the productivity of workers and job opportunities (Palei 2015). With COVID-19 and increased demand for digitalisation, the development of soft infrastructure is paramount for economic recovery.

Infrastructure investment has a direct effect on production processes and improves supply chain resilience. As such, supply chain managers need to focus on developing regional and local infrastructure in order to improve production processes and increase efficiencies. There are further benefits associated with efficient transportation systems and the supply chain, coupled with information communications technology (ICT) applications to track raw materials and finished products (Rezza et al. 2017).

In relation to infrastructure and trade facilitation, a study on the correlation between the two identified that African countries could improve global value chain integration by improving infrastructure. Maritime and air connectivity were identified as major determinants of value-added performance, together with regional collaboration. Furthermore, strong relationships were found to exist between infrastructure and trade facilitation improvements with trading partners. As such, in order to improve value chain connectivity, well-functioning infrastructure in trading partners is also important.

Digital technology also plays a major role in economic development and needs to be supported with sound infrastructure. As economies move toward digitalisation, digital infrastructure is the foundation that enables businesses to move into higher value-added segments in all value chains and reach digital maturity. For example, without high-speed networks and highly secured available and reliable data centres, there would be no level of digitalisation for businesses of any size. (Waldhauser 2019).

Furthermore, infrastructure is an enabler of trade facilitation. In a study on the linkages between infrastructure and trade facilitation

in African countries, infrastructure improvement was emphasised as an area that required attention in sub-Saharan Africa (SSA) to enable countries in the region to move up global value chains, thus reinforcing the need for high-quality and well-connected infrastructure (Shepherd 2017, 1–22).

Moreover, infrastructure also influences the level of foreign direct investment (FDI) countries attract. A country with good infrastructure is likely to attract greater levels of FDI as investors usually search for markets where benefits can be maximised and costs of production reduced. This can be achieved if the infrastructure is in good condition and provides adequate support to industry. For example, Malaysia has been able to capitalise on its high-quality infrastructure to become one the most successful Southeast Asian countries in terms of attracting FDI (Bakar et al. 2012, 205–211). Another study relating to the impact of infrastructure development on FDI in Cameroon, revealed that communication infrastructure improvements had a positive impact on FDI in both the short and long terms (Nguea 2020).

In the Pacific region, a study on the impact of telecommunications infrastructure on economic growth, revealed that growth in the telecommunications sector had a positive influence on output per worker. The study revealed that a 1 per cent increase in telecommunications access through telephone connectivity contributed to a 0.33 per cent short-term increase and a 0.43 per cent long-term increase in worker productivity (Kumar et al. 2015, 284–295).

3. Synergy between basic and digital infrastructure

This section of the paper will examine in detail the interrelationship between basic infrastructure and digital infrastructure for last mile users. In order to have a well-functioning digital infrastructure ecosystem, it is imperative that economies have access to affordable and quality basic infrastructure. In relation to the integration of such technology for infrastructure, both the information technology (IT) and digital infrastructure needs of countries have to be ascertained, as they are complementary components of efficiently functioning digital economies. IT infrastructure includes the basic hardware, software and facilities on which information technology services are developed. These include network equipment (routers); telecom services that provide internet connectivity to leased lines; computer hardware, including basic software and operating systems; facilities to house infrastructure such as data centres; power generation capabilities, such as solar panels at data centres and solar battery systems; backup power generators to provide redundancy; and computing platforms, such as cloud computing and information security via hardware and software systems for intrusion detection.

Digital infrastructure components include the basic services that are necessary to enable the information technology capabilities of a nation or region. Digital infrastructure comprises the internet backbone, which includes principal data routers through which networks of different nations and regions are connected to form the internet. These include submarine communication cables and facilities that are used by tier 1 networks for interconnections. Fixed broadband services are also an example of digital infrastructure that connect regions and cities with wired internet, enabling last mile connections to businesses, data centres and households. Mobile telecommunications and cellular networks, which provide wireless broadband internet and communication services as well as communication satellites, are also important digital infrastructure components, providing network or information services. Wi-Fi networks are an important enabler in the digital economy, supporting, for example, the Internet of Things (IoT): encompassing advanced digital infrastructure, which includes robots, machines, sensors, and other facilitating infrastructure, products and vehicles that use Wi-Fi networks.

Coupled with these digital components, basic infrastructure providing water, energy, roads, ports and telecommunications infrastructure are pre-requisites for information technology and digital infrastructure. For example, hard telecommunications infrastructure is required

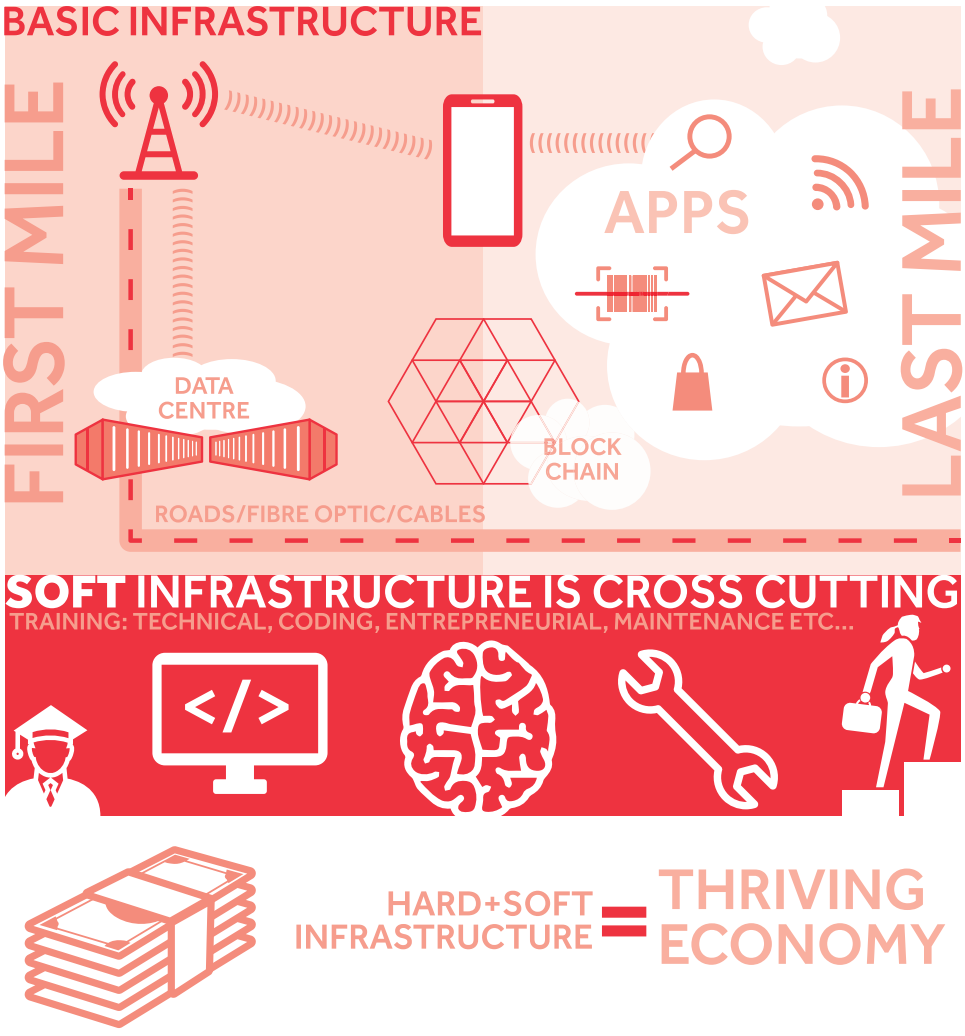
for the transmission of electronic waves and the internet to digital devices, for them then to connect to end-users. Ports, roads and energy are required for the construction of fibre optic cable networks that facilitate the functioning of digital infrastructure, such as data centres for cloud computing services or technologies such as block chain technology to allow countries to localise data.

Hard telecommunications infrastructure plays many other important facilitating and enabling roles. In order to have robust cloud infrastructure, with localised data centres, a country must have a cost-effective energy sector. The role of the telecommunications infrastructure is critical in enabling such affordability. Mobile technologies that use cellular data use wired networks, and thus require investment in network fibre optics. High-speed and high-frequency wireless technologies require investment in transmitters to provide access to adequate bandwidth and Wi-Fi for internet access. The telecoms sector is dependent on energy, ports and road infrastructure for the set-up of fibre optics and transmitters. Countries with well-developed basic infrastructure are able engage in the digital economy at a faster rate in comparison to those that lag behind in this area.

Several enabling digital tools depend on basic infrastructure to function in the digital economy. Enabling digital infrastructure ranges from mobile phones, to block chains and distributed ledgers, to online tools, including Infrastructure as a Service (IaaS) applications, Platform as a Service (PaaS) applications and Software as a Service (SaaS) application.

Depending on the nature of the business, the demand for different IT infrastructure varies. For example, micro, small and medium-sized enterprises (MSMEs) and small and medium-sized enterprises (SMEs) may require good telecom infrastructure to facilitate high-speed

Figure 1. Synergy between hard and soft digital infrastructure



internet access and the use of mobile technology as an enabler to access to SaaS for business applications. On the other hand, for businesses that are larger scale and at higher levels of digital maturity, data security issues and IT infrastructure affordability may become more important. These businesses may utilise IaaS, coupled with high-speed internet access for their own tailor-made platforms and software services for business operations. In the latter case, the data would be stored in-country.

For a well-functioning digital infrastructure ecosystem, Commonwealth countries must consider basic infrastructure, IT infrastructure and digital-enabling infrastructure as key interlinked components. Figure 1 provides an example of the synergy between basic infrastructure, IT and digital-enabling infrastructure. In addition to these, soft infrastructure, capacity building and the training of personnel to operate the infrastructure is also critical. Given that digitalisation correlates with agile development, the development of skills and capacity should be a continuous process. The COVID-19 pandemic has highlighted the need for deeper digitalisation and increased connectivity with and among countries. Addressing digital infrastructure divides is integral to economic recovery from the pandemic, as well as to adapting to new business environments.

4. Digital divide and infrastructure gaps in the Commonwealth

The 54 Commonwealth member countries are at different stages of development. Some economies are more advanced than others and across the Commonwealth, countries are at various levels of digital engagement and digital maturity (see Annex 1). As a result, for the digital economy and digital trade to develop, the concerns of the digital divide in relation to the infrastructure needs must be addressed.

This section provides a comparative analysis of the digital infrastructure gap among the Commonwealth's five regions, based on available data:

- The Commonwealth Asia region (Bangladesh, Brunei Darussalam, India, Malaysia, Maldives, Pakistan, Singapore and Sri Lanka)
- The Commonwealth Europe region (Cyprus, Malta and the United Kingdom)
- The Commonwealth Africa region (Botswana, Eswatini, The Gambia, Ghana, Lesotho, Malawi, Mozambique, Namibia, Nigeria, Rwanda, Sierra Leone, South Africa, Uganda and Zambia)
- The Commonwealth Caribbean and Americas region (The Bahamas, Barbados, Canada, Guyana, Jamaica, Saint Lucia, Saint Vincent and the Grenadines, and Trinidad and Tobago)
- The Commonwealth Pacific region (Australia, Fiji Islands, New Zealand, Papua New Guinea, Samoa, Tonga and Vanuatu)

4.1 Digital infrastructure in Commonwealth countries

For well-functioning enabling digital infrastructure – such as mobile technologies, cloud storage and other software as a service (SaaS) applications.– to operate, countries must have adequate underlying hard digital infrastructure in place that ensures reasonable internet connectivity for efficient functioning of these applications to reach end users.

In order to assess access to and quality of digital infrastructure, four components need to be analysed: network coverage, network performance, enabling infrastructure and spectrum allocation:

1. *Network coverage*: this reflects the strength of the network coverage for Commonwealth countries, measured as a percentage of the population covered by 2G, 3G, 4G or 5G networks. The generation of network coverage measures the range of coverage: for example, 4G provides greater coverage than 2G.
2. *Network performance*: this reflects the speed of the internet, measured by

average mobile broadband download and upload speeds and broadband latencies. Network performance is an important factor to ensure that information/data is efficiently exchanged and is an important factor in ensuring competitiveness and facilitating business operation in the digital economy.

3. *Other enabling basic infrastructure*: this reflects the percentage of the population that has access to basic infrastructure such as electricity, telecommunications, internet bandwidths, secure servers and internet exchange points.
4. *Spectrum allocation*: this is an important requirement for cellular companies in transmitting data, as different technologies have different ranges. Allocation per operator is measured by digital dividend spectrum per operator, from 1 GHz -3GHz .or above per operator

In order to measure underpinning digital infrastructure performance, an analysis of these four areas allows for an assessment of the digital divide within and across the Commonwealth. The data for the analysis has been sourced from GSMA with each component having different indicators sourced from various databases as per Annex 2. The analysis reflects scores of each component ranging from 0–100, with 0 being the lowest and 100 being the highest. It provides a basis to show how economies are performing in relation to digital and enabling infrastructure and where gaps exist in the Commonwealth.

Commonwealth Asia

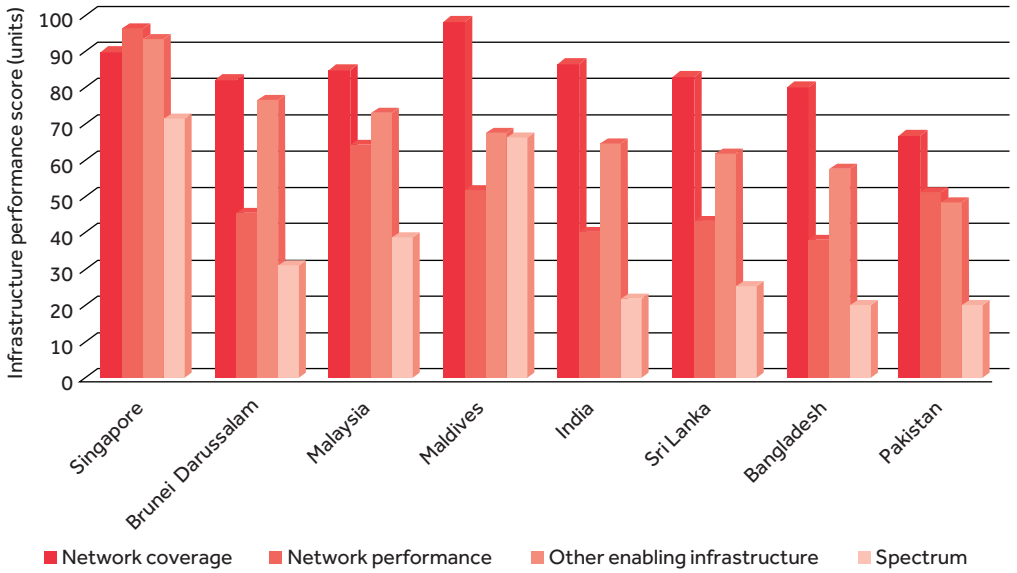
Figure 2 shows the digital infrastructure performance of the Commonwealth Asia region, based on network coverage, network performance, other enabling infrastructure and spectrum allocation.

It is clear that the economies are operating at different levels in relation to digital infrastructure across Commonwealth Asia.

In relation to network coverage, all the countries – with the exception of Pakistan – had a network coverage score of 80 and above, indicating high rates of network coverage for most of the population. However, in terms of network performance, or the speed of the internet in relation to the average mobile broadband download, upload and latency speeds, Singapore outperformed other regional economies by a wide margin, with a score of 96 compared to Malaysia, which ranked second with a score of 63. Other Commonwealth Asia country scores ranged from 52 to 38.

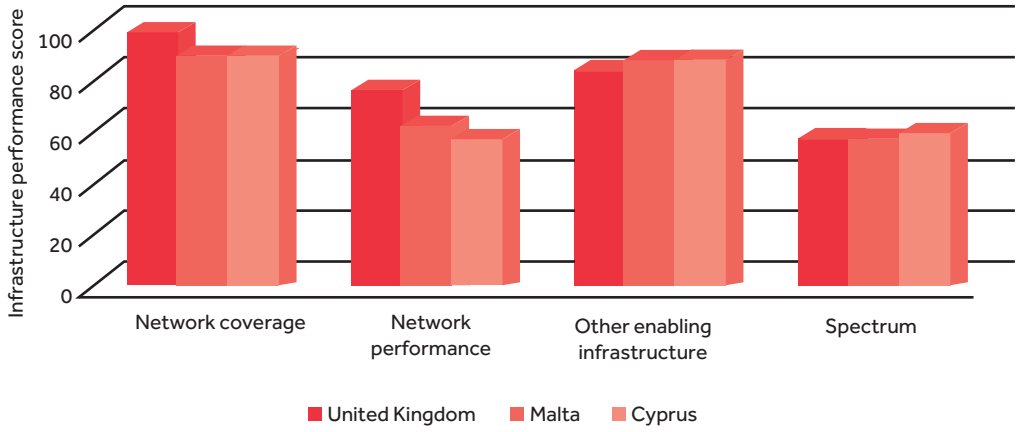
On other enabling infrastructure, measuring the percentage of the population with access to basic infrastructure, Singapore outperformed other countries, with an enabling infrastructure score of 93 compared to the regional range of 48–73. The South Asian countries of Pakistan, Bangladesh, Sri Lanka and India scored the

Figure 2. Digital infrastructure performance – Asia



Source: GSMA database and authors' own depiction

Figure 3. Digital infrastructure performance – Europe



Source: GSMA database and authors' own depiction

lowest in the Asia region, ranging between 48 and 65, with Pakistan being the lowest.

Regarding spectrum allocation, these scores are important indicators to determine how the cellular companies operating in the Asia region are able to transmit data. For the Commonwealth Asia region, Singapore scored the highest at 71 in relation to spectrum allocation for companies to transmit data. On the other hand, it is interesting to note that economies with the largest populations, such as Pakistan, Bangladesh and India, ranked lowest in relation to spectrum allocation and transmission of data, with scores of 20 to 22.

Commonwealth Europe

In the Commonwealth Europe region, while economies still differed in terms of infrastructure development, these differences were narrow in comparison with other regions.

In relation to network coverage, all the countries in the Europe region had scores of 89–98, led by the United Kingdom with a score of 98. While this shows that in relation to network coverage, a wide range of the Commonwealth Europe population enjoy high levels of access, the region scored relatively low in terms of network performance. This determines the speed of the internet in relation to average mobile broadband downloads, uploads and latencies. The United Kingdom had the highest score of 76 on network performance, followed by Malta at 61 and Cyprus at 58. The network performance of the Europe region was higher relative to other regions of the Commonwealth.

Commonwealth Europe also performed better than other regions on other enabling infrastructure, which relates to the percentage of the population with access to basic infrastructure, such as electricity and basic telecommunications infrastructure. Cyprus and Malta had a score of 87, whereas the UK had a score of 83.

The spectrum allocation scores are important indicators in determining how cellular companies operating in Commonwealth Europe are able to transmit data. Despite overall performance being better than other Commonwealth regions, this is an area which could be further improved. Cyprus had a score of 58, the UK was at 57 and Malta was at 56 – all of which lagged the performance of Singapore in the Commonwealth Asia region, for example.

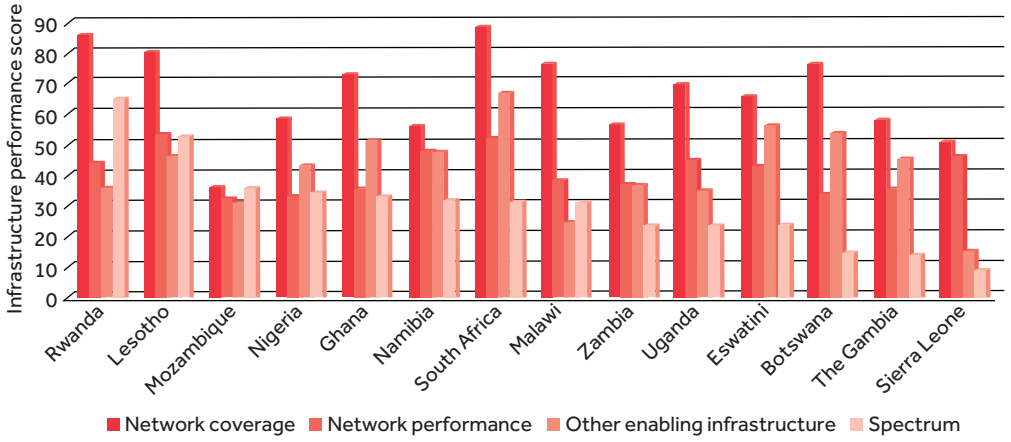
Commonwealth Africa

Commonwealth Africa's digital infrastructure performance varied significantly across countries.

In terms of network coverage, while South Africa, Lesotho and Rwanda had a network coverage score of 80 and above, countries such as The Gambia, Zambia, Sierra Leone, Namibia and Mozambique had low network coverage, with scores of 60 and below, illustrating the digital divide in the region.

Network performance reflects the speed of the internet, measured as average mobile broadband download, upload and latencies. Commonwealth Africa as a whole was found to be lagging behind relative to other regions, which exacerbates a number of other digital economy challenges – including digital trade facilitation, provision of efficient e-government services, and private sector competitiveness.

Figure 4. Digital infrastructure performance – Africa



Source: GSMA database and authors own depiction

Lesotho was the highest scoring in terms of network performance, with a score of 53, followed by South Africa at 52 and Namibia at 47.

On other enabling infrastructure, the digital infrastructure divide was even greater in relation to percentage of the population having access to basic infrastructure in the Commonwealth, implying a large percentage Africa's population did not have basic infrastructure for the digital economy – such as electricity, roads, water, internet bandwidth, telecommunications infrastructure and secure servers. The overall score of the African Commonwealth region was poor in comparison with other regions. South Africa had a score of 61, followed by Eswatini at 56 and Botswana at 53. The lowest range scores for enabling infrastructure were those of Mozambique (with a score of 30), Malawi (24) and Sierra Leone (15).

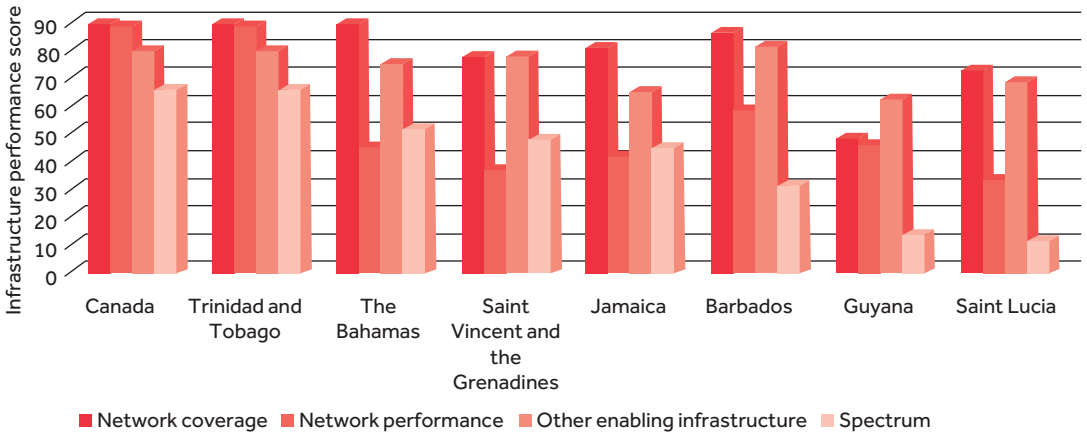
Spectrum allocation scores are important indicators to determine how cellular companies are able to transmit data. For the African region, overall spectrum allocation scores were much lower compared to other regions such as Asia and Europe. Rwanda and Lesotho performed best in the region, with scores of 65 and 52 respectively, but these were still low relative to other regions. For the rest of the region, the spectrum allocation score was below 35, with Botswana, The Gambia and Sierra Leone having the lowest scores of 14, 13 and 8 respectively.

Commonwealth Caribbean and Americas region

Figure 5 shows the digital infrastructure performance for the Caribbean and Americas region and illustrates the region's digital divide.

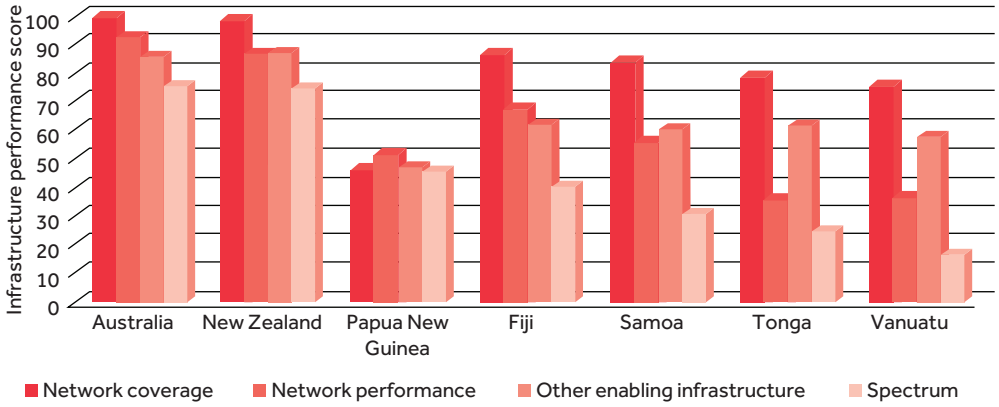
In relation to network coverage, almost all countries in the region scored relatively highly, with the exception of Guyana. Canada and The Bahamas led, with a network coverage score of 89, followed by Trinidad and Tobago and

Figure 5. Digital infrastructure performance – Caribbean and Americas



Source: GSMA database and authors own depiction

Figure 6. Digital infrastructure performance – Pacific



Source: GSMA database and authors own depiction

Barbados, with scores of 86, and Jamaica with 80. Guyana had the lowest network performance score of 47, indicating the low strength of its network coverage as percentage of total population. Relative to the African and Pacific regions, Commonwealth Caribbean and the Americas countries performed well.

For network performance, Canada performed best on internet speed, with a score of 88, contrasted by the Caribbean countries where low internet speeds impacts their online connectivity and digitalisation. Barbados and Trinidad and Tobago's network performance scored highest at 58 and 50, respectively, while rest of the Caribbean countries had network performance scores below 50, with Saint Lucia having the lowest score of 33.

On other enabling infrastructure, access to basic infrastructure – such as electricity, internet bandwidth per internet servers and internet exchange points – the region's overall performance was better relative to other regions such as Africa and the Pacific. Barbados, Canada and Saint Vincent led, with the regions highest enabling infrastructure scores of 81, 79 and 77, respectively.

Spectrum allocation scores, which measure the effectiveness of cellular companies in transmitting data, showed mixed results. Canada performed highest in the region, with a score of 65, followed by Trinidad and Tobago (score of 56) and The Bahamas with score of 51. Saint Lucia had the lowest spectrum allocation score at 11.

Commonwealth Pacific

Moving to the Commonwealth Pacific, the region's digital infrastructure performance is shown in Figure 6 which illustrates the digital divide across these countries.

In relation to network coverage, Australia and New Zealand scored highest at 99, indicating near complete coverage for their populations. Fiji also had good network coverage, with a score of 87, followed by Samoa with 84. Tonga and Vanuatu also performed relatively well, with scores of 78 and 76, respectively. However, Papua New Guinea, despite being one of the largest economies in the Pacific, had the region's lowest coverage score of 47.

In relation to network performance, Australia and New Zealand again led with scores of 92 and 87, with Tonga and Vanuatu having the lowest internet speeds with scores of 36 and 37 respectively.

On enabling infrastructure – measuring access to basic infrastructure such as electricity, internet bandwidth per internet servers and internet exchange points – Australia and New Zealand had the highest scores and outperformed the other countries in the Pacific region, with scores of 87 and 86, respectively. The low scores in other Pacific countries illustrate the need for basic infrastructure development in the region, with Papua New Guinea scoring the lowest at 47.

In relation to spectrum allocation, measuring the effectiveness of cellular companies to transmit data, Australia and New Zealand had the highest score, both at 75, which was also the highest spectrum allocation score in the Commonwealth. The rest of the Pacific lagged behind, with Samoa, Tonga and Vanuatu having the lowest scores of 31, 24 and 16, respectively.

4.2 Digital divide in relation to the affordability of digital infrastructure

In assessing the digital divide across the Commonwealth, the affordability of enabling tools that connect last mile users is an additional parameter that must be considered. This involves measuring the affordability of digital tools such as mobile technology and handheld devices. Differences in the affordability of these enabling tools can create and/or widen digital divides across the Commonwealth.

To assess digital infrastructure affordability in Commonwealth countries, the following factors were considered:

1. *Mobile tariffs*: measured at the cost of 100MB–5GMB data in terms of the percentage of monthly gross domestic product (GDP) per capita.
2. *Handset prices*: measured at the cost of the cheapest available internet-enabled devices, as a percentage of monthly GDP per capita.
3. *Taxation*: measured by tax as a percentage of total cost of mobile ownership and sector-specific tax, as percentage of total cost of the mobile technology.
4. *Inequality*: measured as inequality in income, using the Atkinson measure[5] Commonwealth Asia

Figure 7 illustrates the ranking scores on affordability of digital enabling tools, such as mobile technologies, across the Commonwealth Asia region.

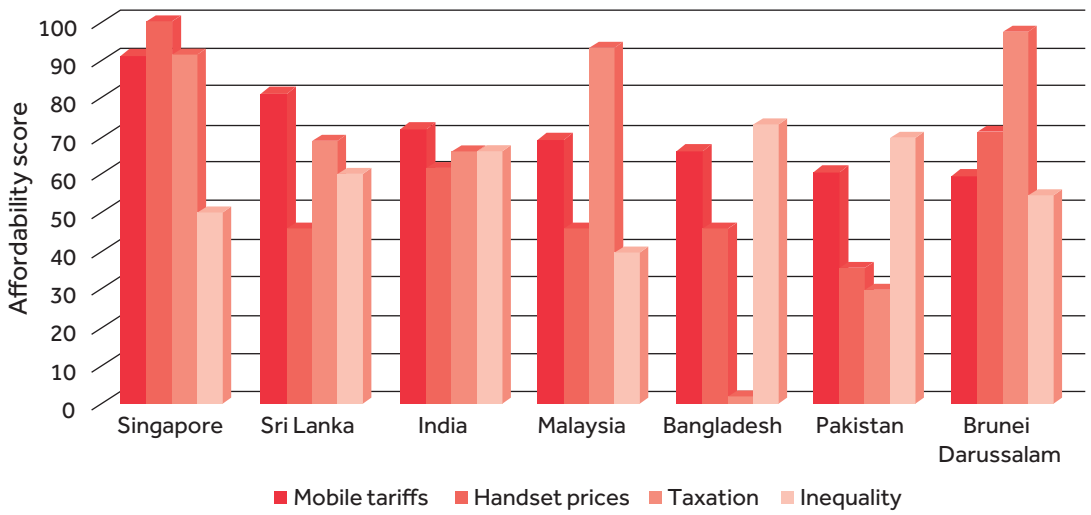
In terms of the mobile tariff scores, Singapore ranked highest with a score of 91, indicating high internet affordability thanks to the low cost of mobile data. Sri Lanka ranked second, with a score of 81, followed by India with 72. The rest of the Commonwealth Asia region had reasonable costs for data, with Brunei Darussalam scoring lowest with 60.

On handset prices, Singapore's perfect score of 100 indicated that the cheapest internet-enabled devices were affordable by its population in terms of a percentage of monthly GDP per capita. This was followed by Brunei Darussalam at 71 and India at 62. The cost of handsets was higher in other countries in Commonwealth Asia relative to income levels, with those in Pakistan being least affordable with the lowest score of 35.

The amount of tax paid on enabling mobile technologies is also a factor that affects affordability and access to digital infrastructure. Across Commonwealth Asia, Brunei Darussalam, Malaysia and Singapore scored highest on taxation, with scores of 98, 93 and 91 respectively. The rest of the region had reasonable tax scores, with Pakistan and Bangladesh scoring the lowest.

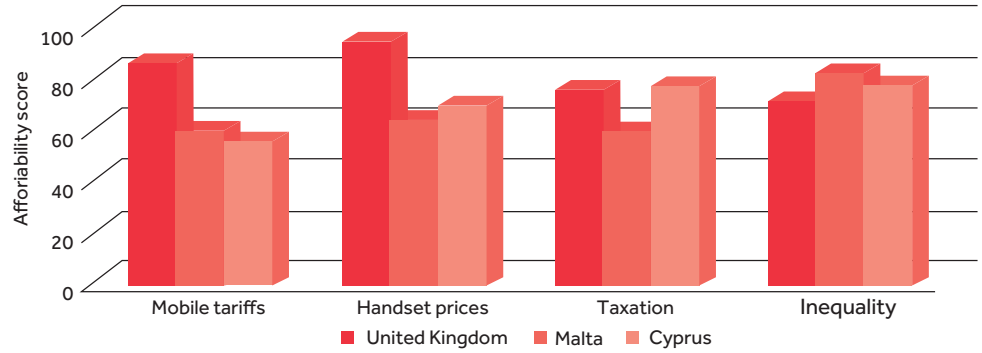
On income inequality, South Asian countries, including Bangladesh, Pakistan and India, had higher inequalities, with scores of 73, 70 and 66. Southeast Asian countries such as Singapore and Malaysia had lower income inequality and thus performed better with scores of 50 and 39, respectively.

Figure 7. Affordability of digital infrastructure – Asia



Source: GSMA database and authors' own depiction

Figure 8. Affordability of digital infrastructure – Europe



Source: GSMA database and authors own depiction

Commonwealth Europe

Figure 8 shows ranking scores on affordability of the digital infrastructure in the Commonwealth Europe region.

In terms of the mobile tariff scores, the UK ranked highest with 85, indicating the low cost of data and thus making use of the internet more affordable. Malta ranked second, with a score of 59 and Cyprus third with 54. As such, the Commonwealth Europe region performed relatively well in relation to cost and affordability of data in comparison to other regions.

On handset prices, the UK scored the highest at 94, indicating that it had the cheapest internet-enabled mobile devices, followed by Cyprus and Malta.

The amount of tax paid on enabling mobile technologies also varied across the region, although tax rates in Commonwealth Europe tended to be low. Malta had the highest score of 76, the UK was close with 75, while Cyprus followed with 59.

Income inequalities exist in the region; however, Europe performs better than other Commonwealth regions. Malta had a score of 81, followed by Cyprus with 77 and the UK with 70.

Commonwealth Africa

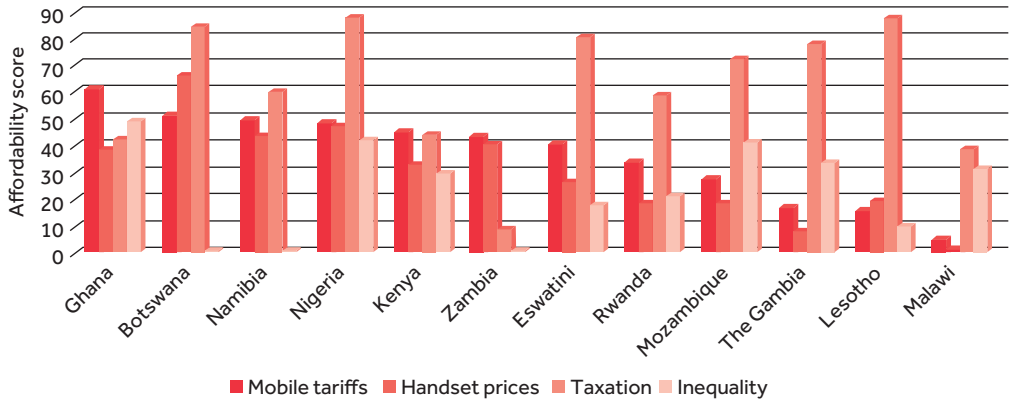
Figure 9 shows the ranking scores on affordability of digital enabling tools in Commonwealth Africa.

Mobile tariff scores illustrate the high costs of data in Commonwealth Africa relative to other regions, such as Asia and Europe. Ghana, Botswana and Namibia scored highest in terms of affordability in the region, with 61, 52 and 50 respectively. Other countries had scores below 50, with The Gambia, Lesotho and Malawi having the least affordable mobile data.

In relation to handset prices, Africa again had the highest costs relative to other regions of the Commonwealth. Botswana, Nigeria and Namibia had the lowest cost, with scores of 66, 47 and 43, respectively. Rwanda, The Gambia and Malawi had the highest cost for handsets with low scores of 18, 8 and 1, respectively.

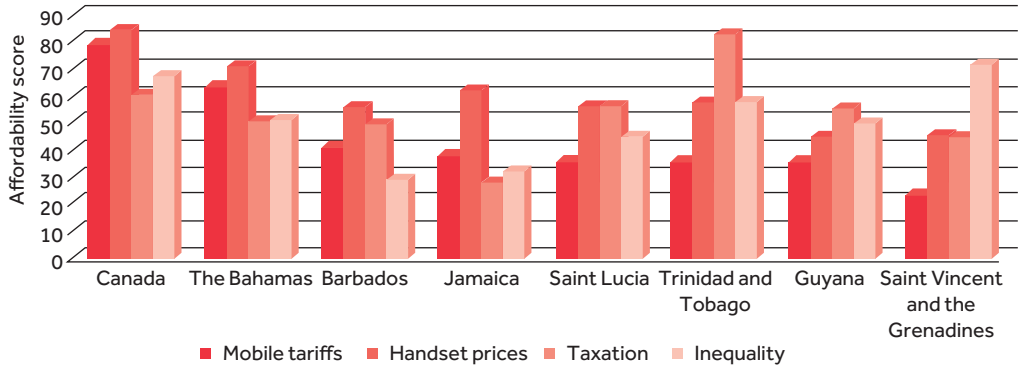
In relation to taxation, Nigeria, Lesotho and Botswana performed better in comparison to

Figure 9. Affordability of digital infrastructure – Africa



Source: GSMA database and authors own depiction

Figure 10. Affordability of digital infrastructure – Caribbean and Americas



Source: GSMA database and authors own depiction

other countries in the region. Nigeria had a score of 88, Lesotho 87 and Botswana 85. On the other hand, Ghana, Malawi and Zambia ranked the lowest on this measure, with scores of 42, 39 and 9.

Income inequality is also a major factor in digital infrastructure affordability across Commonwealth Africa and results in a significant digital divide. The region's highest affordability score in this area was below 50, with Ghana, Nigeria and Mozambique scoring 49 and 42, respectively. The rest of the region performed poorly, with inequality scores below 34.

Commonwealth Caribbean and Americas

Figure 10 shows the scores on affordability of digital enabling tools across the Commonwealth Caribbean and Americas region.

In relation to mobile tariffs, Canada was the most affordable, with the highest score of 79, followed by The Bahamas at 64 and Barbados at 41. The rest of the Caribbean region scored below 41. With exception to Canada, the cost of data in the Caribbean region was high relative to the income levels of the population, with all countries scoring below 41.

On handset prices, Canada, The Bahamas and Jamaica had the highest affordability scores, with 84, 71 and 64 respectively. The rest of the Caribbean performed lower, with Saint Vincent having the lowest score of 45.

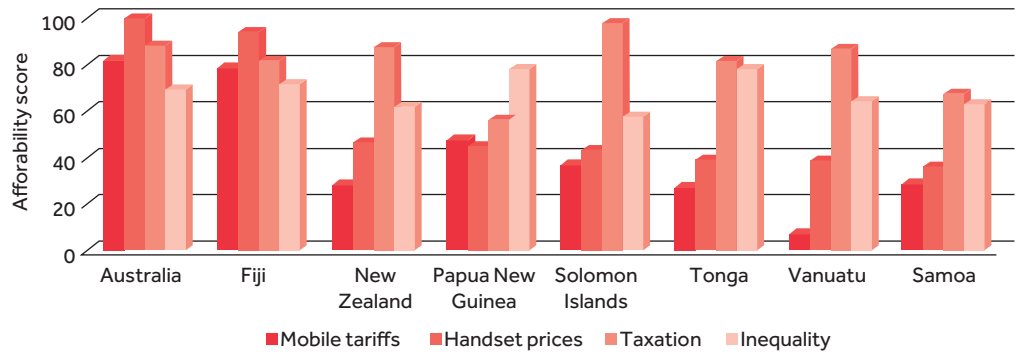
In relation to taxation, Trinidad and Tobago, Canada and Saint Lucia performed better than the rest of the region, with scores of 83, 60 and 56, respectively. The rest of the countries in the region had scores between 28 and 55, with Jamaica having the lowest affordability score of 28 on taxation.

On inequality, the region performed better relative to digital infrastructure affordability than Commonwealth Africa, with Saint Vincent, Canada, and Trinidad and Tobago have the highest scores of 71, 67 and 58, respectively. The rest of the Caribbean region had scores below 50, with Barbados having the lowest score of 29.

Commonwealth Pacific

Figure 11 shows the ranking scores on affordability of digital enabling infrastructure across the Commonwealth Pacific region.

Figure 11. Affordability of digital infrastructure – Pacific



Source: GSMA database and authors own depiction

In terms of mobile tariffs, Australia had the highest score of 83, followed by Fiji at 78 and New Zealand at 47. The rest of the Pacific scored below 37, with Samoa having the lowest score of 7. In common with the Caribbean region, the high cost of data is a large contributor to the digital divide in Commonwealth Pacific countries.

On handset prices, Australia scored the highest at 100, like Singapore in the Commonwealth Asian region. Fiji ranked a close second at 94 and was performing at par with countries in Asia on handset costs. The rest of the Pacific scored are between 46 and 36.

On taxation, mobile technologies were relatively more affordable in the region in comparison to the Commonwealth Africa and Caribbean regions, in line with some Commonwealth Asia countries. Solomon Islands had the highest score of 97, followed by Australia and New Zealand at 88, and Vanuatu at 87.

Regarding income inequality, Tonga and Papua New Guinea have the highest score of 78. This is followed by Fiji and Australia with scores of with scores of 72 and 69. The rest of the Pacific countries have scores ranging from 56-64.

4.3 Digital divide in relation to literacy and software and application services

An assessment of literacy levels, coupled with online security and access/development of software application skills, provides an important final layer of the information technology analysis. These are important factors in the digital infrastructure assessment in terms of it connecting with last mile users and customers.

Commonwealth Asia

Figure 12 shows the performance of software and application infrastructure scores for the Commonwealth Asia region.

In relation to online security, Singapore ranked the highest in score with 90, followed by Malaysia at 89 and India at 72. Sri Lanka and Pakistan with Maldives scoring the lowest.

In relation to the literacy rate scores, Maldives performed best with a score of 98, followed by Singapore and Brunei Darussalam at 97, and then Malaysia at 95. India, Bangladesh and Pakistan scored lowest at 74, 74 and 59, respectively.

In relation to accessibility of top ranked apps, Singapore scored the highest at 100, followed by Malaysia at 58 and Brunei Darussalam at 50. Sri Lanka and Pakistan scored the lowest at 21 and 20.

In relation to apps developed per person, Asia performed better than other regions of the Commonwealth. Singapore, Malaysia and Maldives had the highest scores of 100, 82 and 80, respectively. Pakistan and Bangladesh scored the lowest at 64 and 53.

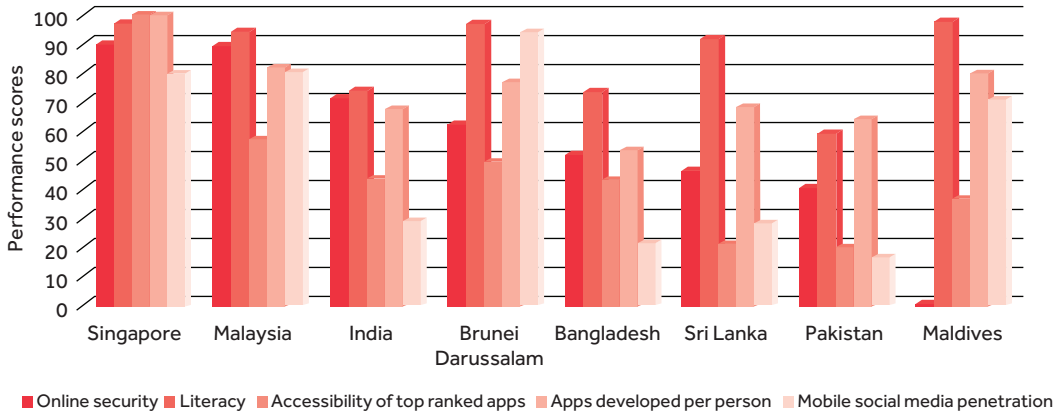
In relation to mobile social media penetration, Brunei Darussalam, Malaysia and Singapore scored the highest at 94, 81 and 80, respectively. Lagging behind were Bangladesh, scoring 22, and Pakistan, with 17.

Commonwealth Europe

Figure 13 shows the performance of software and application infrastructure in the Commonwealth Europe region.

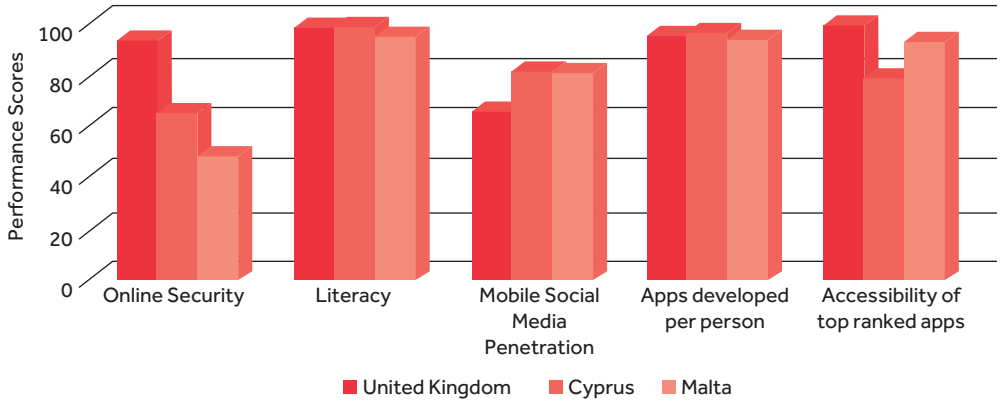
In relation to online security, the UK had the highest score at 93, followed by Cyprus at 65 and Malta at 48.

Figure 12. Performance of software and application infrastructure – Asia



Source: GSMA database and authors own depiction

Figure 13. Performance of software and application infrastructure – Europe



Source: GSMA database and authors own depiction

In terms of literacy scores, meanwhile, the region performed better relative to other regions of the Commonwealth, led by the UK and Cyprus with a score of 99 and Malta with 95.

Accessibility of top ranked apps was also high, with the UK scoring 100, followed by Malta at 93 and Cyprus at 79.

Apps developed per person in the region was high, with Cyprus having a score of 97, followed closely by the UK at 96 and Malta at 94.

Mobile social media penetration scores for the region, meanwhile, were also relatively high with Cyprus scoring 82, Malta scoring 80 and the United Kingdom at 66.

Commonwealth Africa

Figure 14 shows the performance of software and application infrastructure in the Commonwealth Africa region.

In relation to online security, Mauritius led, with a score of 88, followed by Kenya with 75 and Rwanda with 70. Eswatini, Namibia and Lesotho scored lowest, at 13, 13 and 5, respectively.

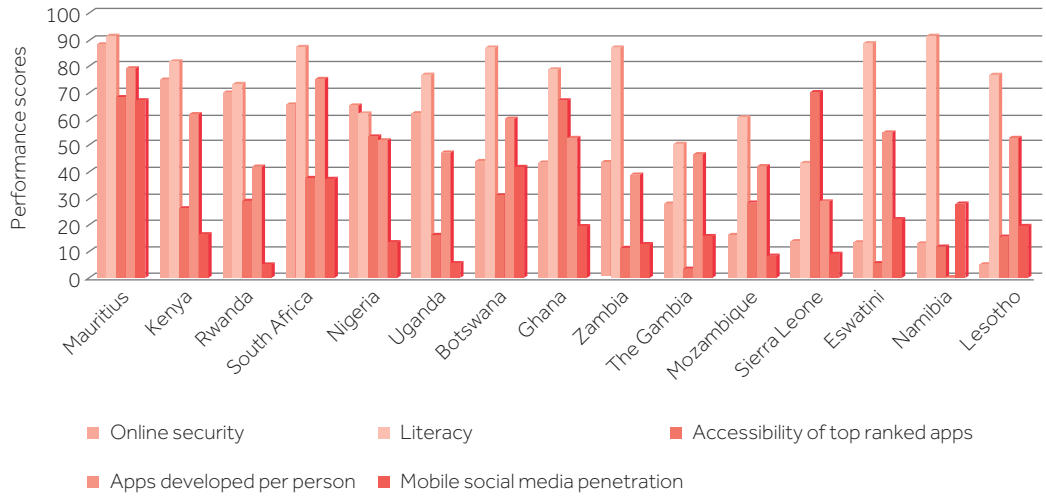
On literacy, Namibia, Mauritius and Eswatini scored the highest at 92, 91 and 88, whereas Mozambique, The Gambia and Sierra Leone scored lowest with 61, 51 and 43, respectively.

In relation to access to top ranked applications, Sierra Leone, Mauritius and Ghana scored highest, with 70, 68 and 67, respectively. Zambia, Eswatini and The Gambia scored the lowest at 11, 5 and 3, respectively.

On apps developed per person, Mauritius ranked the highest at 79, with South Africa at 75 and Kenya at 62. Zambia and Sierra Leone scored the lowest at 39 and 29, respectively.

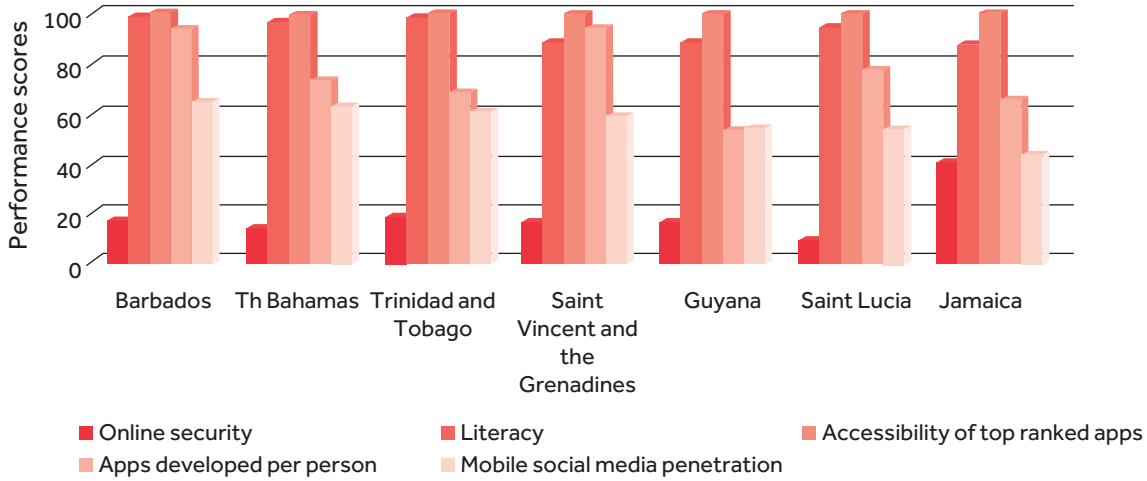
In terms of mobile social media penetration, the region scored lower than other regions of

Figure 14. Performance of software and application infrastructure – Africa



Source: GSMA database and authors own depiction.

Figure 15. Performance of software and application infrastructure – Caribbean



Source: GSMA database and authors own depiction

the Commonwealth, such as Asia and Europe. Mauritius performed best with a score of 67, followed by Botswana with 42 and South Africa with 37. The lowest performing countries were Mozambique, with a score of 8, Uganda with a score of 6 and Rwanda with score of 5.

Commonwealth Caribbean and Americas

Figure 15 shows the performance of software and application infrastructure in the Commonwealth Caribbean and Americas region.

In relation to online security, the region as a whole was not performing well. Jamaica had a score of 41, followed by Trinidad and Tobago with 19 and Barbados and Saint Vincent and the Grenadines at 17. The Bahamas, Guyana and Saint Lucia had scores of 15, 13 and 10 respectively.

In terms of literacy, the region was performing well, with Barbados scoring a perfect 100, Trinidad and Tobago scoring 99 and The Bahamas scoring 97 Jamaica and Saint Vincent and the Grenadines have scores of 88, followed by Guyana with a score of 86.

On access to top ranked apps, the region was performing well, scoring 100 across all countries.

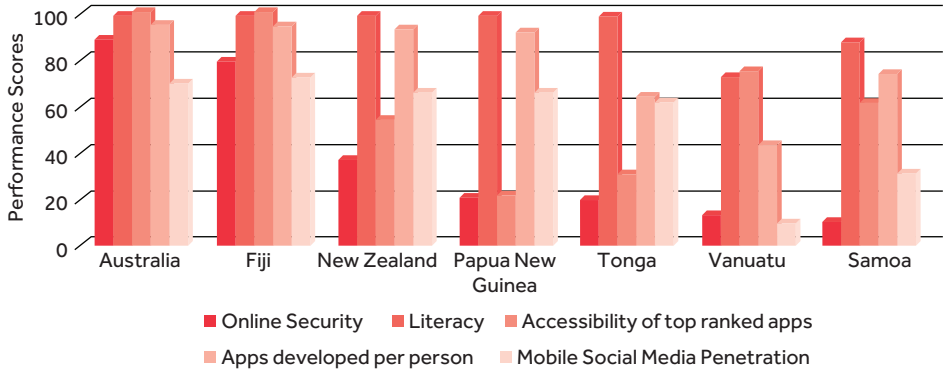
On apps developed per person, the scores varied, with Saint Vincent and the Grenadines having a score of 95, Barbados at 94 and Saint Lucia at 77. Trinidad and Tobago had a score of 69, Jamaica 66 and Guyana 53.

For mobile social media penetration, the scores were relatively lower overall, with Barbados scoring 65, The Bahamas 64, and Trinidad and Tobago scoring 61. Guyana and Saint Lucia had scores of 54 and Jamaica scored 44.

Commonwealth Pacific

Figure 16 shows the performance of software and application infrastructure for the Commonwealth Pacific region.

Figure 16. Performance of software and application infrastructure – Pacific



Source: GSMA database and authors own depiction

In relation to online security, Australia scored highest at 89, followed by Fiji at 79. The rest of the region then dropped off significantly, with New Zealand scoring 37, Papua New Guinea scoring 21, Tonga 19, Vanuatu 13 and Samoa 10.

In relation to literacy, the region performed very well, with Australia, Fiji, New Zealand, Papua New Guinea and Tonga all having scores of 99. Samoa followed with a score of 88 and then Vanuatu with 72.

In relation to accessibility of top ranked apps, Australia and Fiji had perfect scores of 100. Vanuatu and Samoa have scores of 76 and 61. New Zealand, Tonga and Papua New Guinea Vanuatu and Samoa had scores of 55, 30 and 21.

On apps developed per person, Australia was scored at 95, Fiji was scored at 94, New Zealand had a score of 93 and Papua New Guinea had a score of 92. Samoa, Tonga and Vanuatu had scores of 74, 64 and 43 respectively.

On mobile social media penetration, the region needed to improve its access relative to other regions. Fiji, Australia and New Zealand had scores of 72, 70 and 66. Papua New Guinea, Tonga and Samoa had scores of 64, 62 and 31, respectively, and Vanuatu had a score of 8.

4.4 Digital divide in relation to gender in the Commonwealth

Assessing the digital divide in the Commonwealth in relation to education, income levels, access to and use of digital infrastructure from a gender perspective is important to understand the nature of the digital divide challenges women face across the Commonwealth.

Globally, one in three young people between the ages of 15 and 29 reside in Commonwealth countries. They constitute around 640 million of the Commonwealth's total 1.8 billion population. The integration of women into the digital economy is therefore critical to bridging the digital divide.

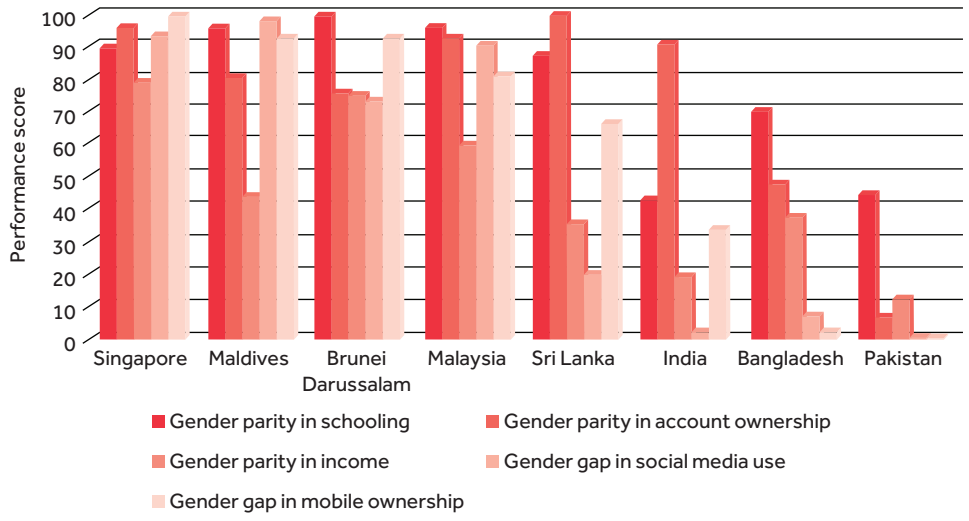
This section assesses various regional factors affecting women's ability to access, afford and utilise digital technologies and infrastructure. The following factors were taken into account:

1. *Gender parity in schooling*: measured by the mean years of schooling of males versus females.
2. *Gender parity in income*: measured by gross national income (GNI) per capita of females to males.
3. *Gender parity in bank account ownership*: measured by gender parity in having an account.
4. *Gender gap in social media use*: measured by gender ratio for social media usage.
5. *Gender gap in mobile ownership*: measured by gender ratio for mobile device ownership and usage.

Figure 17 shows the gender divide in relation to access, use and affordability of digital infrastructure in the Commonwealth Asia region.

The gender parity scores illustrate the disparity between men and women in relation to

Figure 17. Gender digital divide – Asia



Source: GSMA database and authors own depiction

schooling, account ownership, income, social media usage and mobile ownership.

In relation to schooling, India, Pakistan and Bangladesh lagged behind on female schooling. India ranked the lowest with a score of 43, behind Pakistan at 44 and Bangladesh at 70. Brunei Darussalam, Maldives, Malaysia, Singapore and Sri Lanka performed better in relation to education of females, with Brunei Darussalam having the highest score of 100, signifying gender equality in education. Maldives and Malaysia also led with scores of 96, followed by Singapore with 90 and Sri Lanka with 87.

In terms of ownership of accounts, Pakistan scored lowest at 7, signifying a large disparity between men and women, while Bangladesh and Brunei Darussalam also scored relatively low compared to other countries in the Commonwealth Asia region, with scores of 48 and 76, respectively. Maldives, India, Malaysia, Singapore and Sri Lanka led the region with scores ranging between 81 and 99.

Regarding the gender divide on income, except for Singapore, the scores across Commonwealth Asia were all below 80. This signified large income gaps between men and women in the region. Pakistan scored lowest with 13, India was 19, Sri Lanka 36, Bangladesh 38, Maldives 44, Malaysia 60 and Brunei Darussalam scored 75.

In relation to the gender gap in social media use, Pakistan, India, Bangladesh and Sri Lanka showed huge gender disparity, with scores from 0 to 20. Brunei Darussalam was in the middle range, with a score of 74. Malaysia, Singapore and Maldives had small gender gaps in social media use; however, in comparison to the rest of the countries in Commonwealth Asia, their performance was much closer to parity with scores of 90–98.

The disparity in mobile device ownership also showed a large gender digital divide in the region. The South Asian countries of Pakistan, Bangladesh and India scored lowest, ranging between 0 and 34, while Sri Lanka performed better but still with a large disparity, with a score of 67. Malaysia scored 81, while Singapore, Maldives and Brunei Darussalam demonstrated higher parity, all with scores above 90. Overall, in Asia, there is a strong relationship between the years of schooling and the ownership of accounts, income, social media use and mobile ownership. The greater the gender parity in the years of schooling, the worse the performance in other areas creating greater gender divide.

Commonwealth Europe

Figure 18 shows the gender divide in relation to access, use and affordability of digital infrastructure in the Commonwealth Europe region.

The scores show that gender parity is better in comparison to other regions in this more developed region; however, the gender digital divide remains.

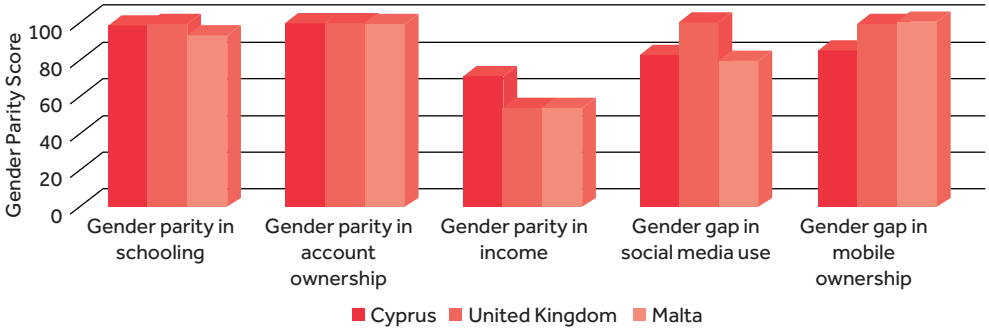
In relation to gender parity in schooling, the UK, Cyprus and Malta performed well with gender parity scores above 93.

Regarding account ownership, the scores were also high in all the three countries, between 99 and 100, signifying parity or near-parity. This indicates that for women, access to finance is easier in comparison to other regions.

However, in terms of affordability, measured by the income level, gender parity in income was low in these countries. The United Kingdom and Malta had scores of 53, while Cyprus had a score of 70. This is an area for improvement.

In relation to the gender gap in social media use, the scores were relatively better. Cyprus,

Figure 18. Gender digital divide – Europe



Source: GSMA database and authors own depiction

the UK and Malta all had scores above 80. The performance scores for mobile device ownership were also high for United Kingdom and Malta (100) and relatively high for Cyprus (83).

The Europe region performed better than other regions in the Commonwealth in terms of gender equality in digital infrastructure, but certain levels of gender disparity still exist and need to be addressed.

Commonwealth Africa

Figure 19 shows the gender divide in the Commonwealth in relation to access, use and affordability of digital infrastructure in the Commonwealth Africa region. The scores illustrate the disparity between males and females in the region in relation to schooling, owning of accounts, income levels, social media use and mobile ownership.

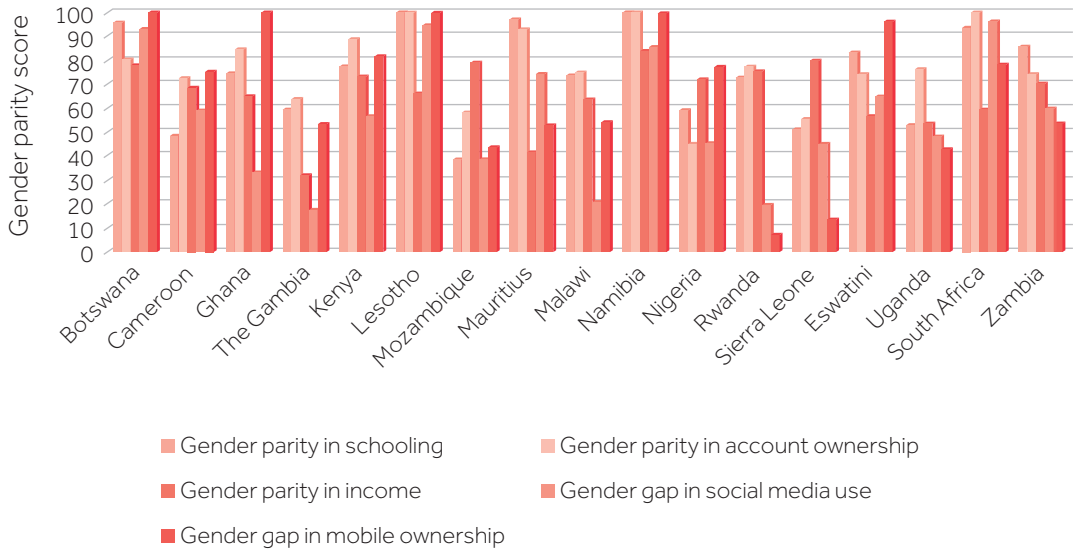
In relation to gender parity in schooling, Mozambique and Cameroon had the lowest scores (39 and 48, respectively) and showed the greater gender divide. Sierra Leone, Uganda, Nigeria, The Gambia, Rwanda, Malawi and Ghana had scores ranging from 51 to 75. Kenya, Eswatini and Zambia are performing relatively better, with scores of 78–86; however, the divide could further be closed. South Africa, Botswana, Mauritius, Namibia and Lesotho were the best performers in relation to schooling of males and females, all with scores over 90.

On bank account ownership, high performers included Lesotho, Namibia, South Africa, Mauritius, Kenya, Ghana and Botswana, all with scores above 80. Countries in the middle range included Rwanda, Uganda, Malawi, Zambia and Cameroon, all with scores above 70. For the rest of the region – including The Gambia, Mozambique, Sierra Leone and Nigeria – scores were below 64. Ensuring access to capital through account ownership is critical to the region in terms of closing the gender digital divide and providing equitable access to finance.

Income gender parity in Commonwealth Africa was relatively low compared to other indicators. Almost half of the countries in the region scored less than 70, including The Gambia, Mauritius, Uganda, Eswatini, South Africa, Malawi, Ghana, Lesotho and Cameroon. The rest of the countries scored between 70 and 84, including Zambia, Nigeria, Kenya, Rwanda, Botswana, Mozambique, Sierra Leone and Namibia.

On the gender gap in social media use, the results across Commonwealth Africa varied among countries. This correlates to the level of education and income and the gender divide that exists in these areas, which has an impact on the use of social media. Countries with a lower gender divide and income parity between men and women perform better relative to those with greater a divide. The Gambia, Rwanda, Malawi, Ghana, Mozambique, Sierra Leone, Nigeria and Uganda scored lowest in the region, ranging from 17 to 48. Zambia,

Figure 19. Gender digital divide – Africa



Source: GSMA database and authors own depiction

Eswatini, Mauritius, Namibia, Botswana, Lesotho and South Africa scored in the range from 57 to 96. Namibia, Botswana, Lesotho and South Africa were best performing countries in the region.

On gender parity in mobile device ownership, Malawi, Zambia, The Gambia, Mozambique, Uganda, Sierra Leone and Rwanda were among countries with the largest gender gap, with scores ranging from 54 to 7. Cameroon, Nigeria and South Africa had gender gap scores between 75 and 78. The rest of the countries in the region scored above 80, including Kenya, Eswatini, Ghana, Namibia, Botswana and Lesotho.

Commonwealth Caribbean and Americas

Figure 20 shows the gender digital divide in Commonwealth Caribbean and Americas region. Relative to other regions, the Caribbean region's overall performance was better.

In relation to gender parity in schooling, all the countries scored 100, signifying equal schooling opportunities for men and women/boys and girls.

Regarding account ownership, some disparity remained, but the region performed better than others in the Commonwealth. Saint Lucia had the lowest score of 78 and the rest of the Caribbean countries had scores above 80.

Income disparity between males and females is an area in need of improvement for the region. Guyana scored lowest at 40, while Saint Vincent and the Grenadines, Dominican Republic, Trinidad and Tobago, Saint Lucia, Jamaica, The Bahamas and Canada had scores ranging from 55 to 65. Barbados had the highest score of 73 and was best performing country in the region in terms of gender parity in income.

In relation to the gender gap in social media use, the region performed better than the rest of the Commonwealth: all countries had scores of 100, except for Dominican Republic which had a score of 96.

In terms of gender parity in mobile device ownership, Canada had the lowest score of 78. The rest of the countries in the region had scores ranging from 85 to 100.

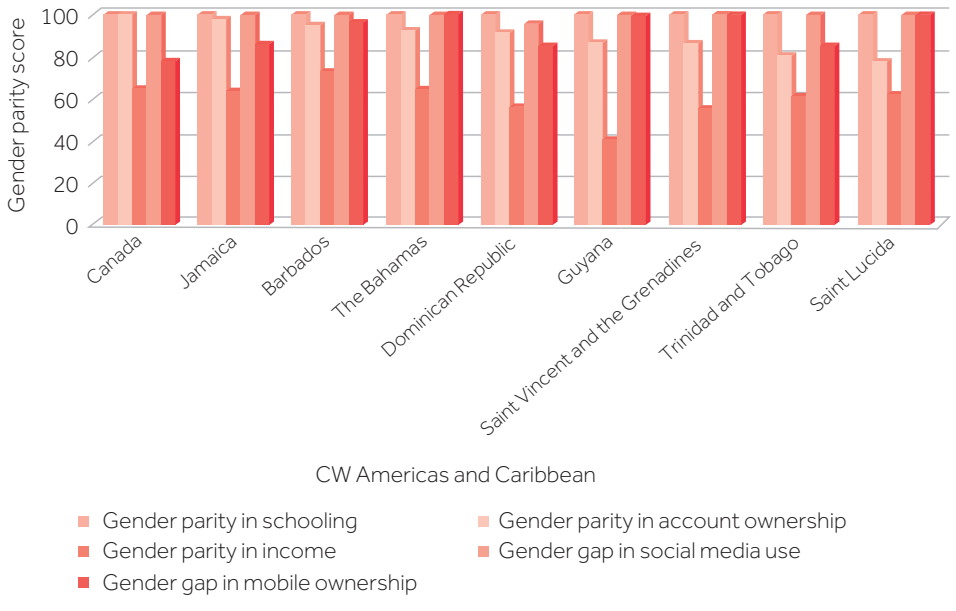
Commonwealth Pacific

Figure 21 shows the gender digital divide in the Commonwealth Pacific region.

In relation to schooling, scores varied across the region, with Papua New Guinea scoring lowest at 63. The rest of the countries performed better, with scores of 83 and above, including Vanuatu, Solomon Islands, New Zealand, Samoa, Tonga, Fiji and Australia.

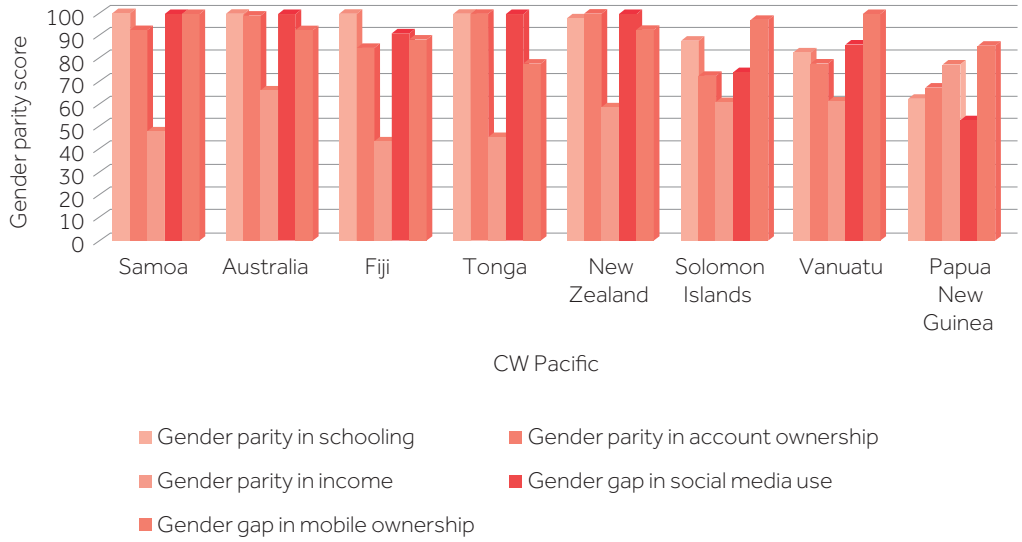
On gender parity in bank account ownership, Papua New Guinea, Solomon Islands and Vanuatu were in the lower range with scores from 68 to 78. The rest of the Pacific countries had scores above 80, indicating better access to finance for women.

Figure 20. Gender digital divide – Caribbean and Americas



Source: GSMA database and authors own depiction

Figure 21. Gender digital divide – Pacific



Source: GSMA database and authors own depiction

The performance of the Commonwealth Pacific in terms of gender parity on income had significant room for improvement. The difference in the income between females and males varied across the region, with Fiji, Tonga and Samoa having the lowest scores of 44, 46 and 48, respectively. New Zealand, Solomon Islands, Vanuatu and Australia had scores ranging from 58 to 66, with Papua New Guinea having the highest score of 78.

In relation to the gender gap in social media use, Papua New Guinea had the highest gender gap, with the lowest score of 53. This was followed by Solomon Islands and Vanuatu, with scores of 74 and 86, respectively. The rest of the Pacific countries were found to be performing better and had closed the gender gap in social media use significantly. These countries included Fiji, Tonga, Samoa, New Zealand and Australia, all of which scored above 90.

In relation to the gender gap in mobile device ownership, the Pacific as a region performed better relative to Commonwealth Asia and Africa. Tonga had the lowest score of 78, but the other scores were between 86 and 100, led by Samoa and Tonga.

5. Conclusion and policy recommendations

The COVID-19 pandemic has accelerated the need for deeper digitalisation across Commonwealth economies. This paper has focused on and highlighted the digital infrastructure divide across the Commonwealth member states, including the relationship between basic and digital infrastructure and how these are complementary in addressing issues on the digital divide. Furthermore, in order to understand the digital infrastructure landscape of the Commonwealth, the paper has analysed the infrastructure gaps across the Commonwealth at the regional level, by assessing infrastructure performance, affordability, literacy (soft infrastructure) and also the gender divide in member states.

The findings affirm that digital infrastructure gaps exist in all regions of the Commonwealth, although the extent of these gaps differ by various indicators. In order to successfully address digital infrastructure gaps and boost post-pandemic economic recovery, countries therefore need to prioritise addressing these specific areas in their infrastructure policy frameworks.

With evolving business models across firms, there is further need to develop digital strategies to support sustainable economic growth. Basic and digital infrastructure are both core

components to COVID-19 economic recovery and to achieving longer-term sustainable development goals – in particular SDG 9, which relates to digital infrastructure and innovation. In the context of this paper, the assessment for SDG 9 relates to digital infrastructure and enablers in the digital economy.

Industrialisation and innovative manufacturing capabilities across the Commonwealth will only increase if the performance, access and affordability of both basic and enabling digital infrastructure is improved across Commonwealth member states. Sound digital infrastructure is necessary for new and existing businesses to thrive in the post-COVID-19 era. In the digital economy, increased supply chain resilience, global value chain integration and digital trade facilitation – including for medium, small and micro-enterprise development – must all be underpinned by sound digital infrastructure.

To facilitate post-COVID-19 economic recovery in the digital economy, certain government services also require digitalisation. This paper provides evidence that both hard infrastructure (basic and enabling) and soft infrastructure (education, capacity building and training) are critical for the functioning of the digital economy. The 'Principles on Sustainable Investment in Digital Infrastructure', agreed by members of the Commonwealth Connectivity Agenda's Physical Connectivity Cluster also identifies the role of infrastructure in socioeconomic development.

The analysis provides evidence that digital divides exist across the Commonwealth in terms of access, affordability and performance of hard infrastructure and soft infrastructure, which includes knowledge and technical skills. Some regions – such as Europe and Asia – performed better than others, such as Africa, the Pacific and the Caribbean. However, within each region, there were individual country-level digital divides which have to be improved through basic and digital infrastructure, both in terms of hard and soft infrastructure, in order to improve the overall capacity of the Commonwealth to integrate into the digital economy. Inclusivity and gender equity are crucial factors in reaping the full benefits of the digital economy. In relation to this, this paper has assessed the gender digital divide across various indicators and provides evidence that the gender divide in relation to digital infrastructure exists in the Commonwealth. In order to bridge this divide, member countries need to include digital empowerment as part of their overall women's economic empowerment agenda at the Commonwealth level.

On the basis of these findings, this paper recommends the following:

- Continuous work with the Commonwealth Connectivity Agenda's Physical Connectivity Cluster, through the implementation of the 'Principles on Sustainable Investment in Digital Infrastructure', to address the digital divide – including the digital infrastructure divide – across the Commonwealth, with women's empowerment being a key aspect.
- The initiation of informal groups of experts from multidisciplinary fields to further enable learning across technical aspects of digital infrastructure. This is critical to this process. Scaling these discussions in the next phase of the Commonwealth Connectivity Agenda's work at the regional level is key. The development of capacity building and training, for example, online e-training on the technical aspects of the digital economy, including IaaS, PaaS and SaaS, is also important. These actions would also benefit businesses across Commonwealth.
- Further collaboration and partnership with relevant international organisations on evidence-based knowledge product development, in tandem with regional- and national-level implementation.
- Establishment of regional and national-level training, dialogue and discussion on infrastructure prioritisation frameworks for infrastructure development. This will be critical to delivering tailor-made solutions across the Commonwealth in the post-COVID-19 recovery period. As a priority in the short term, soft infrastructure development that provides technical training and capacity building will be important in paving the way for growth of the digital economy. In this regard, specific targeted e-learning courses to enhance soft infrastructure skills, working with universities and other knowledge partners, will be necessary.

Notes

1 Project Syndicate (2014), 'The Infrastructure Solution', available at: https://www.project-syndicate.org/commentary/martin-n--baily-and-robert-palter-make-the-case-for-a-smarter-approach-to-the-planning-and-management-of-projects#csiQR7w1tGRQjpIH.99

2 The Australian Government (2020–21), 'Infrastructure, trade facilitation and international competitiveness', available at: https://www.dfat.gov.au/aid/topics/investment-priorities/infrastructure-trade-facilitation-international-competitiveness/Pages/infrastructure-trade-facilitation-international-competitiveness

3 United Nations (no date), Sustainable Development Goals, Goal 9: Build resilient infrastructure, promote sustainable industrialization and foster innovation, available at: https://www.un.org/sustainabledevelopment/infrastructure-industrialization/

4 Designing Buildings Wiki (2021), available at: https://www.designingbuildings.co.uk/wiki/Infrastructure

5 It is the percentage of total income that the society would forego, to ensure it has a more equal share of income between its citizens.

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Annex 1. Key economic indicators for selected Commonwealth countries, by region (2019)

Country name	Region	Population (total)
Singapore	Asia	5,703,569
Brunei Darussalam	Asia	433,285
Malaysia	Asia	31,949,777
Maldives	Asia	530,953
India	Asia	1,366,417,754
Sri Lanka	Asia	21,803,000
Bangladesh	Asia	163,046,161
Pakistan	Asia	216,565,318
United Kingdom	Europe	66,834,405
Malta	Europe	502,653
Cyprus	Europe	1,198,575
Rwanda	Africa	12,626,950
Lesotho	Africa	2,125,268
Mozambique	Africa	30,366,036
Nigeria	Africa	200,963,599
Ghana	Africa	30,417,856
Namibia	Africa	2,494,530
South Africa	Africa	58,558,270
Malawi	Africa	18,628,747
Zambia	Africa	17,861,030
Uganda	Africa	44,269,594
Eswatini	Africa	1,148,130
Botswana	Africa	2,303,697
Gambia, The	Africa	2,347,706
Sierra Leone	Africa	7,813,215
Canada	Americas & Caribbean	37,589,262
Trinidad and Tobago	Americas & Caribbean	1,394,973
Saint Vincent and the Grenadines	Americas & Caribbean	110,589
Jamaica	Americas & Caribbean	2,948,279
Barbados	Americas & Caribbean	287,025
Guyana	Americas & Caribbean	782,766
Saint Lucia	Americas & Caribbean	182,790
Australia	Pacific	25,364,307
New Zealand	Pacific	4,917,000
Papua New Guinea	Pacific	8,776,109
Fiji	Pacific	889,953
Samoa	Pacific	197,097
Tonga	Pacific	104,494
Vanuatu	Pacific	299,882

Country name	Region	GDP growth (annual %)
Singapore	Asia	0.7
Brunei Darussalam	Asia	3.9

(*Continued*)

Malaysia	Asia	4.3
Maldives	Asia	7.0
India	Asia	4.2
Sri Lanka	Asia	2.3
Bangladesh	Asia	8.2
Pakistan	Asia	1.0
United Kingdom	Europe	1.5
Malta	Europe	4.9
Cyprus	Europe	3.1
Rwanda	Africa	9.4
Lesotho	Africa	–0.8
Mozambique	Africa	2.3
Nigeria	Africa	2.2
Ghana	Africa	6.5
Namibia	Africa	–1.1
South Africa	Africa	0.2
Malawi	Africa	4.4
Zambia	Africa	1.4
Uganda	Africa	6.8
Eswatini	Africa	2.2
Botswana	Africa	3.0
Gambia, The	Africa	6.1
Sierra Leone	Africa	5.5
Canada	Americas & Caribbean	1.7
Trinidad and Tobago	Americas & Caribbean	0.0
Saint Vincent and the Grenadines	Americas & Caribbean	0.5
Jamaica	Americas & Caribbean	0.7
Barbados	Americas & Caribbean	–0.1
Guyana	Americas & Caribbean	5.4
Saint Lucia	Americas & Caribbean	1.7
Australia	Pacific	2.2
New Zealand	Pacific	2.8
Papua New Guinea	Pacific	5.9
Fiji	Pacific	–0.4
Samoa	Pacific	3.6
Tonga	Pacific	0.7
Vanuatu	Pacific	3.3

Country name	Region	Mobile cellular subscription (per 100 people)
Singapore	Asia	156
Brunei Darussalam	Asia	133
Malaysia	Asia	140
Maldives	Asia	156
India	Asia	84
Sri Lanka	Asia	144
Bangladesh	Asia	102
Pakistan	Asia	76
United Kingdom	Europe	120

(*Continued*)

Malta	Europe	144
Cyprus	Europe	144
Rwanda	Africa	76
Lesotho	Africa	74
Mozambique	Africa	49
Nigeria	Africa	92
Ghana	Africa	134
Namibia	Africa	113
South Africa	Africa	166
Malawi	Africa	48
Zambia	Africa	96
Uganda	Africa	57
Eswatini	Africa	..
Botswana	Africa	163
Gambia, The	Africa	..
Sierra Leone	Africa	86
Canada	Americas & Caribbean	92
Trinidad and Tobago	Americas & Caribbean	155
Saint Vincent and the Grenadines	Americas & Caribbean	93
Jamaica	Americas & Caribbean	103
Barbados	Americas & Caribbean	115
Guyana	Americas & Caribbean	..
Saint Lucia	Americas & Caribbean	..
Australia	Pacific	111
New Zealand	Pacific	..
Papua New Guinea	Pacific	..
Fiji	Pacific	..
Samoa	Pacific	..
Tonga	Pacific	59
Vanuatu	Pacific	88

Country name	**Region**	**GDP per capita (constant 2010 US$)**
Singapore	Asia	58,830
Brunei Darussalam	Asia	32,327
Malaysia	Asia	12,487
Maldives	Asia	8,477
India	Asia	2,152
Sri Lanka	Asia	4,012
Bangladesh	Asia	1,288
Pakistan	Asia	1,185
United Kingdom	Europe	43,712
Malta	Europe	28,976
Cyprus	Europe	32,093
Rwanda	Africa	901
Lesotho	Africa	1,353
Mozambique	Africa	589
Nigeria	Africa	2,374
Ghana	Africa	1,884

(*Continued*)

Namibia	Africa	5,766
South Africa	Africa	7,346
Malawi	Africa	524
Zambia	Africa	1,654
Uganda	Africa	963
Eswatini	Africa	4,818
Botswana	Africa	8,093
Gambia, The	Africa	815
Sierra Leone	Africa	488
Canada	Americas & Caribbean	51,589
Trinidad and Tobago	Americas & Caribbean	15,105
Saint Vincent and the Grenadines	Americas & Caribbean	6,863
Jamaica	Americas & Caribbean	4,867
Barbados	Americas & Caribbean	16,100
Guyana	Americas & Caribbean	6,107
Saint Lucia	Americas & Caribbean	9,351
Australia	Pacific	57,187
New Zealand	Pacific	38,993
Papua New Guinea	Pacific	2,490
Fiji	Pacific	4,739
Samoa	Pacific	3,869
Tonga	Pacific	4,355
Vanuatu	Pacific	2,887

Country name	Region	Fixed broadband subscriptions
Singapore	Asia	1,504,000
Brunei Darussalam	Asia	54,195
Malaysia	Asia	2,964,500
Maldives	Asia	52,976
India	Asia	19,156,559
Sri Lanka	Asia	1,666,317
Bangladesh	Asia	8,085,500
Pakistan	Asia	1,760,870
United Kingdom	Europe	26,786,963
Malta	Europe	202,513
Cyprus	Europe	326,565
Rwanda	Africa	8,885
Lesotho	Africa	6,329
Mozambique	Africa	69,975
Nigeria	Africa	83,360
Ghana	Africa	58,518
Namibia	Africa	63,314
South Africa	Africa	1,250,356
Malawi	Africa	11,358
Zambia	Africa	88,891
Uganda	Africa	N/A
Eswatini	Africa	8,000
Botswana	Africa	49,295
Gambia, The	Africa	4,433

(*Continued*)

Sierra Leone	Africa	N/A
Canada	Americas & Caribbean	15,273,496
Trinidad and Tobago	Americas & Caribbean	339,340
St. Vincent and the Grenadines	Americas & Caribbean	22,491
Jamaica	Americas & Caribbean	317,907
Barbados	Americas & Caribbean	106,803
Guyana	Americas & Caribbean	64,889
St. Lucia	Americas & Caribbean	32,265
Australia	Pacific	8,752,830
New Zealand	Pacific	1,647,000
Papua New Guinea	Pacific	18,000
Fiji	Pacific	13,033
Samoa	Pacific	1,692
Tonga	Pacific	3,703
Vanuatu	Pacific	7,888
Data from database: World Development Indicators		
Last updated: 19 March 2021		

Annex 2. Data indicator and source

Indicator	Measure	Data Source
1. Network coverage	Percentage of network covered by either 2G, 3G or 4G network technology	GSMA and ITU
2. Network performance	Average mobile broadband download speeds	Ookla's speedtest intelligence
3. Other enabling infrastructure	Percentage of population with access to electricity, international internet bandwidth per user, secure servers, and/or internet exchange points	World Bank and ITU
4. Spectrum	Digital Dividend Spectrum per operator	GSMA
Indicator	**Measure**	**Data Source**
1. Mobile tariffs	Cost of data as percentage of GDP per capita	Tarifica
2. Handset prices	Cost of cheapest internet-enabled devices and percentage of GDP/ capita	Tarifica
3. Taxation	Tax as a percentage of total mobile ownership	GSMA
4. Inequality	Inequality in income (Atkinson measure)	UNDP
Indicator	**Measure**	**Data Source**
1.Online security	ITU Global Cybersecurity index score	ITU
2. Accessibility to top ranked apps	Accessibility of the most population mobile apps	Appfigures
3. Apps developed per person	Mobile apps developed per person	Appfigures
4. Mobile social media penetration	Mobile social media penetration score	Datareportal
Indicator	**Measure**	**Data Source**
1. Gender parity in schooling	Gender parity for mean years of schooling	UNDP/UNESCO
2. Gender parity in social media use	Gender gap ratio for social media use	Facebook audience insight/data reportal
3. Gender parity in account ownership	Gender parity index for having an account	World Bank Findex
4. Gender parity in mobile ownership	Gender gap ratio for mobile ownership and usage	GSMA
**Data consolidated from various databases available at GSMA database		