Impact of COVID-19 on the Internet Ecosystem in Bangladesh, Bhutan, and Pakistan

Internet Society

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Key Findings

- Internet performance was negatively affected in Bangladesh, Bhutan, and Pakistan during the lockdown period of the COVID-19 pandemic (first two quarters of 2020).
- During the lockdown period, data traffic increased in Bangladesh (up 21 percent), Bhutan (up 25 to 30 percent), and Pakistan (up 19 percent).
- Average broadband speed in these countries is well below par as compared with other countries in the Asia-Pacific and even below the average of South and Southwest Asia. The exception is Pakistan's mobile broadband.
- The Internet Society conducted a user survey of Internet performance during the COVID-19 pandemic (first two quarters of 2020) in Bangladesh, Bhutan, and Pakistan. The results show that:
    - 62 percent of the total respondents faced regular Internet performance issues during the pandemic.
    - Social media platforms, over-the-top services (e.g., online video streaming) and e-learning were the top user activities on the Internet during COVID-19 lockdown.
    - 68 percent of the total respondents faced problems with e-learning, and 60 percent found it difficult to work from home, both being the top two adverse implications reported by users in all these countries.
    - Slow browsing (56 percent), low download speed (51 percent), and frequent disconnection (48 percent) are the most common underlying problems with Internet access.
    - Users became more dissatisfied with the speed, reliability, and steadiness of their Internet connections, and also with customer service.
    - Users are spending more money on their Internet connection during the pandemic.
    - Most of the users (except Bhutan) either did not believe or were not aware that their government or ISP made any special efforts to improve the Internet connectivity during the COVID-19 pandemic.
- The government approach towards handling the unexpected traffic surge requires a strategic shift from "immediate but short term" to "proactive and long term."

- Renewed government efforts are required in Bangladesh and Bhutan to overcome the international connectivity challenges, by increasing submarine fiber optic links.
- Fixed line penetration is critically low in these countries, which puts huge pressure on the mobile networks carrying bulk of the subscriber share.
- Low spectrum allocation and even lower fiber-to-tower ratio result in quality-of-service issues on the mobile networks.
- Digital content infrastructure is underdeveloped with lack of local content and applications.
- There exists a strong technical and business case to deploy more Internet Exchange Points (IXPs) that are vital elements of the Internet infrastructure.

1 Introduction

Almost a year and a half into the COVID-19 pandemic, the Internet has taken center stage to sustain life and business amid the various "waves and variants" of the novel coronavirus. States have adopted swift measures, using digital technologies, to empower their citizens during lockdowns and vaccination drives. It is estimated that the crisis has accelerated the adoption of a wide range of digital technologies by at least two years[1].

While every country is striving for digital transformation, the unprecedented uptake of remote education, work-from-home, e-commerce, e-government services, and content consumption on social media and streaming platforms put serious question marks on the resilience and capacity of the global Internet infrastructure. Despite initial setbacks, Internet infrastructure withstood the traffic spikes and bandwidth demands, thanks to measures adopted by governments and industry actors.

Quality-of-service issues became evident and deficiencies in the Internet value chain got exposed in many parts of the world, especially in developing countries, across different parameters such as speed and reliability. The pre-existing shortfalls in the digital outlook in terms of inclusion, speed, coverage, and affordability were accentuated, putting further pressure on states to take reactive measures on prevailing problems. Now, Internet traffic patterns are coming back to pre-COVID-19 levels (before March 2020), but the question remains: What can be done on the national level to sustain (or improve) the service quality during disaster situations, when Internet access is needed the most by citizens?

1.1 Scope

This report examines the effect of the COVID-19 pandemic(first two quarters of 2020) on Internet performance in three South Asian countries: Bangladesh, Bhutan, and Pakistan. The report includes a comprehensive user survey in these countries that compares end users' perception about their Internet experience, before and during the pandemic.

1 Rana Foroohar, "Big Tech's viral boom could be its undoing," Financial Times, May 17, 2020; Richard Waters, "Lockdown has brought the digital future forward — but will we slip back?" Financial Times, May 1, 2020.

The survey results provided useful insight that helped in setting up the context of the report, followed by these steps:

- In step one, we created an overview of existing Internet infrastructure;
- In step two, we identified and explored the weak links in the infrastructure; and
- Finally in step three, we provided concrete recommendations to improve Internet connectivity and prepare stakeholders for future emergencies.

We followed a similar approach for an earlier report about Internet performance during the COVID-19 pandemic in Afghanistan, Nepal, and Sri Lanka that was published by Internet Society in March 2021[2]. Based on positive feedback on the report by Internet stakeholders in those countries, plus interest from Internet communities in Bangladesh, Bhutan, and Pakistan, we developed this second report.

1.2 Internet Traffic and Speed

COVID-19 had a significant impact on Internet traffic, as the average international Internet traffic increased by 48 percent, while peak traffic rose by 47 percent in 2020[3]. During the same period, Internet bandwidth rose by 35 percent to reach 618 Tbps in 2020. In 2019 it rose 26 percent —at the time the largest one-year increase since 2013[4].

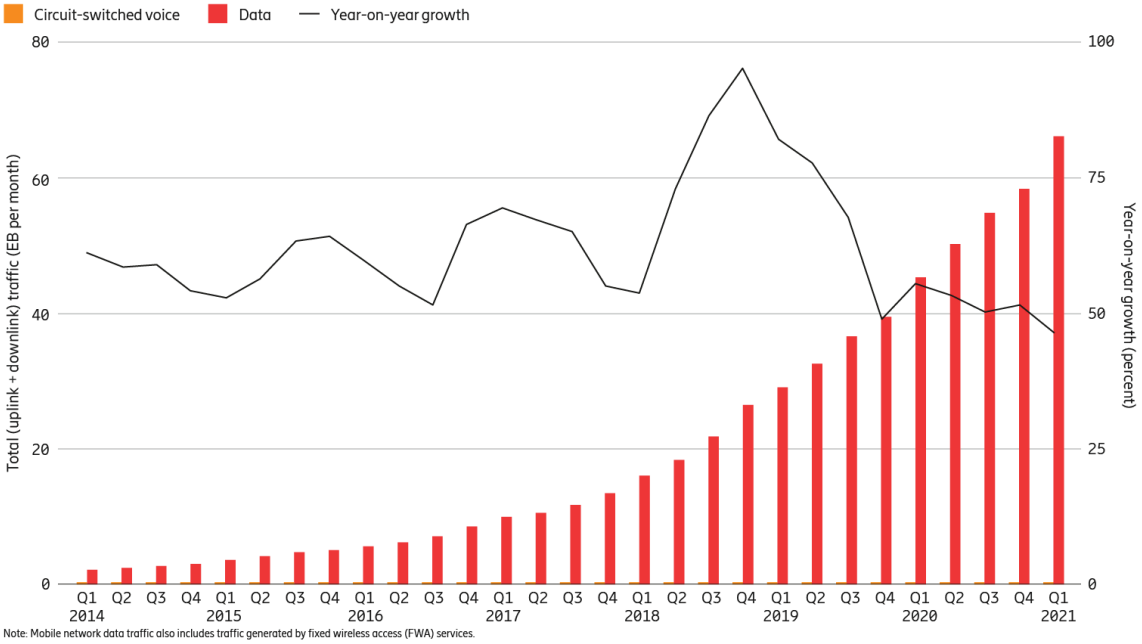
2 https://www.internetsociety.org/wp-content/uploads/2020/12/Asia-Covid-report-EN-March-2021.pdf

3 Telegeography

4 Ibid

Figure 1 shows that total global monthly network data and voice traffic from Q1 2014 to Q1 2021 grew by 46 percent between Q1 2020 and Q1 2021, with the total exceeding 66 Exabytes. This traffic growth is primarily caused by the rising uptake of smartphones and an increase in average data subscription, driven by increased video content viewing, such as YouTube and Netflix, which constitutes more than 15 percent and more than 11 percent of all traffic on consumer broadband networks respectively[5]. Similarly, Cisco WebEx video conferencing application experienced 24 times higher volume, whereas Facebook reported increases of 100 percent on voice calls and 50 percent on text messaging over its WhatsApp, Facebook Messenger, and Instagram platforms. Due to higher demand, several application providers such as Netflix, Akamai, and YouTube.

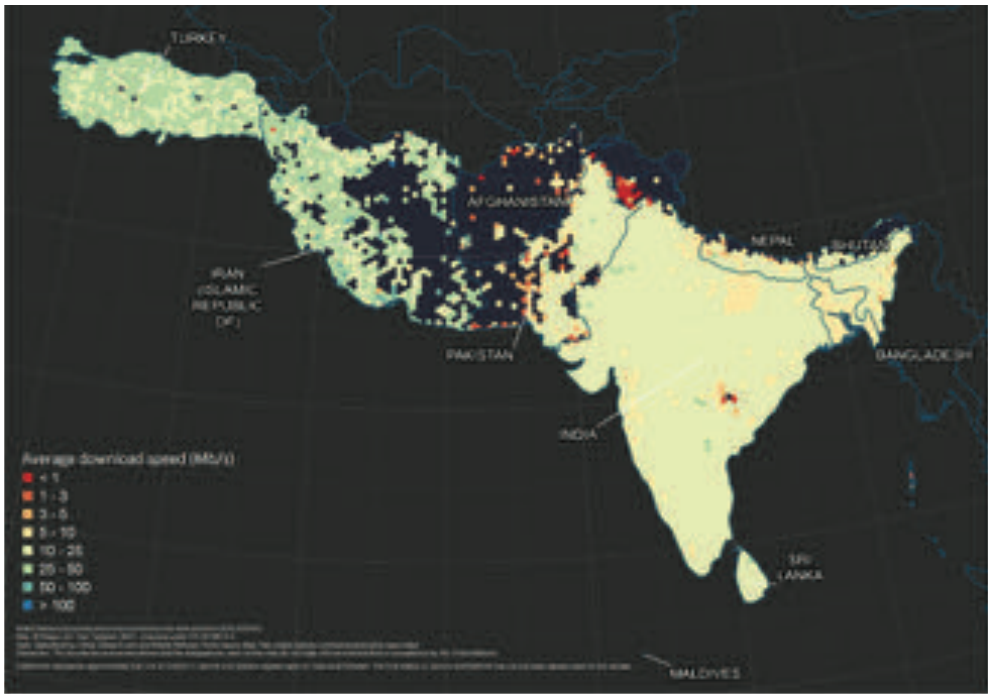
Figure 1: Global Mobile Data Traffic and Growth



Source: Ericsson Mobility Report

5 Sandvine Global Internet Phenomenon Report

Figure 2: Average Mobile Broadband Speed in South and South-West Asia shifted default settings from high definition to standard definition globally.



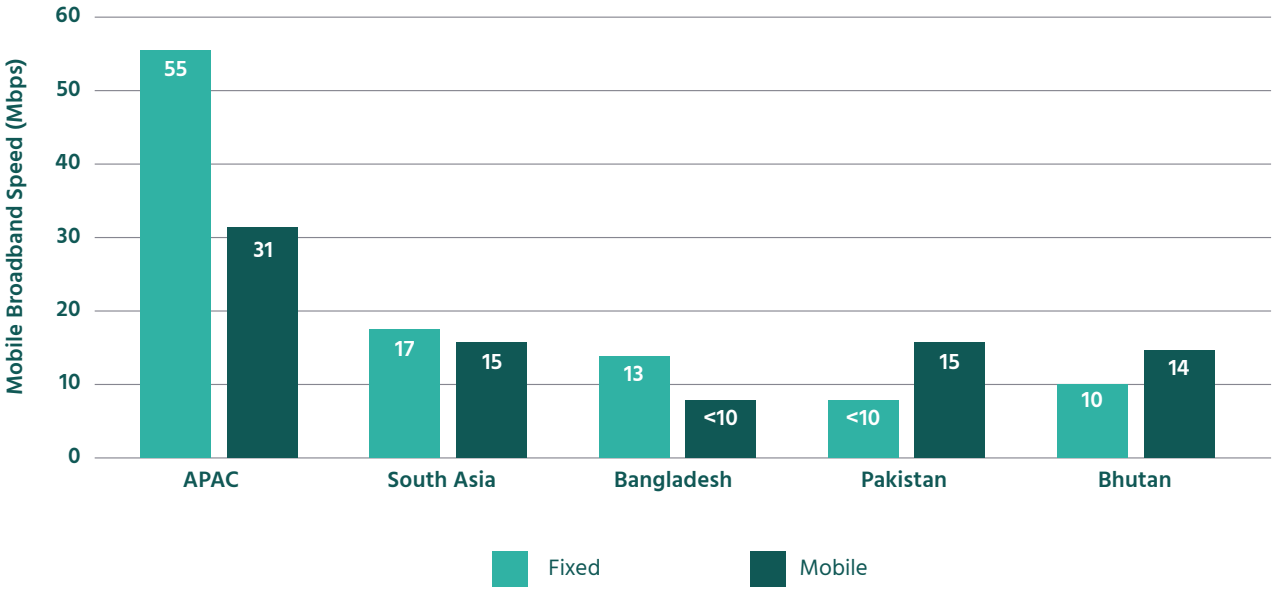
Source: 'Ofa, SV. And Aparicio, CB. (2021). Visualizing Broadband Speeds in Asia and the Pacific. Asia-Pacific Information Superhighway Working Paper No. 02/2021. United Nations ESCAP, ICT and Disaster Risk Reduction Division, May 2021. Bangkok.

During the lockdown period (March – June 2020), data traffic increased by a similar margin in Bangladesh (up 21 percent), Bhutan (up 25-30 percent), and Pakistan (up 19 percent)[6]. The main drivers behind this trend are content viewing, work-from-home, and e-learning, whereas catalytic effects on e-commerce, e-health, and information search have also been observed. A study conducted by Google and Kantar revealed that COVID-19 lockdowns led to a 10 percent increase in daily Internet usage among urban users in Pakistan[7]. Increased traffic is bound to have implications on the end-user experience, especially in terms of broadband speeds. According to the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), the average broadband speed of the Asia-Pacific region is 55 Megabits per second (Mbps) for fixed networks, whereas the average mobile broadband speed is 31 Mbps. However, these figures drop significantly for South and Southwest Asia, where the average fixed broadband and mobile broadband speeds are 17 Mbps and 15 Mbps respectively (Figure 2).

6 GSMA (Bangladesh), BTL and TashiCell (Bhutan), PTA Annual Report 2020 (Pakistan)

7 Google and Kantar 'Pakistan's Journey to Digital', July 2021

Figure 3: Average Fixed and Mobile Broadband Speed (Mbps)



Source: 'Ofa, SV. And Aparicio, CB. (2021). Visualizing Broadband Speeds in Asia and the Pacific. Asia-pacific Information Superhighway Working Paper No. 02/2021. United Nations ESCAP, ICT and Disaster Risk Reduction Division, May 2021. Bangkok

If we look at the average fixed and mobile broadband speeds in Bangladesh, Bhutan, and Pakistan, we discover some interesting insights (Figure 3). All of the countries are well below the average broadband speed, not only in the Asia-Pacific but also within the sub-region of South and Southwest Asia (except for Pakistan in the case of mobile broadband). Bangladesh has a higher fixed broadband speed than Pakistan and Bhutan, but its mobile broadband speed is less than 10 Mbps. Conversely, Pakistan and Bhutan have a slower fixed broadband compared with mobile broadband. Pakistan catches up with the rest of South Asia in terms of average mobile broadband speed, but the average fixed broadband speed is less than 10 Mbps. Bhutan's average fixed and mobile broadband speeds, of 10 Mbps and 14 Mbps respectively, are below the South Asian average and also lower than the average speed of other landlocked countries (fixed 14 Mbps, mobile 17 Mbps).

It is evident from the facts and figures above that the Internet experience in Bangladesh, Bhutan, and Pakistan is quite different, each having its priorities, achievements, and challenges. We will explore the state of the three countries' Internet infrastructure in the next section to see how they are digitally connected with the rest of the world.

2 State of Internet Infrastructure

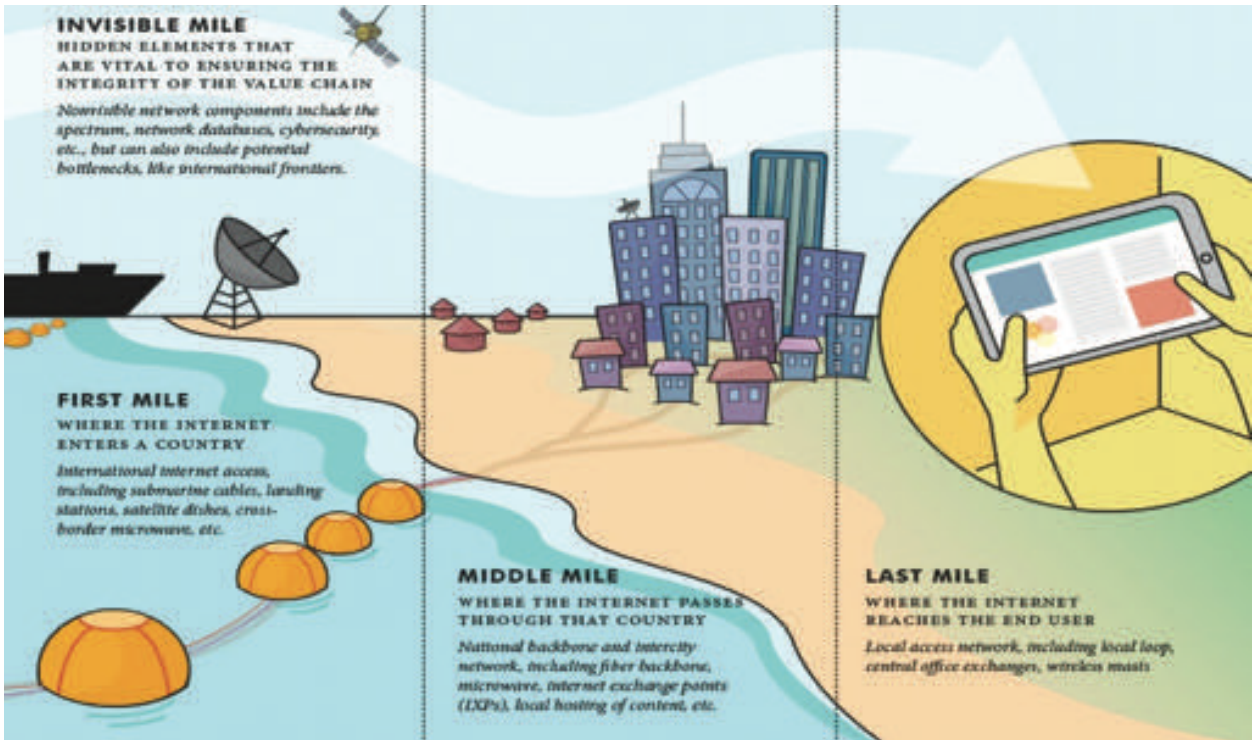
Internet is delivered through a combination of physical and virtual components over a vast network of networks. The way devices are connected via fixed or wireless media is called the "Access Network," while the applications and standards that enable meaningful use of communication over the physical links are termed "Services." We will examine both of these infrastructure elements to present a holistic view of the state of affairs in all three countries.

2.1 Network

Access network or simply network denotes the physical connections (miles) that carry the Internet traffic from outside the country to the end-user device and vice versa. The network includes hardware, computing equipment, devices, fiber cables dropped on the ocean bed, towers deployed at a mountain top, and bands of frequencies ("the spectrum") communicating via towers or satellite. Typically, the network consists of:

- First mile: international submarine fiber cables or satellite links
- Middle mile: national backhaul consisting of fiber or microwave links
- Last mile: fixed or wireless connection to the end-user device

Figure 4: Access Infrastructure

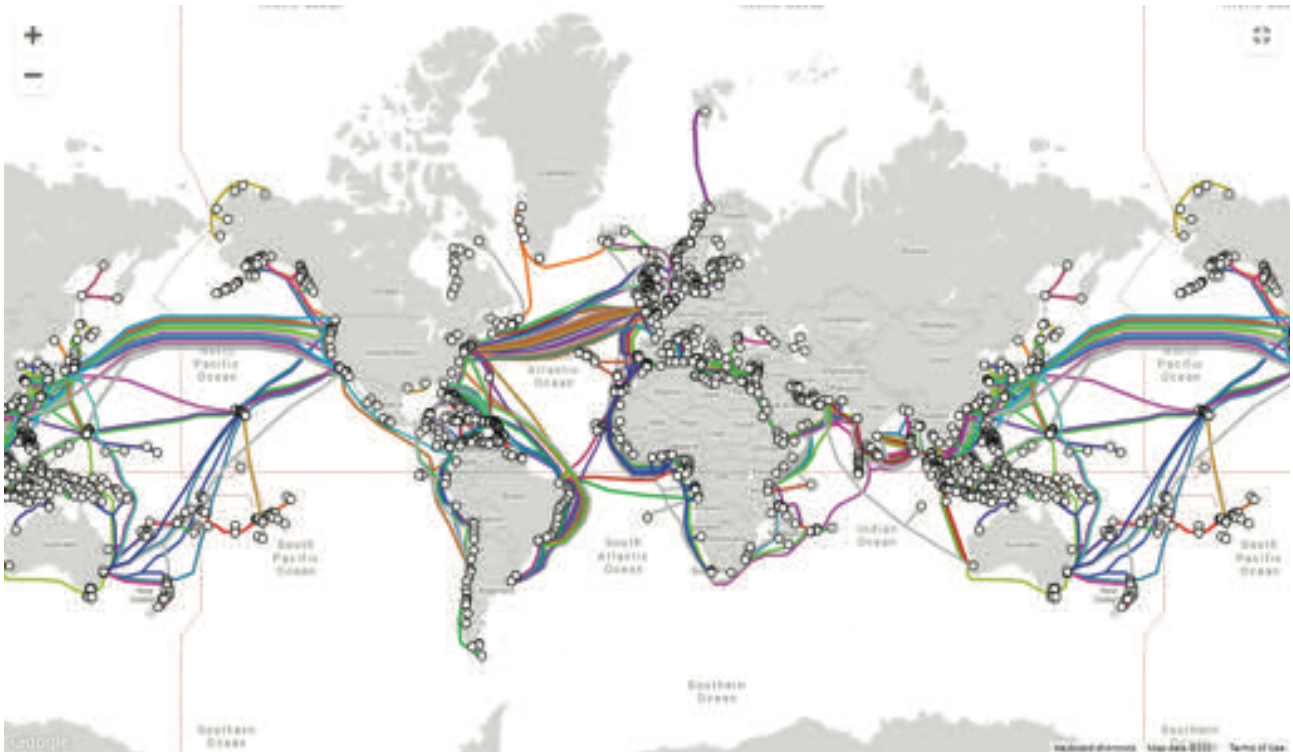


Source: World Bank

2.1.1 International Connectivity

The delivery of Internet traffic to and from a country is carried out via terrestrial, undersea, or satellite channels, depending upon geography, population distribution, and topography. It is quite expensive to use satellite connectivity, therefore, optical fiber links (by land or sea) are the preferred physical link to connect continents and states, carrying 98 percent of global Internet traffic. Even in the case of a landlocked country like Bhutan, the Internet traffic will eventually travel to other continents via one of the submarine cables connected with a neighboring country. As of early 2021, there are approximately 426 submarine cables in service, with 1.3 million kilometers of fiber laid down around the world[8]. The total number of cables is constantly changing as new cables enter service and older cables are decommissioned. Based on publicly available sources, an additional $8.1 billion worth of new cables will be launched between 2020 and 2022[9].

Figure 5: International Submarine Cable Map



Source: Telegeography

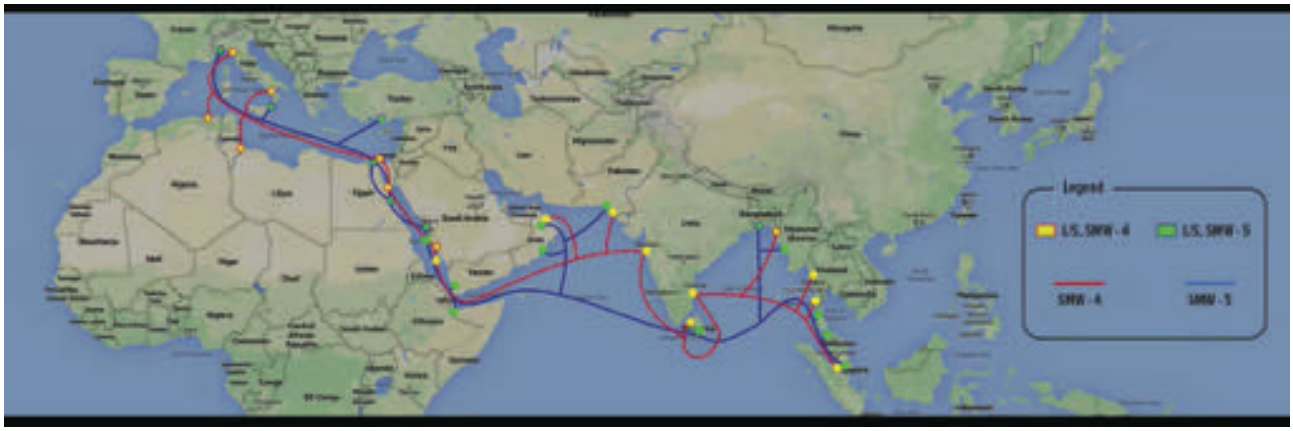
8 https://www.submarinecablemap.com/

9 Telegeography, State of Network 2021

The sum of all international fiber and satellite connections is collectively referred to as the International Internet Bandwidth of a country or region[10]. A higher international bandwidth enables a better flow of data over the fiber links and may ultimately result in a better user experience. In the interest of cost saving by the cable operators, the installed capacity of cables is commissioned for actual data flow depending upon the change or anticipated change in bandwidth demand.

Bangladesh is connected by two submarine cables with the rest of the world and by six international terrestrial links with India. In 2005, the first submarine fiber link was established with Southeast Asia–Middle East–Western Europe 4 (SEA-ME-WE 4) via a landing station at Jhilongja, Cox's Bazar. A second connection came much later in 2017 through SEA-ME-WE 5, with a cable landing station at Kuakata, Patuakhali. Recently, the government approved a project proposal for the third submarine cable connection with SEA-ME-WE 6, to be activated by June 2024. All of the submarine cables are owned and managed by state-owned Bangladesh Submarine Cable Company Ltd. (BSCCL), providing 1,535 Gbps connectivity. In addition, terrestrial links are established with India by six International Terrestrial Cable (ITC) operators that provide a total of 1000 to 1100 Gbps bandwidth. Hence Bangladesh has a total bandwidth capacity of 2,600 Gbps from existing international fiber links, whereas the third submarine cable will add another 7,200 Gbps to the international bandwidth capacity[11]. Currently, almost 91 percent of the total bandwidth is consumed in the country on average, which necessitates the adoption of swift measures to increase the bandwidth capacity[12].

Figure 6: Bangladesh Submarine Cable Map



Source: Bangladesh Submarine Cable Company Limited (BSCCL)

10 Total Lit/equipped international bandwidth capacity refers to the total lit capacity of international links, namely fire-optic cables, international radio links and satellite uplinks to orbital satellites in the end of the reference year (expressed in Mbit/s) (Source: ITU).

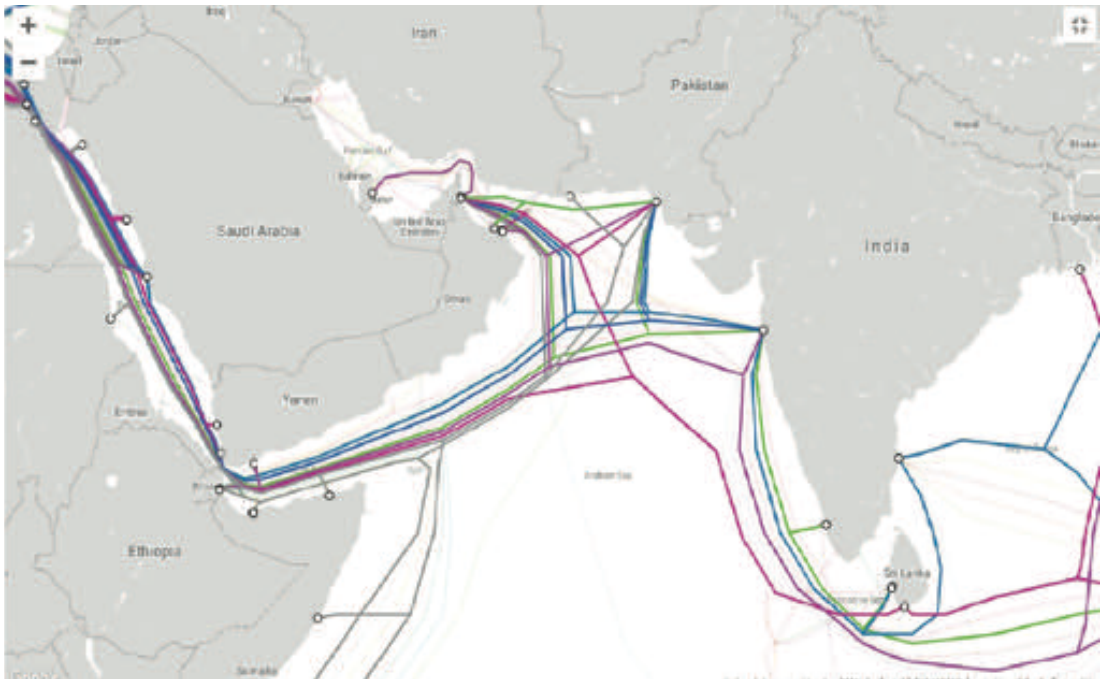
11 Bangladesh Telecommunication Regulatory Commission (BTRC), Dhakatribune.com

12 https://www.dhakatribune.com/business/2021/05/22/bangladesh-might-run-out-of-internet-bandwidth-as-early-as-2023

Bhutan has no direct access to the sea; therefore it has established two terrestrial fiber links at Phuentsholing (2007) and Galephu (2011), operated by Tashi InfoComm Ltd. (TICL) and Bhutan Telecom Ltd. (BTL), both of which converge at Siliguri, India. This connectivity allows the Bhutanese operators to access two International Points of Presence (PoPs) and transit links at the London Internet Exchange Point (LINX), Hong Kong Internet Exchange (HKIX), Singapore Internet Exchange (SGIX), and Los Angeles International Internet Exchange (LAIIX). Collectively, Bhutan has more than 40 Gbps international Internet bandwidth[13].

Pakistan is connected with the rest of the world through six submarine cables (SEA-ME-WE 3, SEA-ME-WE 4, SEA-ME-WE 5, AAE1, TWA1 and I-ME-WE), having 4 landing stations and additional 19 terrestrial links with neighboring countries. Pakistan Telecommunication Company Limited (PTCL) and Transworld Associates (TWA) carry Internet traffic to and from the country over their respective submarine cables. Pakistan has recently established an 820KM terrestrial link with China under the China-Pakistan Economic Corridor project that is operated by Special Communication Organization (SCO). The total installed capacity of the fiber optic links stands at 6.4 Tbps, out of which 3.8 Tbps has been consumed by operators so far. Therefore Pakistan has sufficient international Internet bandwidth capacity in the existing setup, and there are two more submarine cables (PEACE and AFRICA-1) in the pipeline.

Figure 7: Pakistan Submarine Cable Map

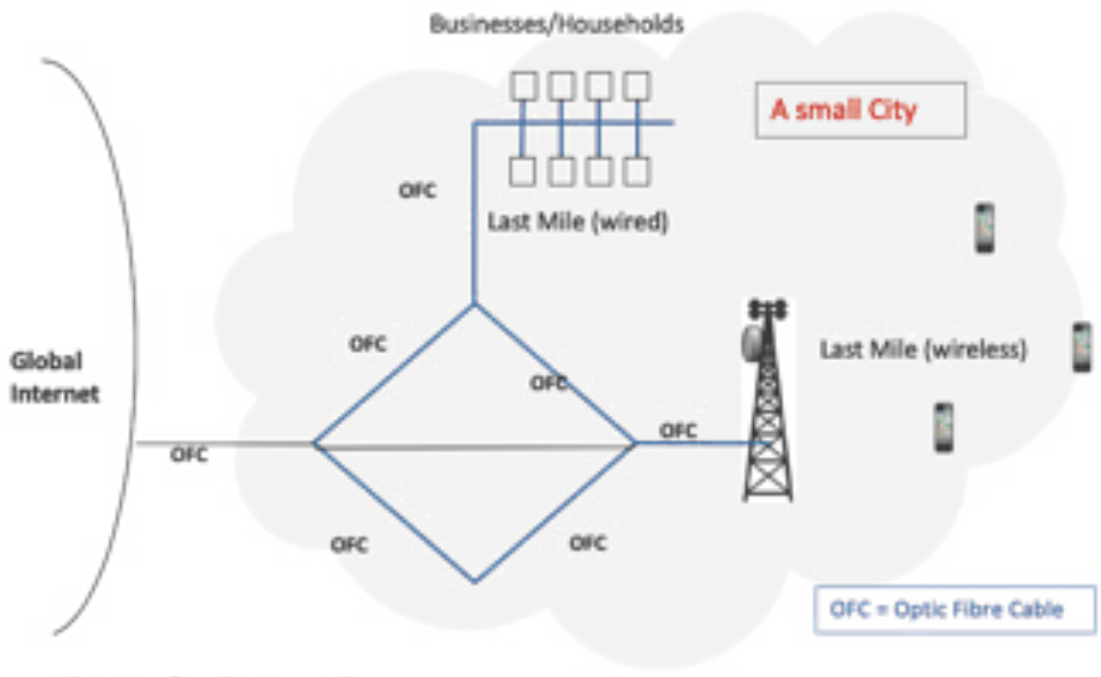


Source: submarinecablemap.com

2.1.2 Domestic Backhaul and Last Mile Infrastructure

Backhaul (or middle mile) and last mile are the essential segments of the network infrastructure that distribute the Internet traffic from the international cable landing stations (submarine or terrestrial) at the national borders to the telecom service providers in the country. In the next step, the data and voice traffic is distributed to various parts of the country, hopping through Internet exchanges, cell towers, Points of Presence (PoPs), metro fiber, and elsewhere, as per the national network architecture. Finally, Internet Service Providers (ISPs) terminate the traffic at the end-user premises and/or devices, over fixed or wireless media. While the international connectivity is usually owned and operated by multinational consortiums, the national backbone, middle, and last-mile infrastructure requires significant investment by the national carriers, with policy and regulatory support of the government.

Figure 8: Backhaul and Last-Mile at a Glance



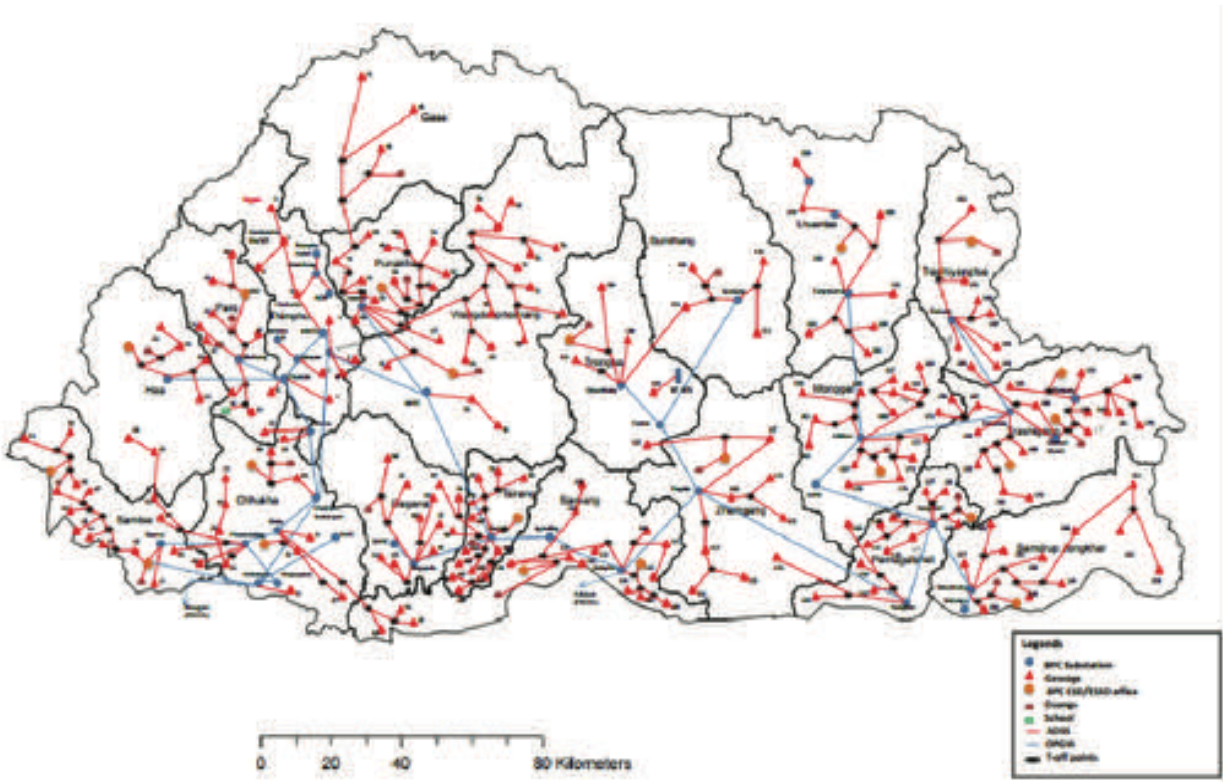
Bangladesh has four Mobile Network Operators (MNOs) providing 3G, 4G, and LTE, plus two landline operators. Broadband penetration is 59 percent (98.6 million) while 3G, 4G, and LTE access is available to more than 98 percent of the population. 92 percent of the country's overall subscriber base uses the Internet over mobile networks[14]. Bangladesh has a complex regulatory model where tiers of operators carry voice and data traffic across the country. Under Bangladesh Telecom Policy, eight licenses have been issued to National Internet Exchange (NIX) operators that route inter-operator domestic voice and data traffic, while six National Telecommunication Transmission Network (NTTN) operators handle the national Internet/fiber backbone on the transmission layer. There are 121 licensed nationwide ISPs in Bangladesh, in addition to 87 ISPs permitted to operate in the central zone (including Dhaka) and 253 restricted to other regions. Two companies also hold specific licenses for Very Small Aperture Terminal (VSAT), a satellite communications system that serves home and business users provision, although 12 other ISPs also use VSAT[15]. The state-owned Bangladesh Telecommunication Company Limited (BTCL) claims fiber-optic presence in 64 districts, 478 Upazilas (sub-districts), and 1,212 unions over an optical network spanning 24,000 kilometers. In addition, the government has rolled out major fiberization projects such as Optical Fiber Cable Network Development at union and district level while also connecting 587 government and educational institutes to BTCL's fiber-optic network. Bangladesh is also a member of the South Asia Sub-regional Economic Cooperation (SASEC) network that connected Bangladesh, Bhutan, India, and Nepal in 2014.

14 BTRC, GSMA Intelligence

15 BTRC License Summary

Bhutan has two MNOs providing 3G, 4G, and LTE services, one fixed-line operator, and six Internet service providers that serve 0.75 million cellular subscribers, out of which 96 percent are using mobile broadband. 90 percent of the population is covered by 3G and 85 percent by 4G signal[16]. The Ministry of Information and Communications (MoIC) of the Royal Government of Bhutan has rolled out the National Broadband Master Plan Implementation Project (NBMP) to establish an optical-fiber backbone network throughout the country. The project has connected 20 districts (dzongkhags) and 201 villages with 3500 kilometers of optical fiber[17]. The government provides free access to dark fiber for telecom and broadband operators.

Figure 9: Bhutan Fiber Optic Network



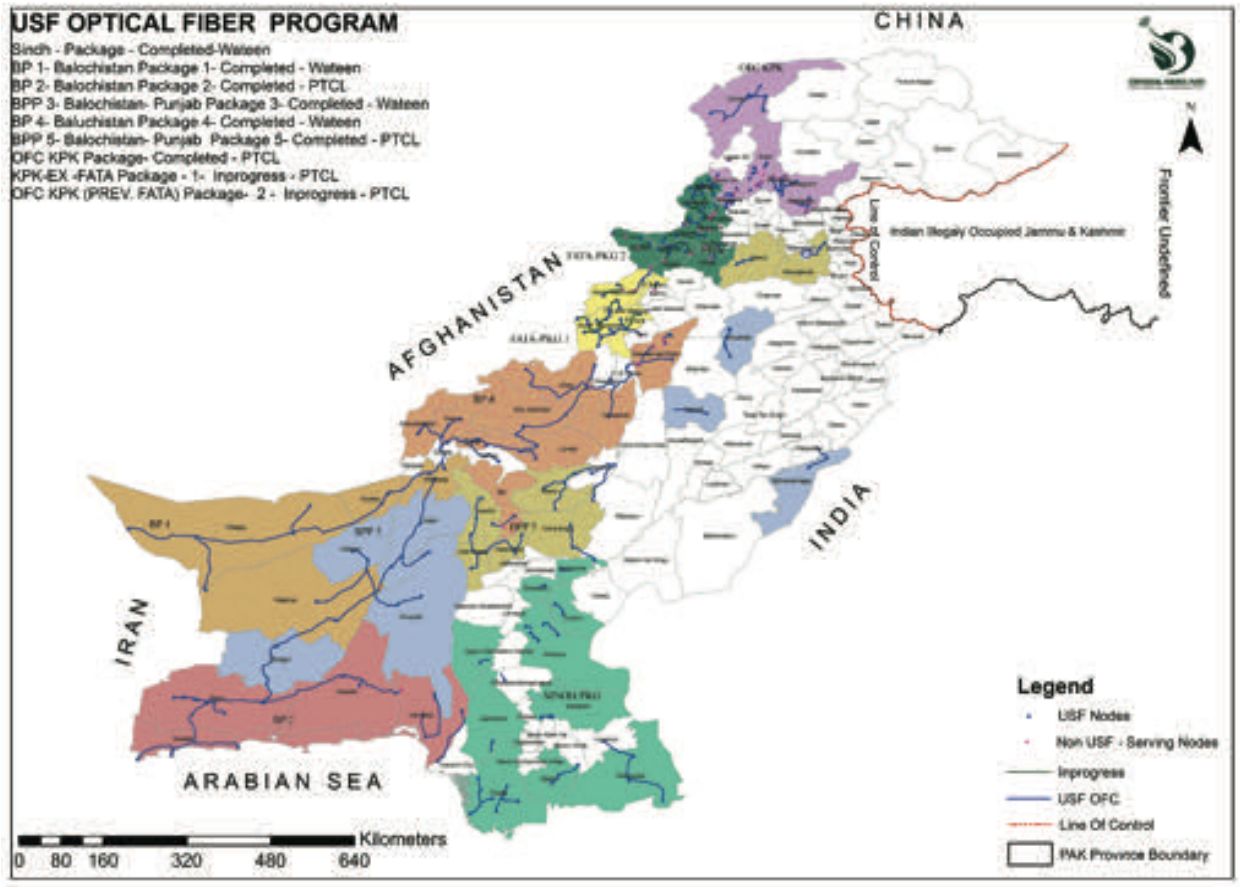
Source: Bhutan Power Corporation Ltd.

16 BICMA, GSMA Intelligence

17 https://www.moic.gov.bt/en/press-release-national-fiber-monitoring-system/, Telegrography

Pakistan has four MNOs providing 3G, 4G, and LTE services, three major fixed-line operators, and 190 ISPs in 2021. Mobile broadband is available to more than 90 percent of the population, but the penetration is 47 percent, with 102.7 million broadband subscribers by the end of June 2021. More than 110,000 kilometers of fiber has been laid down, comprising 57,150 kilometers of backhaul and 52,850 kilometers of last-mile access[18]. In addition to the fiber laid down by the operators, the Universal Service Fund (USF) has been fairly active in expanding broadband coverage in rural areas of Pakistan. Since its inception in 2006, more than $800 million has been invested by the fund in Pakistan. Major backhaul operators are PTCL, Wateen, Link dot net, and Multinet, whereas last mile service is provided by multiple operators. PTCL extended 100 Gbps backbone transport network in all major cities. The metro transport networks in Islamabad, Karachi, and Lahore, along with subsidiary transport links, were upgraded to 100 Gbps.

Figure 10: USF Fiber Optic Network



Source: Universal Service Fund

18 Pakistan Telecommunication Authority (PTA)

Table 1: Domestic Fiber-Optic Deployment in Pakistan

Operator	Fiber Deployed (in KMs)		
	Backhaul	Last Mile	Total
Wateen Telecom	15039	15245	30284
PTCL	16293	7401	21970
Multinet	7025	7967	14991
Link dot net	11901	1417	13318
Nayatel	Nil	8191	8191
Others	6892	12629	21246
Total	57,150	52,850	110,000

Note: Another 14000 x OFC is under use of FLL, WLL, CVAS, and other small operators
Source: Pakistan Telecommunication Authority

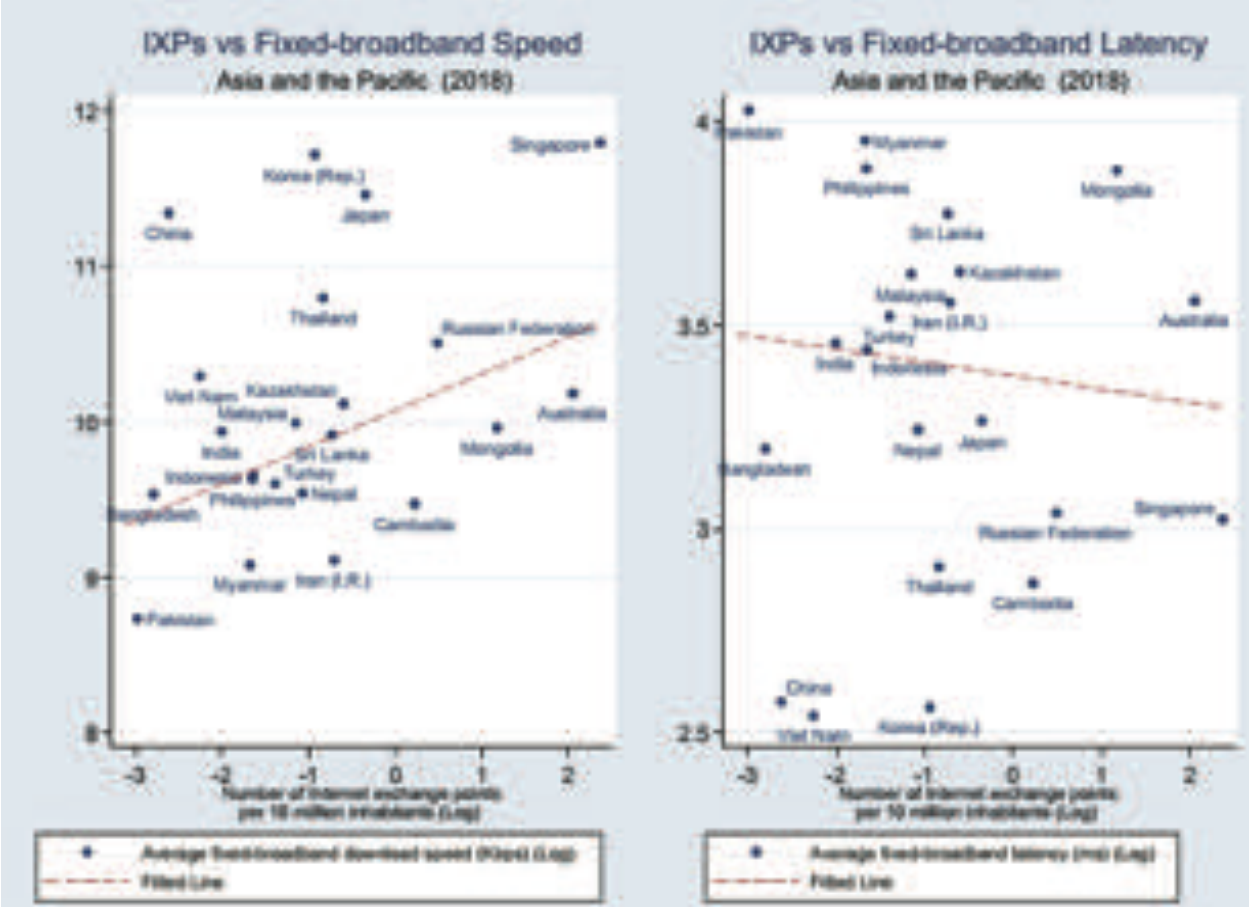
2.1.3 Internet Exchange Points (IXPs)

One of the critical success factors in establishing a robust infrastructure is the way ISPs and networks connect. If two ISPs agree to exchange traffic without any settlement cost of the net traffic flow, it is called peering. If the net traffic flow is significantly higher, a pre-agreed cost is paid by the smaller ISP and the arrangement is termed as transit. However, an Internet Exchange Point (IXP) is a physical and often neutral location where multiple ISPs or content providers agree to exchange Internet traffic without transit cost. IXPs tend to keep the national traffic within the geographical boundaries, reducing pressure on the international bandwidth, ultimately increasing speed, and reducing latency of the network. A study by UNESCAP states that for every one percent increase in the number of IXPs per 10 million inhabitants, the fixed-broadband download speed (Kbps) is expected to increase by 0.14 percent[19] (as shown in Figure 10). Similarly, a recent report on effective IXPs strategies in Asia-Pacific by Internet Society provides a good overview of the IXPs development in the region[20].

19 https://www.unescap.org/resources/estimating-effects-internet-exchange-points-fixed-broadband-speed-and-latency

20 https://www.internetsociety.org/wp-content/uploads/2021/06/Internet-Peering-in-Asia-Pacific-EN.pdf

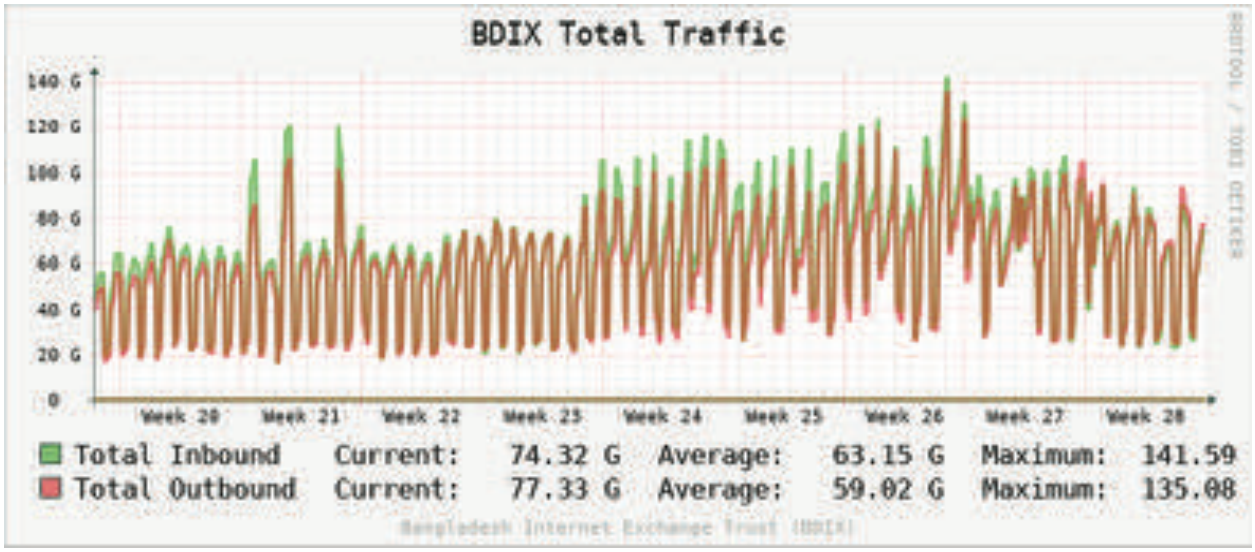
Figure 11: IXPs vs Fixed-broadband Speed and Latency



Source: UNESCAP

Bangladesh Internet Exchange Point (BDIX) is one of the first IXPs in the region, set up in 2004. It connects 120 networks handling an average traffic load of 45 Gbps[21]. BDIX is a not-for-profit venture of the Sustainable Development Networking Foundation (SDNF) Bangladesh.

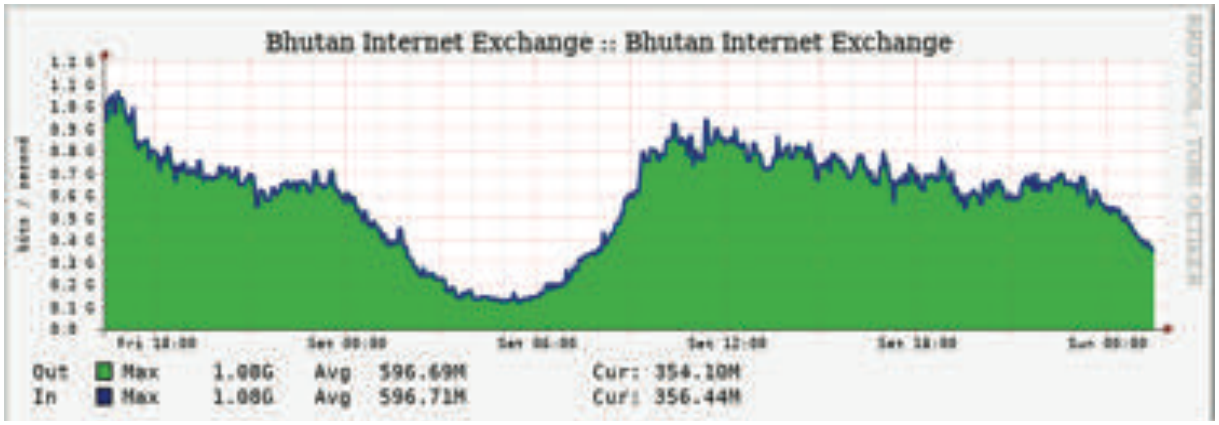
Figure 12: Bangladesh IXP Traffic



Source: BDIX

Bhutan Internet Exchange Point (btIX) was formally established in December 2017 as a nonprofit association of ISPs and operators in Bhutan, under the auspices of the government of Bhutan[22]. Currently, 13 networks are exchanging approximately 600 Mbps average daily traffic on btIX.

Figure 13: Bhutan IXP Traffic



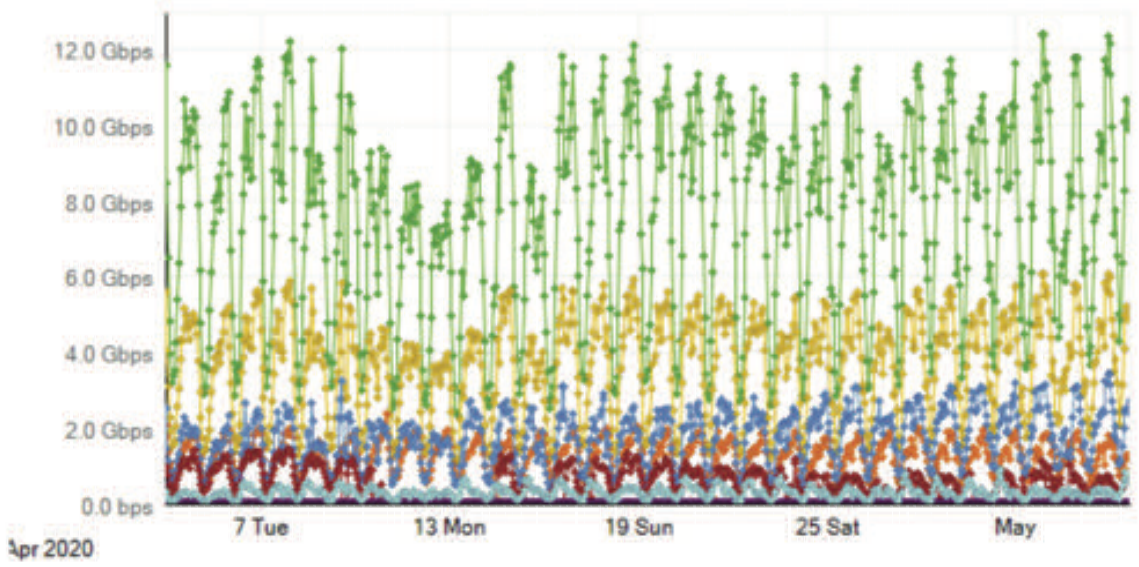
Source: btIX

21 https://bdix.net/

22 btix.bt

Pakistan Internet Exchange Point (PKIX) was first established in Islamabad at a neutral venue, the Higher Education Commission of Pakistan (HEC), in 2016. The second IXP was launched in Karachi in 2019, while work is underway for a third IXP in Lahore. PKIXP handles 16 GB of traffic on average of the 09 networks.

Figure 14: Pakistan IXP Traffic



Source: pkIX

2.2 Services

While the network refers to the physical part of the Internet infrastructure, services are the aggregation of virtual content, protocols, standards, and configurations. In simple terms, services are the what (digital content), the where (routing), and the how (protocols, standards) of Internet infrastructure. Review of services can be done in many ways, but we will look at the status of digital content and how it is delivered over the Internet in Bangladesh, Bhutan, and Pakistan.

2.2.1 Local Content

Internet serves as a medium to deliver digital content created, owned, stored, and distributed by individuals and platforms. Content remains the pivotal element that has a significant impact on how well the Internet performs in a community. International Data Corporation (IDC) predicts that by 2025, 175 zettabytes of data will be created per day[23]. Content over the big platforms in the content business, such as Google, Amazon, Facebook, and Microsoft, constitutes 64 percent of the total used international

23 https://www.bernardmarr.com/default.asp?contentID=1846

capacity in the world[24]. When a user wants to access a video that is hosted outside the country, the data travels over the international links to another location and back. Imagine millions of users watching the same video; it will naturally put more pressure on the international bandwidth. However, if the content is produced locally, it will most likely be consumed over the domestic networks, which serve two very important functions: (i) less stress on the international Internet bandwidth (transit cost-saving) and (ii) reduced latency (improved quality of service(QoS)). This relationship has been examined by the Internet Society, the Organization for Economic Co-operation and Development (OECD), and the United Nations Educational, Scientific, and Cultural Organization (UNESCO). This research demonstrated a strong correlation between infrastructure development and growth of local content[25]. The research also found that more developed local Internet markets tend to report lower international prices for bandwidth, and vice versa. However, a community needs to tackle various challenges through government support: technical (local script, domain names, and more), commercial (hosting cost, production cost, and more), and adoption (language barrier, digital skills, and more).

In its widely acclaimed Mobile Connectivity Index, GSMA measures the level of content and services. The availability of secure online content and services, accessible and relevant to the local population, is measured through various indicators (see table 2).

Table 2: Content & Services

Country	TLDs per capita	E-Gov Score	Mobile Social Media Penetration	Apps developed per person	Number of apps in national language	Accessibility of top-ranked apps	Cybersecurity Index
Bangladesh	28.91	61.18	21.83	53.02	50.60	42.99	52.50
Bhutan	49.92	68.24	56.14	67.88	41.66	29.04	18.10
Pakistan	33.28	62.94	16.89	64.34	48.75	20.38	40.70

Source: GSMA Mobile Connectivity Index 2020

Top-Level Domains (TLDs) per capita include the number of generic top-level domains (gTLDs) and country-code top-level domains (ccTLDs) registered in a country. Bhutan has a higher score than Bangladesh and Pakistan, indicating more web development and domain registrations per capita. The United Nations' E-government Index value represents the adoption of e-government services in a country. Bhutan is ranked 103 in the Index, higher than Bangladesh (119) and Pakistan (153), indicating better adoption of

24 Telegeography, State of Network Report 2021

25 https://www.oecd.org/sti/ieconomy/48761013.pdf

digital technologies for public service delivery. Similarly, Bhutan's penetration of social media users as a percentage of the population is more than that of the other two countries combined. However, the population of Bhutan is a fraction of Bangladesh and Pakistan.

The next three indicators about app development signifies the extent to which a country's population has content they can understand and engage with by mapping the languages spoken in each country against the language of mobile applications. We can see a considerable availability of apps per person and a number of apps in local languages, but the proportion of the population who can use the top 400 apps is much lower, especially in Bhutan and Pakistan. There is a big gap between the availability and usability of apps that are accessible in Bangladesh, Bhutan, and Pakistan. In terms of secure cyberspace measured by ITU's Global Cyber Security Index, Bangladesh (ranked 53) leads Pakistan (ranked 79) and Bhutan (ranked 134).

2.2.2 Data Centers

Data centers are one of the major breakthroughs in the Internet ecosystem. These are physical locations that utilize computing power and storage at unusually high capacity to provide efficient and faster access to digital content. Data centers play a critical role to enable superior user experience by reducing latency and improving redundancy. Big platforms like Google, Facebook, Microsoft, and Amazon establish their data centers or smaller variants at various geographic locations in the world that rapidly deliver their content to end users by reducing distance and latency. Data centers may be established in the form of a single floor or building or co-located at existing premises. While there may be more than three million data centers globally, Asia-Pacific is one of the fastest developing data center regions in the world[26]. At a recent survey of data centers, about half of respondents (48 percent) indicated that customer demand was increasing as a result of the pandemic[27]. According to Structure Research, the colocation market for the Asia–Pacific will grow at an expected compound annual growth rate of 12.2 percent from 2018 to 2024[28]. Singapore and Hong Kong are the hubs of the data center market in the Asia-Pacific thanks to their location, business climate, and tech-friendly policies. Governments have started to establish their own data centers to secure critical national data and services, instead of keeping it on third-party platforms.

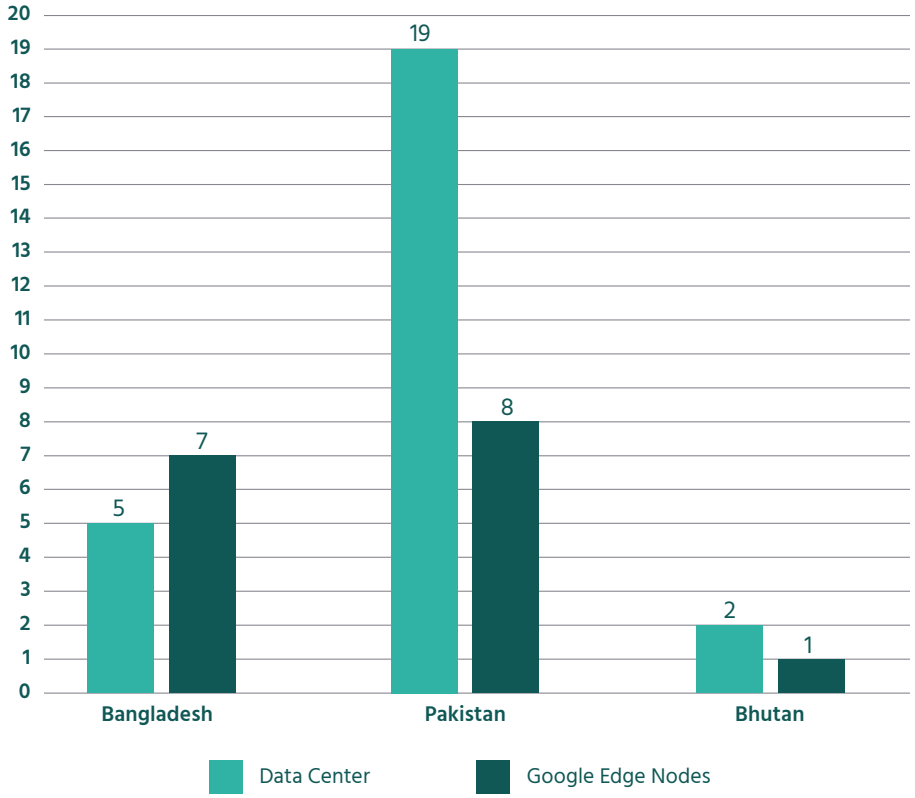
26 New York Times, 2020

27 Telegeography, Data Center Research Service

28 https://www.ironmountain.com/resources/general-articles/s/state-of-the-apac-data-center-market. https://www.nytimes.com/2012/09/23/technology/data-centers-waste-vast-amounts-of-energy-belying-industry-image.html?pagewanted=all&_r=1&

Bhutan established a government data center in 2017 at the Thimphu TechPark, while a private data center was also established at the Thimphu TechPark. More data centers are expected to be established with growing data usage in Bhutan. Bangladesh National Data Center is a tier-IV facility, with two Petabytes capacity, established at the High Tech Park in Kaliakoir, Gazipur. Pakistan has several data centers established and operated by various government organizations such as NTC, Federal Board of Revenue, and the National Database and Registration Authority. Big content platforms are also increasing the deployment of their physical servers in the countries under study. For example, Google Edge Nodes are present in Bhutan (one), Bangladesh (seven), and Pakistan (eight) at various locations to provide better and faster content delivery to the end users.

Figure 15: Hosting Infrastructure



Source: data center catalog

3 User Experience Survey

As part of this study, the Internet Society carried out an online survey to assess the impact of the COVID-19 pandemic on Internet performance on users in Bangladesh, Bhutan, and Pakistan. The survey was carried out from 9-24 June, 2021. Internet users in these countries were invited to share their online experience, measured against the following four pillars:

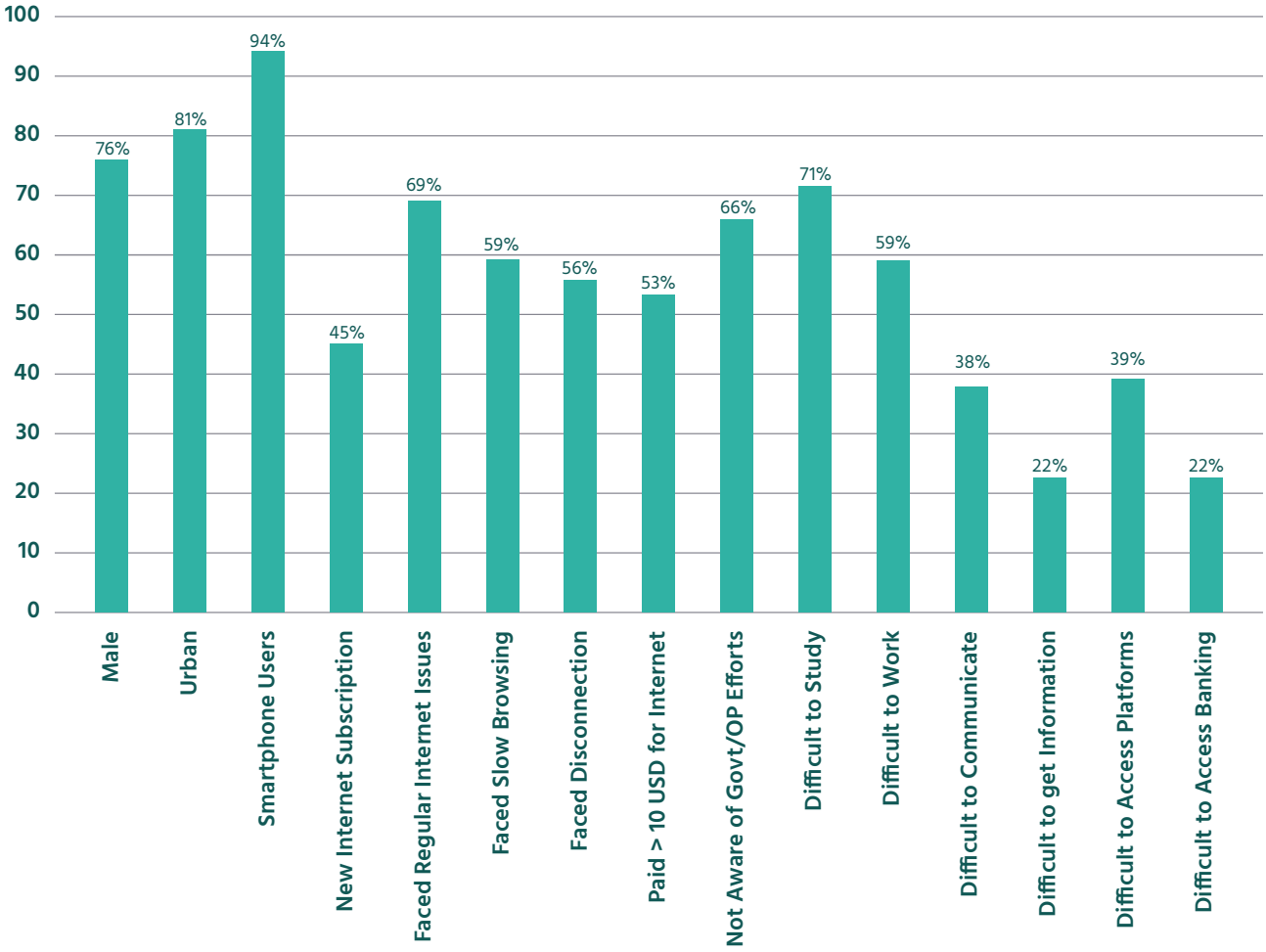
- Respondent profile
- Internet usage
- Type, quality, and cost of Internet services
- Impact of Internet performance on the daily life of respondents.

More than 280 individuals answered the survey: 157 from Bangladesh, 12 from Bhutan, and 115 from Pakistan. This report provides a country-by-country analysis of the findings, followed by a discussion on some common trends found across the three countries.

3.1 Bangladesh

Most respondents from Bangladesh identified as male (76 percent) and lived in the urban areas (81 percent), with the majority from Dhaka (40 percent). Youth provided the highest percentage of responses (including students at 59 percent) who are usually the most active and frequent users of the Internet. Almost all the respondents (more than 95 percent) reported that they use the Internet every day, before and during the pandemic.

Figure 16: Bangladesh Survey Highlights



The pandemic had a significant impact on the usage pattern of respondents in Bangladesh. E-learning became the primary use of the Internet during the pandemic (80 percent), replacing social media (75 percent). There was a drop in the social media and entertainment category while work-from-home, e-banking, e-commerce, and info searches increased during the pandemic. Coupled with the fact that 45 percent of the respondents subscribed to a new Internet connection during the pandemic, this change in usage pattern signifies the change in user behavior, with Internet at the heart of affairs. The use of desktops, laptops, and other smart devices also increased, but in a country where 98 percent of broadband connections are wireless, smartphones remained the primary means to access the Internet, before and during the pandemic (greater than 93 percent). The use of Internet over a fixed line increased by 12 percent, indicating that users preferred to stay at home during the pandemic. The pandemic also had a significant impact on the average cost of service, as 53 percent of the respondents had to pay $10 or more for their connection, as compared with only 31 percent paying the same amount before the pandemic.

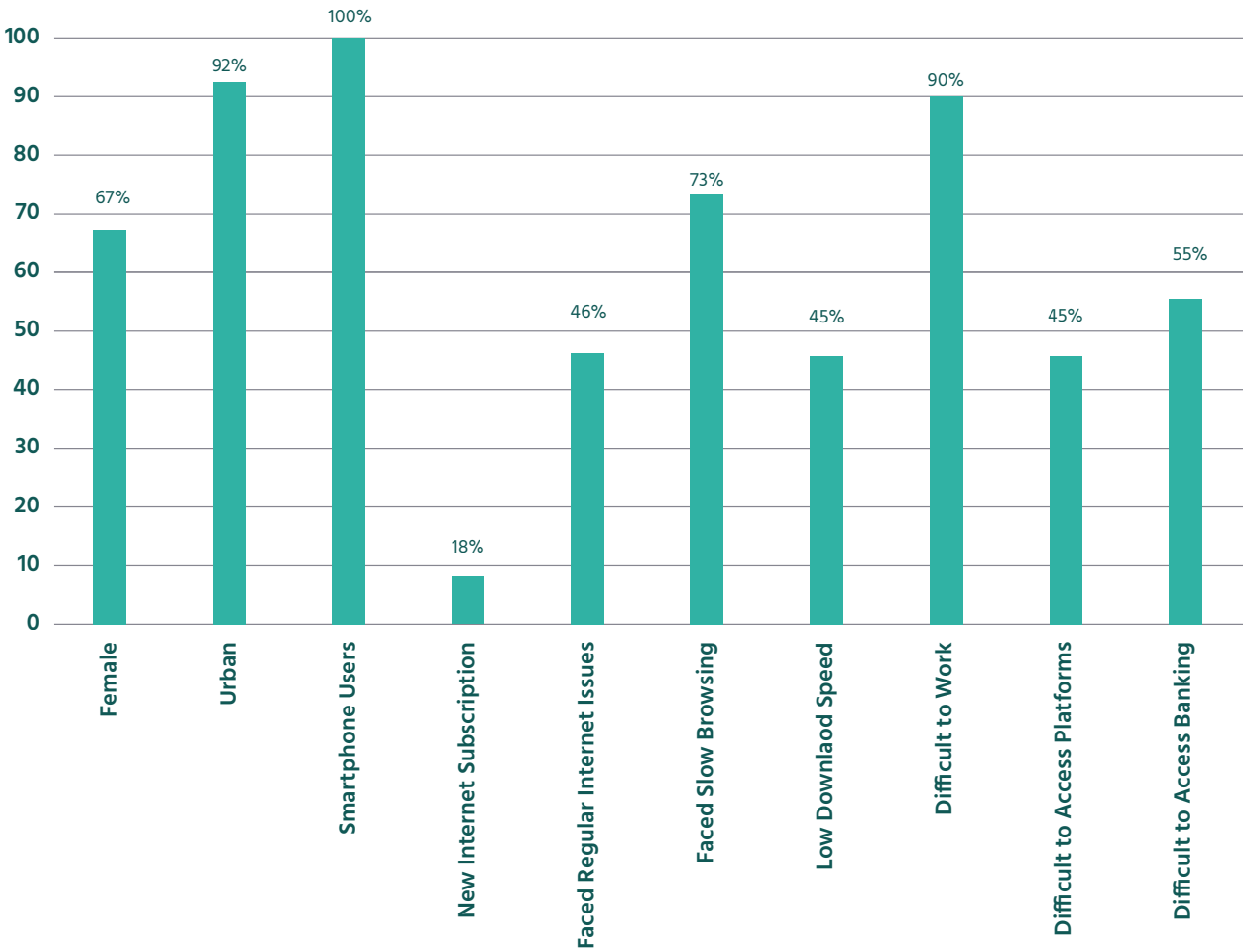
Almost 69 percent of respondents faced regular Internet performance issues since the pandemic emerged. This number jumped to 85 percent in the case of respondents from the rural areas of Bangladesh. Slow browsing (59 percent), frequent disconnection (56 percent), and low download speed (49 percent) are the top three connection problems, depicting a significant drop in quality at the end-user level during the pandemic. This result is further amplified when we see that 40 percent of respondents reduced their ratings for the speed, reliability, and steadiness of their Internet connection when compared with the pre-pandemic period. Looking at another angle, only 2 in 10 respondents were more satisfied with the speed, reliability, and overall value for money of their Internet connection. It is also important to determine the major implications of bad Internet performance on the daily life of an average user. More than 71 percent of respondents expressed difficulty in taking online classes, and 58 percent said it became difficult to work from home. This was followed by difficulties to establish fluid communication with friends and relatives, as well as hurdles in access to digital platforms and entertainment portals.

It is quite evident from the results that the Internet performance could not live up to the expectation of the end-users, who found it difficult to carry out important daily activities of study, work, and entertainment while stuck at home during the lockdowns. Although immediate steps were taken to improve Internet performance, almost three-quarters of respondents did not know of steps taken by their government or their ISPs.

3.2 Bhutan

Survey data collection from Bhutan was challenging, despite efforts to reach out to the community through various channels. Only 12 respondents took the survey, and those respondents mainly worked for the government (91 percent). Therefore, the results may not effectively represent the experience of all community segments.

Figure 17: Bhutan Survey Highlights



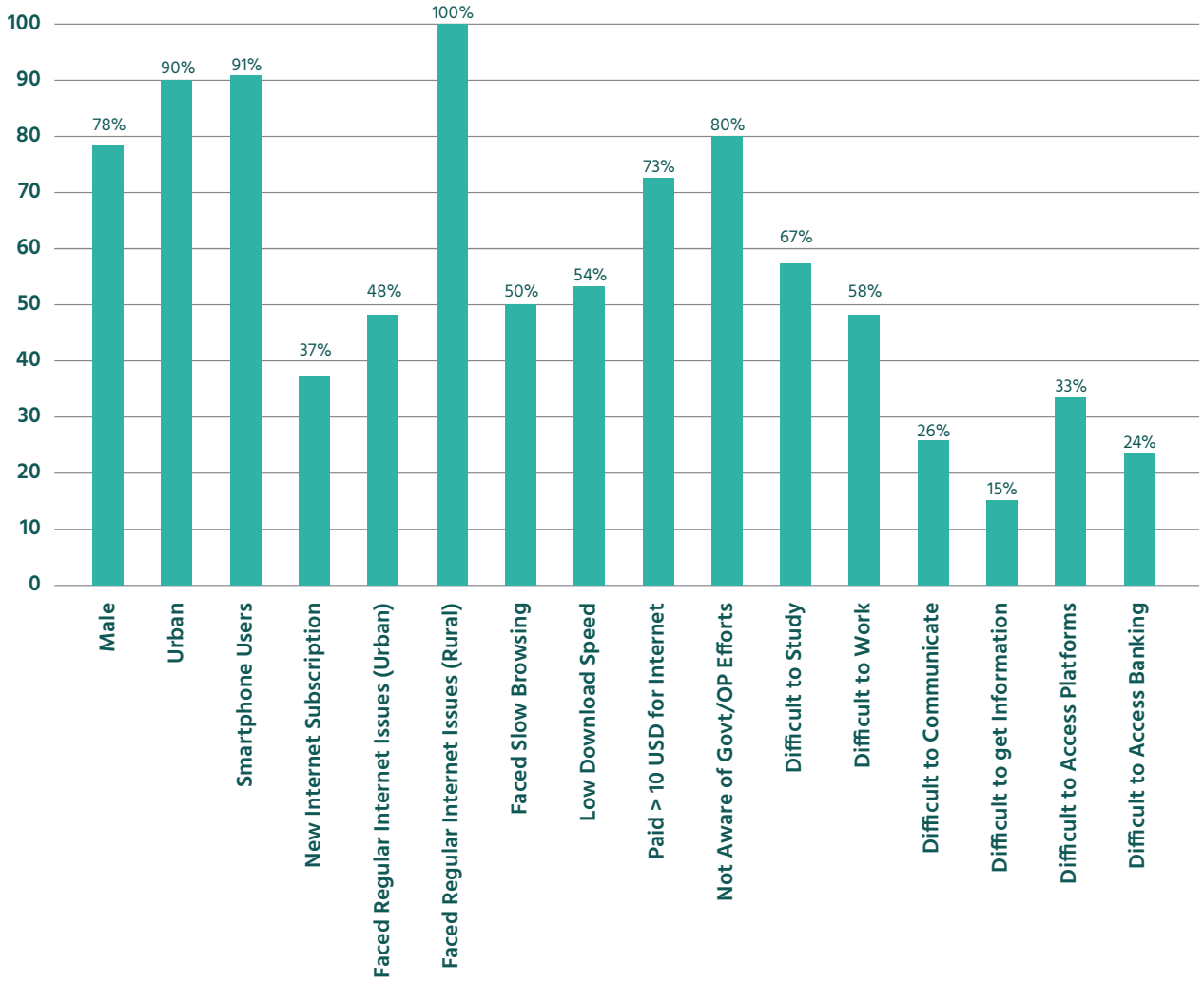
The majority of respondents from Bhutan identified as female (67 percent), residing in urban areas, and employed by the government. All respondents said they used the Internet every day over wireless connections, as they did before the pandemic. Most respondents didn't report major changes in their usage patterns, continuing to use the Internet for social networking, banking, work, study, and entertainment. Internet usage for work, study, banking, and shopping had increased slightly since the pandemic began. 100 percent of respondents said they accessed the Internet with

their mobile phones using mobile Internet. Almost all respondents were satisfied with their Internet performance before the pandemic, 46 percent reported issues during the pandemic. Slow browsing, low download speed, and video quality issues were the most common complaints about Internet use. Moreover, about 60 percent of the respondents reduced their ratings for the speed, reliability, and steadiness of their Internet connection when compared with the pre-pandemic period. Interestingly, 90 percent of respondents said that they faced difficulty in working from home, although most of them are government employees. Accordingly, it is natural to see that most of the subscribers, who belong to the government sector, were aware of the government and industry initiatives to improve Internet performance.

3.3 Pakistan

The majority of respondents identified as male (78 percent) and living in urban areas (90 percent). The bulk of the responses came from students (28 percent) and government (25 percent), which represents a good balance of opinions in the results. Almost all of the respondents (more than 95 percent) use the Internet every day, as they did before and during the pandemic.

Figure 18: Pakistan Survey Highlights



The pandemic changed the usage pattern of respondents in Pakistan. While the use of social media and OTT (over-the-top) services remained the top two activities, overall usage of these activities dropped, from 78 percent to 76 percent and 82 percent to 77 percent respectively. On the other hand, the percentage of respondents using the Internet for online education (75 percent), work-from-home (74 percent), online banking (62 percent), and e-commerce (50 percent) increased by a significant margin during the pandemic. Almost 37 percent of respondents subscribed to a new Internet connection during the pandemic. Most of the respondents used smartphones (91 percent) and laptops (83 percent) as their preferred devices to access the Internet, primarily over fixed-line connections (74 percent). In a market with an already high cost of Internet, the pandemic aggravated the situation, as 73 percent of the respondents paid more than $10, compared with 64 percent before the pandemic.

100 percent of respondents in rural areas faced regular Internet performance issues during the pandemic, compared with 48 percent of respondents from urban areas. This data further reflects the disparity in the quality of Internet infrastructure in the urban and rural areas of Pakistan. Low download speed (54 percent), slow browsing (50 percent), and frequent disconnection (40 percent) are the top three problems faced by Internet users. This result is further amplified when we see that 27 percent of respondents reduced their ratings for the speed, reliability, and steadiness of their Internet connection when compared with the pre-pandemic period. However, Internet users have been generally satisfied with the customer services and price versus performance of their Internet connection.

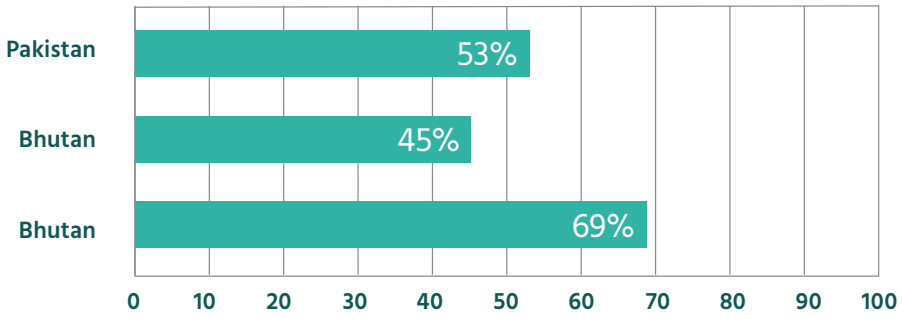
There is a striking similarity in the major implications of bad Internet performance on the daily life of an average user in Pakistan and Bangladesh. More than 67 percent of respondents expressed difficulty in taking online classes, while 58 percent said working from home became problematic. This was followed by hurdles in accessing digital platforms and entertainment portals (33 percent) and establishing fluid communication with friends and relatives (26 percent). While the government and the industry took steps to improve Internet resilience, almost 80 percent of respondents were not aware of these initiatives.

3.4 Cross-Country Trends

Most of the survey respondents are male (except Bhutan), educated, and living in urban areas. They used the Internet at least once a day irrespective of the pandemic lockdowns. They are well familiar with Internet use and its implications on their daily life.

62 percent of the total respondents from all three countries faced regular Internet performance issues during the pandemic. Out of these, 69 percent of users in Bangladesh, 53 percent in Pakistan, and 45 percent in Bhutan reported difficulty with Internet access. We already know that Internet access is essential in the "new normal." Limitations to that access caused many hurdles in the daily lives of users in these countries. 68 percent of the overall respondents faced problems with e-learning, and 60 percent found it difficult to work from home, both being the top two adverse implications reported by users in all these countries. Slow browsing (56 percent), low download speed (51 percent), and frequent disconnection (48 percent) are also the most common underlying problems with Internet access, despite users shifting toward fixed-line use, looking for better connectivity.

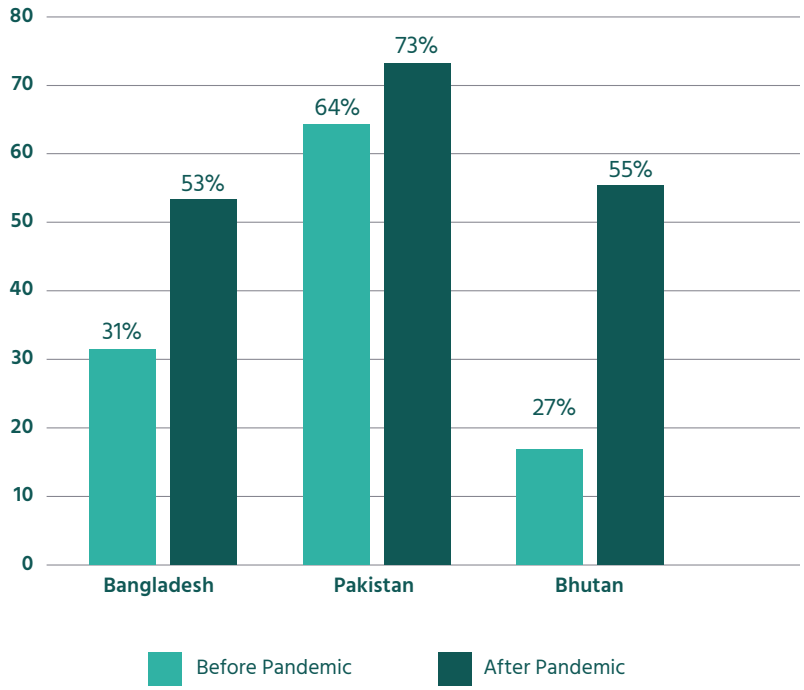
Figure 19: Faced Regular Internet Issues



During the pandemic, **users have generally become more dissatisfied** with the speed, reliability, and steadiness of their Internet connection, and also with their providers' customer service and the expected performance of the Internet given the price paid. More than half of the respondents reduced their ratings for the speed, reliability, and steadiness of their Internet connection during the pandemic, with a 15 to 30 percentage-point drop in satisfaction.

In addition to their increased dissatisfaction, users are spending more money on their Internet connection during the pandemic in all countries. The average prices of fixed broadband and mobile broadband in Asia and the Pacific stand at $9.26 and $3.86 in 2019[29]. However, the percentage of respondents in these countries paying an average $10 or more jumped to 61 percent during the pandemic as compared with 44 percent before the pandemic. As you can see in the Figure 19, while users in Pakistan are spending the most on their Internet connection, Internet users in Bhutan paid double the amount that they used to spend before the pandemic.

Figure 20: Respondents Paying More Than 10 USD on Average for Internet Connection



Most users (93 percent) access the Internet through smartphones or laptops, before and during the pandemic. However, there is a slight increase of eight percent in the use of fixed broadband as compared with mobile broadband during the pandemic.

29 UNESCAP, Visualizing Broadband Speeds in Asia and the Pacific

Internet activities in Bangladesh, Bhutan, and Pakistan depict a varying pattern. Social networking can be seen as the most common activity that features in the top two across all three countries, before and during the pandemic. However, a positive trend is seen in Bangladesh, where e-learning topped the activity chart.

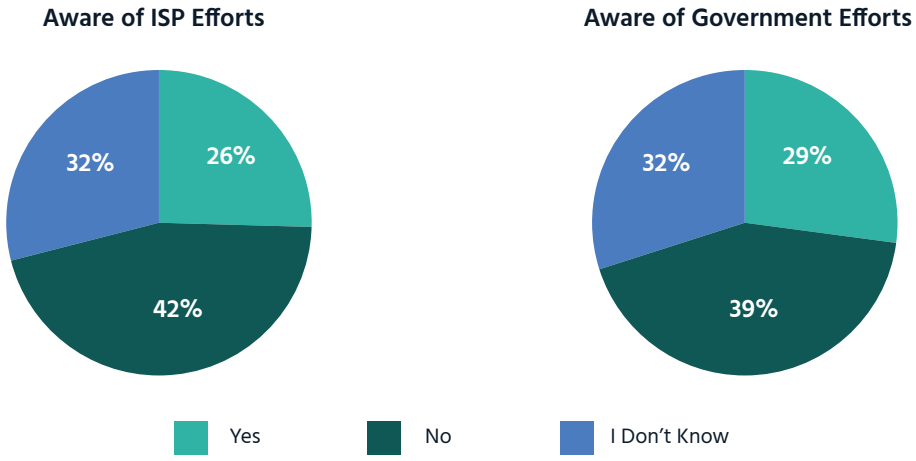
Table 3 - Ranking of Top Internet Activities

Internet Activity	Bangladesh		Bhutan		Pakistan	
	Before	During	Before	During	Before	During
Social Media	1	2	1	1	2	2
OTT Services	2	3	3	2	1	1
Study	3	1	6	6	4	3
Work	6	6	2	3	3	4
Information search	5	5	3	4	4	5
Entertainment	4	4	4	2	5	6

Note: Some rankings are the same because of equal percentage of use.

As we can see from the analysis above, Internet performance in Bangladesh, Bhutan, and Pakistan struggled to match the quality of service that was provided before the pandemic. This deteriorated connectivity had serious implications on the daily life of an average user, in terms of both cost and access. It is also interesting to note that most of the users (except Bhutan) either did not believe or were not aware that their government or ISP made special efforts to improve the Internet connectivity during the COVID-19 pandemic.

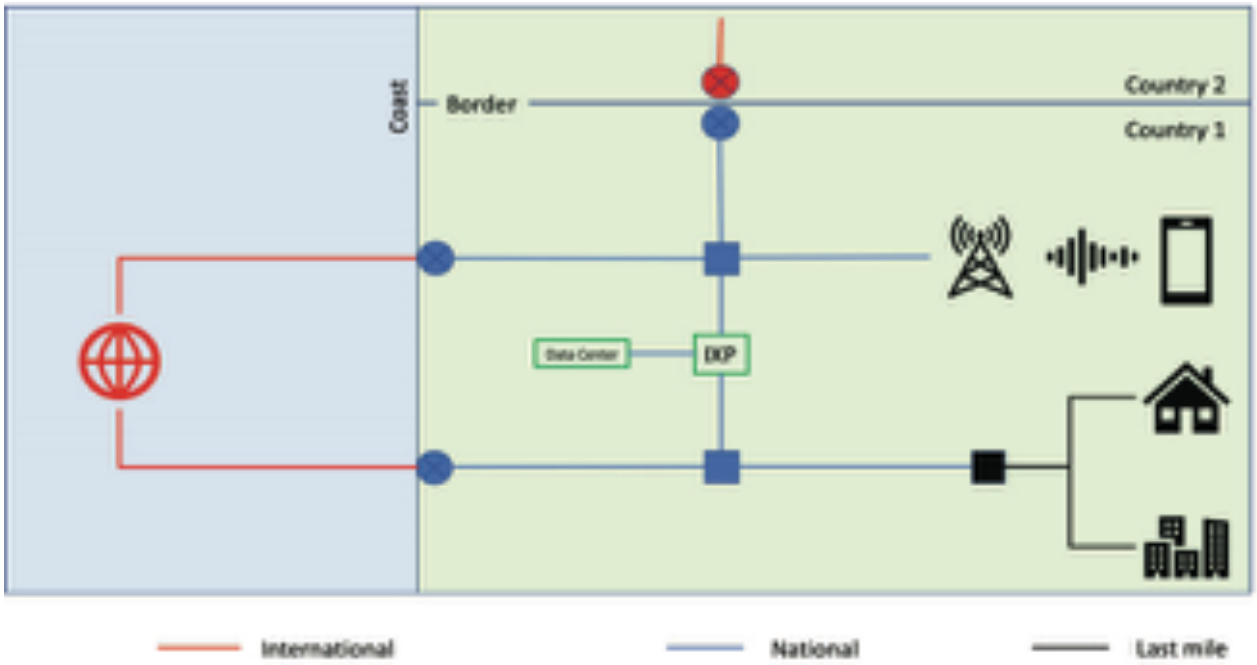
Figure 21: Did Your Government or ISP Take Special Measures to Improve the Quality of Internet During COVID-19



4 Review of Internet Infrastructure

The digital infrastructure of Bangladesh, Bhutan, and Pakistan "felt" the pressure of COVID-19 traffic surge across the entire Internet value chain. In this section, we will reflect on the major bottlenecks in the Internet architecture that affect the end-user experience. While there are a few common areas of improvement on both the international and domestic fronts, other issues are unique to each country. Figure 21 provides a set of best practices across each segment of the Internet infrastructure to improve the connectivity landscape. A country-specific review of the infrastructure is also given below.

Figure 22: Best Practices to Improve Digital Infrastructure



1 Increase international fiber optic links **2** Reduce transit prices **3** Accelerate fiberization **4** Incentivize infrastructure operators **5** Encourage infrastructure sharing **6** Resolve right of way issues **7** Policy reforms for IXPs and data centers **8** More fiber to the home, QoS review **9** More spectrum, QoS review
Source: Internet Society

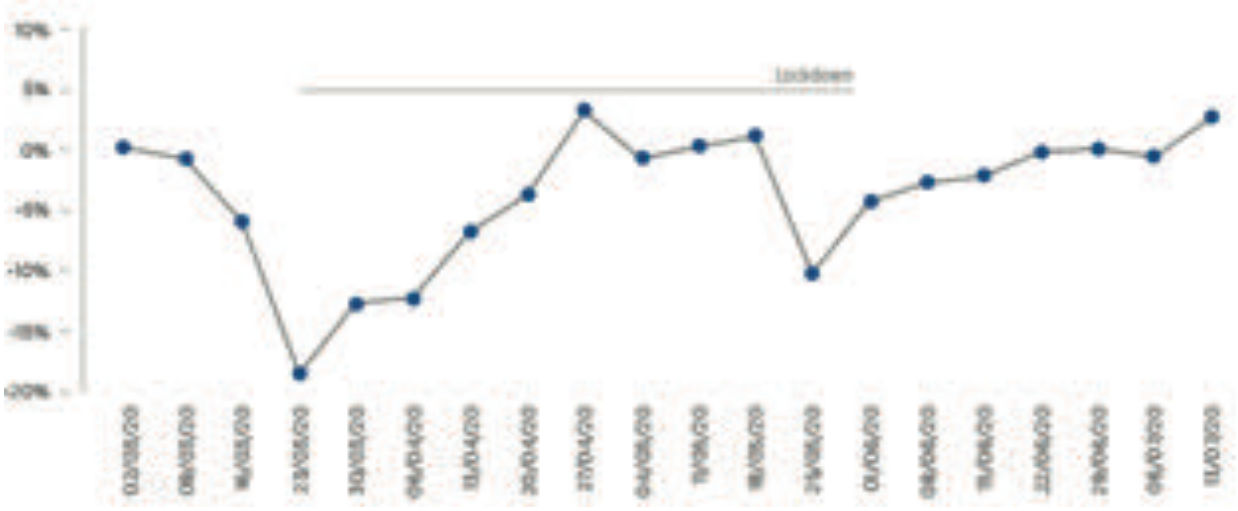
4.1 Network

The international fiber-optic links of Bangladesh are under huge stress because more than 91 percent of the country's energized bandwidth is under the use of the networks. This leaves little room to deal with unusual traffic surges similar to the lockdown restrictions of the COVID-19 pandemic. The ITCs may have the commercial arrangements to buy more bandwidth over terrestrial links, but there is a need to introduce more players in the international submarine connectivity currently monopolized by the state-owned BSCCL. While there is much better competition in the backhaul and last-mile segment, poor fixed-line infrastructure has produced two major outcomes: very low fixed-line penetration/fiber-to-the-home (FTTH) subscriptions (less than 1 percent) and very high mobile Internet subscriptions (greater than 90 percent), which in turn puts tremendous pressures on the MNO infrastructure, especially the spectrum resources. Telecom operators are reported to use 0.82 Megahertz (MHz) spectrum to serve about one million customers, while operators in high-speed countries use a spectrum over 12 MHz to serve the same number of customers[30]. Bangladesh has released the spectrum through various rounds of auctions over the years to improve the situation. Before the pandemic, market leader Grameenphone held 37 MHz, Robi 36.4 MHz, Banglalink 30.6MHz, and Teletalk 25.2 MHz in three different bands. At the most recent auction in March 2021, Bangladesh Telecommunication Regulatory Commission (BTRC) sold 7.4 MHz in the 1800 MHz band and 20 MHz in the 2100 MHz band. However, the country lags behind the Asian average by half, according to the GSMA's Mobile Connectivity Index 2020. Mobile infrastructure has more than 28000 cell towers, and more than 90 percent are 4G enabled, but only 15 percent are connected with fiber, resulting in serious throughput issues at the end-user level[31]. Bangladesh was ranked 134th out of 137 countries for mobile Internet speed in May 2021, according to Ookla SpeedTest Index. However, the Internet speed is stabilizing after the infrastructure sustained the 21 percent increase in data usage during the initial COVID-19 lockdown period.

30 https://www.newagebd.net/article/141464/poor-internet-service-an-irony-of-digital-bangladesh

31 https://www.thedailystar.net/opinion/news/what-are-the-priorities-the-btrc-during-the-pandemic-2086505

Figure 23: Mobile Average Download Speed % Change



Source: Ookla

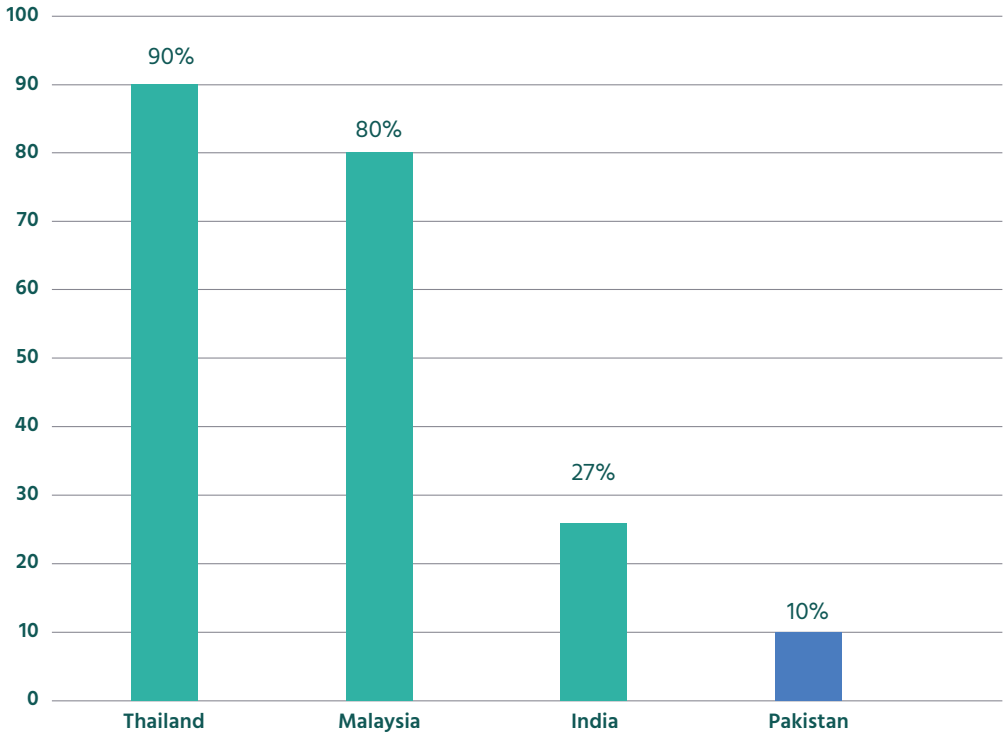
Bhutan has been solely dependent on India for international Internet bandwidth while its decade-long attempts to establish a third international gateway via Bangladesh have not materialized. This is an interesting debacle because the link is just 100 KMs but the price asked by the Indian operators (USD 28 per Mbps) is almost triple the rate at which they get it from Bangladesh (USD 8 per Mbps). Moreover, this price per Mbps is double the rate at which India is providing Internet bandwidth to Bhutan over the existing two links via Siliguri, India. The Indian operators justify the high rates by stating that the Power Grid Corporation of India Limited charges a high price for carrying the telco fiber over its infrastructure. The matter has been discussed multiple times at the highest level on both sides, and it remains unclear whether the issue will be resolved anytime soon. The third gateway is very important for Bhutan, as it will not only provide redundancy but also play an important role in bringing foreign investment in the country's IT sector, since big companies require that the international links are at least 100 kilometers apart from each other[32]. On the national front, Bhutan is well connected with fiber despite harsh terrain and difficult topography. Bhutan also emphasizes QoS monitoring on the fixed and wireless sectors. The Department of Information Technology & Telecom (DITT) launched a Fiber Monitoring System (FMS) funded by the Universal Service Fund to resolve and improve the reliability of fiber networks. DITT issues a quarterly National Fiber Network Reliability Report of the FMS and a Mobile Internet Connectivity Report, after compiling data received from the

32 https://thebhutanese.bt/price-is-the-final-barrier-for-bhutans-third-international-gateway/

operators[33]. Bhutan InfoComm and Media Authority (BICMA) does not set upfront assignment fees and only charges annual fees. BICMA assigned two 2x20 MHz lots in the 700 MHz band to incumbent service providers Tashi InfoComm and Bhutan Telecom in 2016 and 2017 respectively.

Pakistan has multiple submarine fiber-optic links, providing sufficient capacity to meet the bandwidth demand. Thanks to that supply, it also provides excess bandwidth to neighboring countries, like Afghanistan, over terrestrial links. However, the fiber penetration at the backhaul and access infrastructure is quite low. Only 10 percent of the cell towers have fiber-optic connectivity in comparison with other countries in the region. This is the reason that the Universal Service Fund (USF) has started to invest in the backhaul infrastructure as well. Previously, high capital expenditure and right of way issues have been the major hurdles in fiber deployment in the backhaul and access networks. However, a right of way policy released earlier this year aims to facilitate network deployment across the country.

Figure 24 – Fiberized Cell Towers

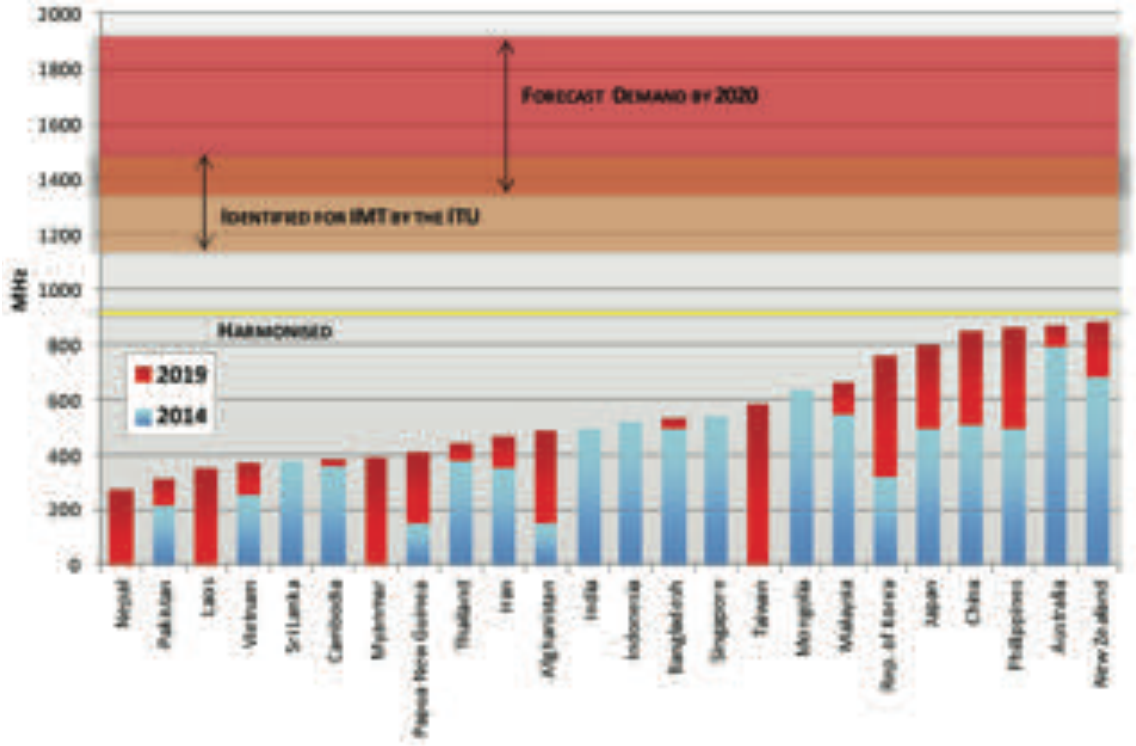


Source: USF

33 https://www.dit.gov.bt/national-fiber-network-reliability-report-april-june-2021-0

Recently, the incumbent operator, Pakistan Telecommunication Company Limited (PTCL), has been rolling out fiber in the major cities of Pakistan. Nayatel and Stormfiber are also providing FTTH in Islamabad, Peshawar, Faisalabad, and Karachi respectively. In May 2021, Facebook and Nayatel announced a deal under which Nayatel will own, build, maintain, and operate a new fiber network and provide wholesale capacity to mobile operators and ISPs with investment and planning support from Facebook[34]. This high-speed fiber cable will connect thousands of sites by 2022 and improve Nayatel coverage on the user level across eight major cities in Pakistan. In the wireless sector, Internet is provided by a host of technologies, but mobile broadband is the dominant medium to access the Internet (98 percent share by technology). This is similar to the market profile of Bangladesh. However, one major difference is that Pakistan has released less spectrum than its regional peers. Coupled with poor fixed-line infrastructure and COVID-19 traffic surges, the quality of service has become a major problem. To address this challenge, Pakistan Telecommunication Authority (PTA) updated the QoS Regulations for Mobile Networks, specifying higher KPIs for data and voice, following an industry consultation process. But the issues run deeper than the regulatory mandate that requires concerted efforts by the industry and government to build Internet resilience and reliability.

Figure 25: Spectrum Licenses for IMT Services

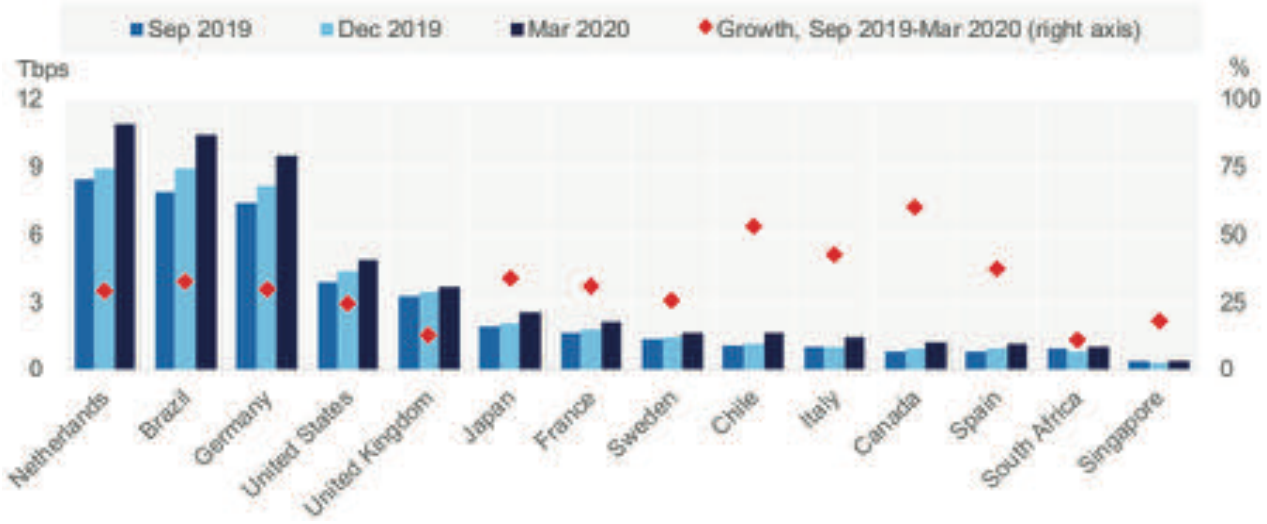


Source: LS Telecom, Analysis of the worldwide licensing and usage of IMT Spectrum

34 https://nayatel.com/nayatel-and-facebook-partner-to-improve-internet-connectivity-for-millions-of-pakistanis-across-eight-cities/

Every country has pros and cons in the digital infrastructure, but there are many common issues and related solutions. For example, we have already established that more traffic traversing over the transit links puts more pressure on the national infrastructure, ultimately affecting the end-user experience. In this case, IXPs provide the quickest, most logical technical solution to mitigate latency, reduce cost, and improve the overall broadband experience by keeping the traffic local. The pre-deployment process of establishing an IXP requires extensive coordination among the participating IXPs and institutions. IXPs in the countries under study handle only a small fraction of the overall Internet traffic because most accessed content is hosted outside the country. If there are more IXPs in the country, it becomes a lot easier to manage the traffic surges in disaster situations such as COVID-19 pandemic[35]. A survey by Internet Society estimated an increase of 7 to 40 percent in the Internet exchange traffic for the Asia-Pacific region during the COVID-19 pandemic[36]. This is evident if we see how traffic has grown over the IXP networks in the developed countries, depicted in Figure 26.

Figure 26: Internet Bandwidth at IXPs



Source: OECD based on data from Packet Clearing House

35 https://www.internetsociety.org/wp-content/uploads/2021/06/Internet-Peering-in-Asia-Pacific-EN.pdf

36 https://www.internetsociety.org/blog/2020/07/ixps-keeping-local-infrastructure-resilient-during-covid-19/

4.2 Services & Content

More availability of local content has a positive effect on Internet infrastructure development, and a drop in bandwidth prices helps deliver more content over the international links. Having a mature local content market allows the operators to keep the traffic local and save transit costs, which in turn could be invested back into the domestic infrastructure. If the content is globally attractive, there will be more outflow of data than inflow over the international fiber-optic links, bringing more revenue to the local industry. Therefore, local content development is particularly important for developing countries looking to provide a better end-user experience while saving transit costs and stress on international links. It will also drive the local hosting infrastructure such as data centers, content delivery networks, and cloud computing. A strong local content market will also drive operators to establish more IXPs to improve network redundancy, efficiency, and cost savings.

All three countries in this study have an underdeveloped local content market, as indicated by their score in the Content & Services enabler of the GSMA Mobile Connectivity Index 2020. One of the important common areas of improvement is the e-government score, which signifies the adoption of digital technologies for public service delivery. If government services are made available online, it will boost local content development, and vice versa. The content producers will be incentivized to create content about government platforms that will increase the user base of such services, which in turn will push the government toward more technology adoption. Affordability of Internet connectivity and devices, lack of digital skills, literacy level, entrepreneurship culture, and government support are some of the major barriers to local content development in these countries. Some of these barriers can be bypassed if a particular skill set is matched with the relevant content type. For example, Pakistan has a literacy rate of 60 percent, but individuals (10 years or older) with entertainment and social media skills are 59 percent and 45 percent respectively[37]. Hence, the potential exists for Pakistan to create quality content using experience and skills that can eventually be monetized. Similarly, social media usage is also high in Bhutan and Bangladesh. Therefore, the government and private sector can explore the possibility of running national-level entrepreneurship programs that educate citizens on digital content production. It will also accelerate the availability of reliable local hosting solutions. Data centers are gaining momentum in these countries, both on the government and private level. Critical government and public data is processed and stored in the national data centers, with multiple security layers for protection against any cyber emergency. It is also important to keep cost in check and deliver superior service quality with minimal downtime to compete against big foreign companies.

37 Pakistan social and living standards measurement survey (2019-20) by Pakistan Bureau of Statistics

Unless there is reliable support infrastructure like electricity, location, taxes, and duties on equipment, and reasonable co-location charges, it will be difficult to attract business for the local data centers.

Internet infrastructure of Bangladesh, Bhutan, and Pakistan endured traffic spikes at the expense of service quality for the end-user. The infrastructure review points out the weak links in Internet landscape, but the next section will outline the way forward to address connectivity challenges that may prevent performance issues in the future.

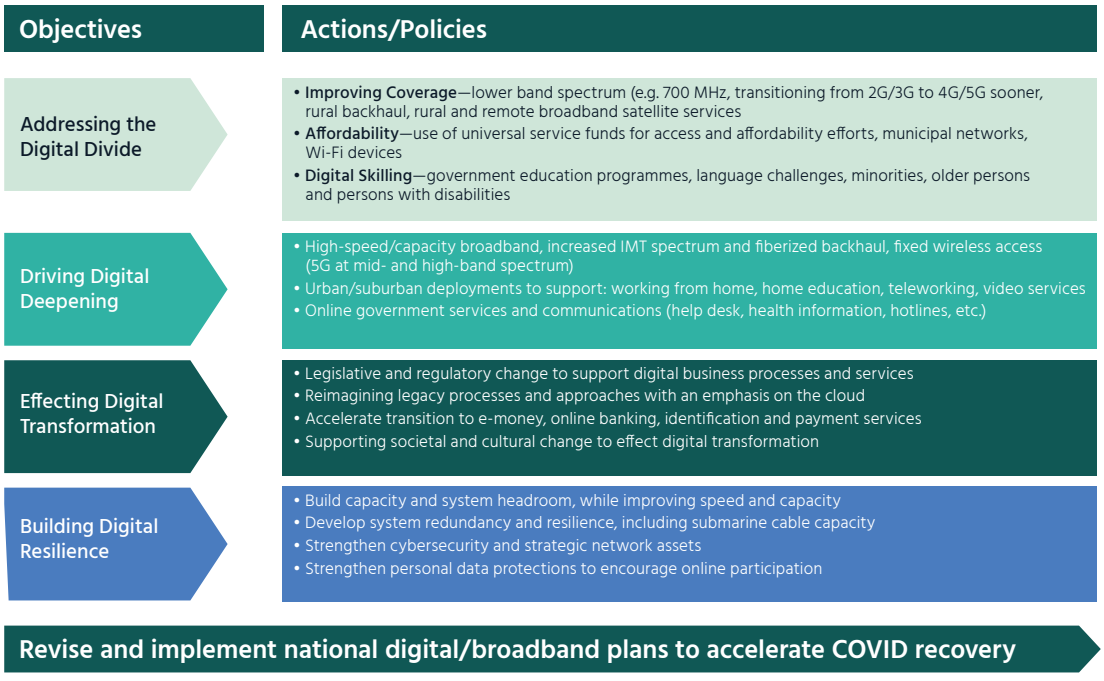
5 Way Forward

Internet connectivity and resilience can be improved by following a methodical approach, guided by whole-of-government ideology and government-industry dialogue. It is essential to develop short-term and long-term plans with specific targets and well-defined responsibilities. In the context of this report, we will first provide some insight into the global best practices for network management during COVID-19 pandemic, followed by important regulatory efforts at the national level. We will use that knowledge to come up with concrete recommendations.

5.1 Global Best Practices

Global evidence suggests that the Internet infrastructure bent but did not break during the pandemic-induced traffic spikes. The short-term measures adopted by governments and operators brought the speed and reliability of the Internet to the pre-COVID-19 level in most parts of the world. However, it is also evident that policymakers and regulators were more inclined toward immediate solutions rather than long-term permanent strategies to cope with the pandemic and beyond. The International Telecommunication Union (ITU) surveyed national regulatory authorities and other stakeholders in late 2020 and early 2021. They found that 73 percent of government institutions supported e-learning during the lockdown period. However, only 27 percent allowed more flexible spectrum use, and 18 percent authorized the use of unlicensed spectrum[38]. This disparity in supportive measures points to the traditional mindset of governments to view spectrum as a revenue source rather than an essential prerequisite to building the Information and Communication Technologies (ICT) ecosystem. It is high time that the stakeholders recognize the importance of each component of the Internet infrastructure, identify gaps, and develop medium- to long-term plans to be prepared for the next big challenge. The ITU recommends that countries focus on a multipronged approach to build digital resilience in their countries, as shown in Figure 27.

Figure 27: Digital Responses to COVID-19

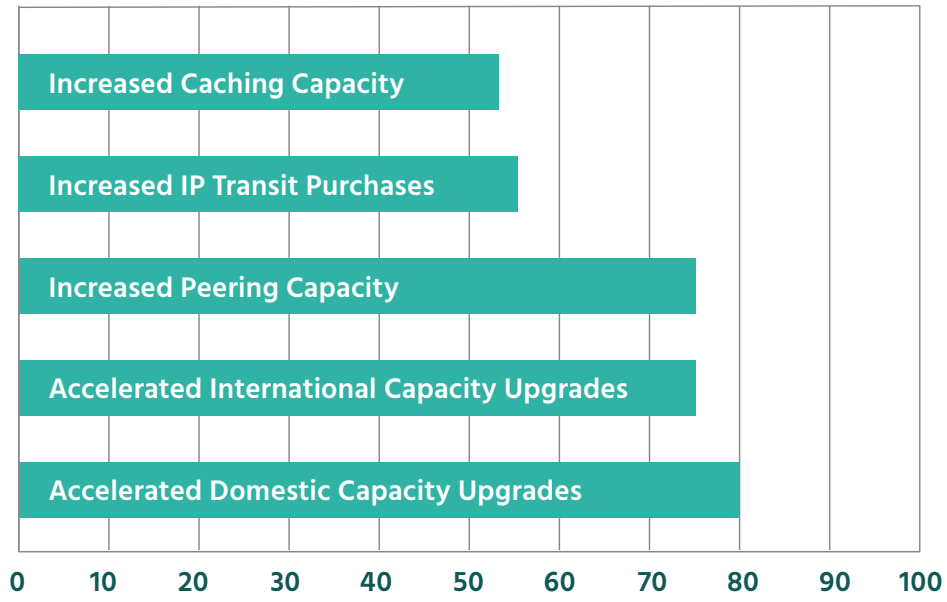


Source: ITU-WPC, March 2021

38 ITU Reg4COVID Survey 2021

Globally, the network operators took several measures to absorb the high bandwidth demand by doing domestic and international connectivity upgrades and increasing peering and caching (see Figure 28).

Figure 28 – Industry Measures for COVID-19



Source: Telegeography, 2021

5.2 National Efforts

Governments and industry actors in Bangladesh, Bhutan, and Pakistan took short- and long-term steps to stabilize the Internet during the pandemic. They declared telecom an essential service; worked with health and educational sectors; provided special ringback tones, awareness text messages, and additional data volumes; extended the validity of prepaid service; and offered flexible payment options, free access to health and information resources, and special tariffs. These are prominent examples common in all three countries. However, there were no concrete measures, like allocation of additional spectrum (as the United States, Ghana, Jordan, and South Africa provided) or special funds for rural broadband connectivity (New Zealand) or free additional bandwidth (Australia)[39]. Instead, one year into the pandemic, the governments decided to auction an additional spectrum. Bangladesh completed the auction process in March 2021 after turning down the operators' request to release additional spectrum during the lockdown period[40]; Pakistan is yet to auction any additional spectrum, although the auction preparations were completed by the PTA in May 2021[41]. Governments' and

39 ITU, Pandemic in the Internet age

40 https://www.mobileworldlive.com/asia/asia-news/bangladesh-operators-demand-more-spectrum-in-lockdown

41 https://www.brecorder.com/news/40098273

industry actors' response to strengthen the Internet infrastructure has been swift, with prime focus on immediate short-term results rather than a long-term approach. However, there are significant policy, regulatory, and industry measures based on the international best practices that can better prepare these countries in a disaster situation like COVID-19, explained in the next section.

5.3 Recommendations

The Internet infrastructure of Bangladesh, Bhutan, and Pakistan has its own unique set of advantages and challenges. In general, we recommend prioritizing best practices, like classifiying telecom services as essential services during lockdowns, subsidizing equipment, sharing infrastructure, reconciling coverage and QoS obligations, and most importantly, doing national contingency planning. However, we recommend the following specific measures for Bangladesh, Bhutan, and Pakistan. These may assist the public and private entities on their journey to strengthen the Internet ecosystem.

Policies and regulations are the most important catalysts to drive digital transformation and ICT development. Network measures taken by operators are often dependent upon regulatory approvals and policy provisions, which further amplifies the importance of government support in crises. Broadband policies in Bhutan, Bangladesh, and Pakistan were last approved in 2014, 2009, and 2004, respectively. While Pakistan is currently in the consultation process for a new broadband policy draft, there is a dire need to continuously review and update policies that have a long-lasting impact on the Internet infrastructure. The same is the case with the overall telecommunication policy that defines the roadmap to develop the mandatory components of the digital landscape in a country. Other policies, regulations, and licensing regimes, such as right of way, coverage obligations, price standardization, QoS tools, spectrum allocation, and taxation structure, are critical success factors for superior Internet performance. On the other hand, having too many policies or complex licensing structure, such as the current licensing regime in Bangladesh, can act as a supply-side barrier due to high complexity with tiers of licensees/entities involved across the Internet value chain. A balance of progressive policy with soft regulation and strict QoS compliance, integrated with the economic vision of the government, should be achieved in the long run.

Next, **fiber deployment and redundancy** at the international and national levels must be prioritized. Bhutan has a different challenge altogether since it is entirely dependent on India for international connectivity, but its domestic infrastructure is much better than neighboring countries. Pakistan and Bangladesh have direct access to multiple submarine cables, but their domestic fixed-line infrastructure is well below par. Fiberization is extremely low in the backhaul (fiber to tower) and access network (fiber to premises). COVID-19-induced high bandwidth utilization has also increased the worldwide demand and price of fiber cables. Mobile operators in developing countries already preferred to connect their backhaul/backbone requirements with the cheaper point-to-point microwave radios having less throughput, which not only affects broadband quality but is also prone to run out of capacity as data traffic soars. Connecting towers with fiber improves the efficient use of the scarce and limited resource of spectrum and adds reliability to the equation. This is exactly what happens in countries like Pakistan, where the supply of international bandwidth outruns the demand but the poor condition of backhaul and last mile deteriorates the bandwidth at the end-user level. It is relatively much easier to increase the international bandwidth by simply buying more capacity from the submarine cable operators, but it takes years of investment and persistence to fiberize the national broadband network. Therefore, fiberization must be a part of medium- to long-term goals under the digital transformation roadmap of these countries.

Spectrum is a valuable yet finite resource that enables wireless communication over long distances, with much less investment than the fixed line. More importantly, it is the nucleus of Internet connectivity in developing countries, where mobile Internet comprises more than 98 percent of the overall broadband subscriber base. Mobile operators have a dominant role in the Internet connectivity landscape, but they are dependent on the government to release a sufficient spectrum at a reasonable price that can be used to provide data and voice services to the masses. However, governments have been more interested in gaining short-term revenue through spectrum auctions rather than the long-term advantages of widespread connectivity through spectrum assignments. This is why we see that allocation of spectrum is extremely rare, as opposed to auctions, in developing countries, even under special circumstances like the pandemic. On the other hand, several countries have fully or partly adopted the United States Federal Communications Commission decision of April 2020 to open up the 6 GHz band for unlicensed use by Wi-Fi 6 technology[42]. In the absence of robust fixed-line infrastructure, the governments should realign their long-term strategic approach and come up with more innovative ways (such as OPENRAN) requiring less capital expenditure on spectrum acquisition, leaving room for more capital investment in the network expansion and upgrades.

42 ITU Pandemic in Internet Age, 2021

A strong Internet backbone and ample spectrum availability does not resolve all of the Internet performance issues in a country. The efficiency and business viability of Internet services also depend upon what content is being delivered over the networks and how. **IXPs, local content development, and reliable hosting solutions** are the crucial components of the Internet infrastructure that keep traffic (or even revenue) within the national boundaries, sparing pressure on costly international transits. The dismal domestic infrastructure of countries like Pakistan and Bangladesh may be further burdened by more national traffic. There is empirical evidence that growth of local content accelerates infrastructure development, and vice versa. The operators will be able to save transit costs that would otherwise be charged if they had to carry content out of the country, and that savings can be invested back into the domestic network. Thus it becomes a win-win situation for all stakeholders. The government can play a significant role in kick-starting this chain reaction by training local resources about content development and providing tax-free equipment and subsidized utility services at neutral locations (such as IT parks) to establish the data centers, content delivery networks, and IXPs.

Network resilience and reliable connectivity can only be realized if the government and private sector work together. This is not just a technical challenge but also encompasses a wide range of other factors, such as logistics supply chain, external dependence (tax, right of way, financing), a secure cyberspace, and digital rights. However, stakeholders must always remember that Internet performance has a far-reaching impact on the future of a nation—with or without COVID-19.