Chapter 7

Connectivity and Information and Communications Technology

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7.1 Introduction[1]

In the last few decades, information and communications technology (ICT) has transformed business management, government operations and indeed social interactions and the lifestyles of individuals. Wave after wave of ICT innovations have spread to every corner of the planet. The level of diffusion and adoption of ICT has, however, varied from country to country depending on the existence of an enabling environment and resources in place to nurture and accelerate the ICT transformation. While the last decades of the previous millennium saw the diffusion and growth of ICTs in developed countries, the opening decades of the present millennium are witnessing exponential ICT penetration rates in the developing countries of Asia, the Pacific, Africa and Latin America.

The role of ICT as an enabler for accelerated economic development and social transformation is established and universally recognised. ICT tools and systems enable the fast and reliable flow of information between individuals and systems. ICT also enables the efficient and rapid processing of data to enable significant improvements in individual and organisational performance and outputs, as well as improving the efficient use of resources. Individuals, business organisations, industrial enterprises and governments are adopting ICTs the world over, continually upgrading their ICT tools and technical systems as newer and better technologies emerge.

The Commonwealth Pacific small states (Fiji, Kiribati, Nauru, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu), have also seen the diffusion of ICTs within their societies. However, ICT diffusion and penetration in these small states are affected by their unique geographical, demographic, social and economic challenges, marked by low populations spread over a large geographical area, a low level of skills, and high vulnerability to natural disasters and climate change. The islands' sparse population, dispersed and spread across long nautical miles of the Pacific Ocean, poses connectivity challenges of an extraordinary magnitude. Similarly, small market sizes in most states discourage private sector investment, as do the challenges posed by their high susceptibility to natural disasters and climate change, as well as the lack of skills and resources to adopt and localise ICTs.

Nevertheless, strategic intervention by Pacific Leaders and policy-makers at the national and regional levels, with support from the international community, have resulted in higher than average ICT penetration rates and expansion of ICT infrastructure and applications. However, many challenges and problems persist.

ICT connectivity is significantly underdeveloped, leaving out a large section of the Pacific population. Addressing these gaps will be critical to take optimal advantage of the opportunities that ICTs can open up for these countries, particularly in their efforts to achieve sustainable development into 2050. Active, systematic and long-term strategic intervention is called for to overcome the gaps and weaknesses that currently exist and to prepare these countries to dynamically absorb technologies as they develop and advance towards 2050.

This chapter critically evaluates the key ICT challenges that the nine Commonwealth Pacific small states faces, as well as the regional and national responses to these challenges. The chapter also draws out some of the key gaps and opportunities in the interventions in place, highlighting a few crucial recommendations that can be considered to prepare the region for a technology-driven knowledge-based society in 2050.

7.2 Context

There has been significant progress in the various strategic areas of ICT development (connectivity and infrastructure, policy and regulations, systems and applications) both at the level of individual countries and regionally. The growth trends in ICT penetration are persisting, with many country-level projects and regional initiatives underway, as well as an expanding involvement of international private sector entities. However, there are major challenges, including expanding and upgrading ICT connectivity in a region with a widely dispersed population; high cost of telecom and internet services; fragmented and suboptimal ICT applications, laws and regulations; low level of ICT skills, innovation and diffusion; and organisational and institutional weaknesses.

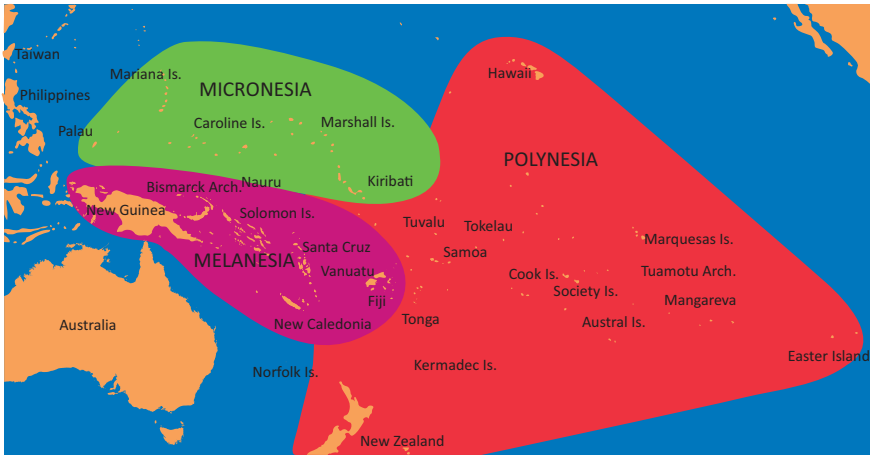
7.2.1 Connectivity and ICT infrastructure

ICTs deal with information either in the static form, such as databases and information repositories, or in the IT systems where its transformation and processing takes place, or over the computer networks and telecommunication lines while it is in transit. In all these states of information, management infrastructure must be provided for the needed processes to take place. Out of the mix of ICT infrastructure components that must be provided for optimal ICT management, perhaps the most basic and fundamental is the ICT connectivity and telecom infrastructure. Connectivity and ICT infrastructure provides accessibility to individuals and systems to receive and send voice and data messages, obtain learning and entertainment content, obtain government services and undertake many other information-based services.

The Commonwealth Pacific small states are part of Oceania, running 9,000 km east to west and about 5,000 km north to south and comprising some 25 countries and territories. The Oceania region includes the more advanced Commonwealth countries of Australia and New Zealand (Figure 7.1).

Satellite has been the main means for providing telecom connectivity for the large number of widely dispersed islands in the Pacific (Table 7.1). The region is mainly served by the Intelsat series of three satellites using C-band[2] to cover the region. The dependence on a single constellation of satellites has been a matter of concern. However,

Figure 7.1 Micronesia, Melanesia and Polynesia zones of Oceania



Source: Pramanik (2014)

this situation is changing, with the arrival of other satellite telecom companies into the region. It is expected that by 2017, seven satellite operators (ABS satellite, Eutelsat, Intersat, JSAT, Kacific, SES and 03B) will provide improved coverage over the region, using better technologies and higher bandwidth. New satellite operators like O3B (2014) and Kacific (2017) are entering the Pacific with affordable broadband satellite solutions. In a co-operation programme with the International Telecommunication Union (ITU), it is expected that 11 island countries will benefit from the service of Kacific and up to 55 rural/remote community e-centres will be established by 2017 to enable applications in the health, education and agriculture sectors.

Wireless telecommunication, originally used for two-way radio communication and broadcasting, is now an important part of the connectivity scenario of the region.

Table 7.1 Satellite and submarine connectivity

Country	Connectivity Option	
	International	Domestic
Fiji	✸✸	✸
Kiribati	✸	✸
Nauru	✸	-
Papua New Guinea	✸✸	✸
Samoa	✸✸	✸
Solomon Is	✸	✸
Tonga	✸	✸
Tuvalu	✸	✸
Vanuatu	✸	✸

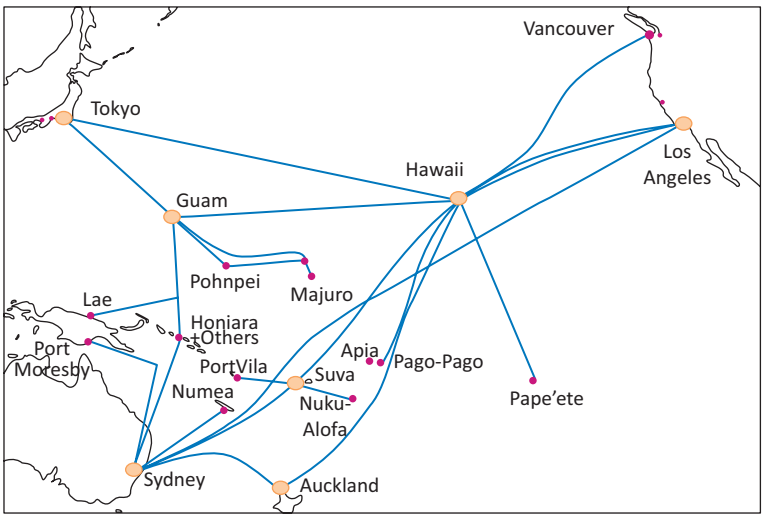
Note: ✸ Submarine cable ✸ Satellite
Source: CROP ICT Working Group Secretariat, 2014

Mobile phones, microwave signal trunking and wireless networking, such as WiMax,[3] are playing an important part to provide last-mile connectivity.

Submarine cable-based connectivity has developed in recent years to supplement terrestrial and satellite-based connectivity infrastructure and to provide higher bandwidth data and voice services. However, the submarine cable connectivity does not fully cover the region at present (Table 7.1). The main trunk lines provide fibre optic connectivity between the US and Australia and New Zealand via Hawaii on one hand and between the US and Japan via Guam on the other (Figure 7.2). The submarine cable connectivity to the Commonwealth small states has been secured through tapping into these two main trunk lines. Five of the nine Commonwealth small states (Fiji, Papua New Guinea, Samoa, Tonga, and Vanuatu) are connected to the existing submarine cable network. The limited traffic to physically distant and sparsely populated islands, particularly Kiribati, Nauru and Tuvalu, cannot make a business case for investment in hugely costly submarine cable infrastructure. However, there is growing awareness that such islands should be connected anyway. Recognising the importance of submarine optical cable network as the basic infrastructure for high-speed broadband connectivity, the governments in the region and their development partners have undertaken several initiatives to expand the submarine network in the region.

Samoa will soon be able to receive high bandwidth and faster internet following the launching of the Samoa Connectivity Project in October 2015. The estimated US$50 million project involves the laying of some 1,300 km of submarine cable to connect Samoa to the Southern Cross Pacific Network's hub in Fiji. This project is being financed under the Pacific Connectivity programme of the World Bank, in partnership with the Australian Government, Asian Development Bank and Samoa Submarine Cable Company. The main objective of the World Bank programme is to undertake a series of projects in partnership with other development agencies to help Pacific island

Figure 7.2 Broad layout of the submarine cable network in the Pacific



Source: Pramanik (2014)

countries achieve more affordable information and communication technologies and reduce their isolation. The Samoa project follows the laying of an 827 km fibre optic cable between Tonga and Fiji, which was completed in August 2013. Plans to connect other countries, such as Kiribati and Solomon Islands, are being developed and over the next few years all Commonwealth Pacific small states should be connected. In addition to the initiatives of the governments and development partners, there are moves by private companies to get involved in the expansion of the submarine cable network in the Pacific region. In early 2016, Huawei Marine Networks, a joint venture between Huawei and Global Marine Systems, expressed interest in the development of fibre optic based connectivity in the Pacific, as part of Huawei's broader strategy to expand its involvement in the region. The Hawaiki Submarine Cable proposal to lay a high capacity cable between Sydney and the United States West coast, stopping in Auckland, Fiji and Hawaii, is another private initiative expected to be ready for service in 2018.

Therefore, while ICT connectivity infrastructure for mobile services and broadband internet seems to be expanding, wide disparities exist within the region and serious gaps exist between the demand for ICT connectivity and telecom services, and what is being currently supplied. Large areas of the region are either not connected at all or receive low-quality narrowband telecom services. The World Bank estimates that the total demand for bandwidth in the region is 44Gbps and only 18 per cent is currently being supplied, with the demand for bandwidth set to increase as the ICT application and diffusion expands in the region.

In addition, although fibre optic submarine cables provide the best means of reliable broadband connectivity, only five of the Commonwealth Pacific small states are connected to the submarine cable network. A recent study (CROP ICTWGS 2014) found that despite the arrival of undersea cable on many islands, ICT penetration has not really improved over the last decade. However, anecdotally, since the arrival of submarine cables in Vanuatu, Samoa and Tonga, the cost of the internet has reduced significantly and penetration has risen just as quickly. The expensive maintenance of the cable and the cost of distributing its connectivity to most islanders remains a challenge. In many places, undersea cable initially provides affordable, quality bandwidth within 5 km of city centres, but as rollout of 3G and 4G steadily increases, more people are accessing broadband. However, residents living beyond this coverage are often able to access only expensive and slow packages.

Furthermore, the high cost of laying and maintaining submarine cables, combined with the small market size in outlying islands, does not make a business case for private sector investment. Therefore, development partner support, as well as innovative business and investment models, will be necessary to expand the submarine cable infrastructure for the Commonwealth Pacific small states.

7.2.2 ICT penetration

Fixed line and mobile connectivity

In terms of fixed line subscriptions, in most Commonwealth Pacific small states there has been a static or declining trend (Table 7.2). The average fixed line subscriptions

Table 7.2 Fixed line subscriptions per 100 inhabitants

Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Fiji	13.7	13.9	14.6	15.3	16.1	15.1	15.0	10.1	8.0	8.5
Kiribati	4.6	4.4	4.3	4.2	8.6	8.6	8.5	8.9	8.8	8.8
Nauru	17.8	17.8	17.8	17.9	17.9	18.9	0.0	0.0	0.0	0.0
PNG	1.1	1.0	0.9	1.0	1.4	1.8	1.9	1.9	1.9	1.9
Samoa	10.8					4.3		4.4	4.4	6.1
Solomon Is	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.4	1.3
Tonga	13.6	18.2	20.6	24.8	29.9	29.8	28.7	28.6	29.4	11.3
Tuvalu	9.2	11.3	13.3	10.2	8.2	12.2	14.7	14.7	14.7	15.2
Vanuatu	3.3	3.5	4.0	4.6	3.1	3.0	2.4	2.0	2.2	2.2
Average*	2.7	2.6	2.7	3.5	3.3	3.5	3.5	3.1	2.9	2.8

Note: *Weighted by population
Source: ITU 2015

per 100 inhabitants either declined or remained static between 2005 and 2014. Fiji recorded the sharpest decline, where fixed line subscriptions declined from 13.7 in 2005 to 8.5 in 2014.

While fixed line subscriptions have either remained static or declined, mobile connectivity has increased exponentially (Table 7.3). On average, mobile penetration for the Commonwealth Pacific small states per 100 inhabitants rose from 4.2 in 2005 to 51.9 in 2014, translating to a relatively rapid unique subscriber growth from 0.4 million in 2005 to 4.7 million in 2014. This is a compound annual growth rate of 26 per cent, well ahead of the global and developing country averages. In Fiji, the sharp decline in fixed line subscriptions was accompanied by a steep increase in mobile subscriptions, from 24.9 in 2005 to 98.8 in 2014.

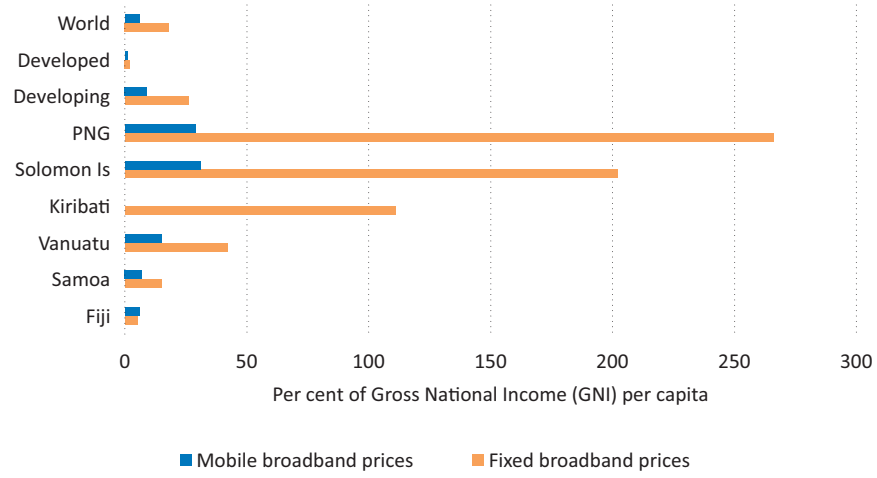
The increasing trend in mobile usage follows expanding availability of mobile phone services progressively covering larger areas of the Pacific, as well as national efforts to enhance a connectivity backbone and introduction of affordable service rates.

Table 7.3 Mobile subscriptions per 100 inhabitants

Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Fiji	24.9	34.4	63.5	71.1	75.1	81.1	83.8	98.2	105.6	98.8
Kiribati	0.7	0.8	0.8	1.1	10.3	10.8	13.9	15.9	16.0	17.4
Nauru						61.9	66.8	67.8	68.0	68.0
PNG	1.2	1.6	4.7	13.8	21.1	27.8	34.2	37.8	41.0	44.9
Samoa	13.3	28.1	47.2	48.0	48.0	48.4	50.0	53.1	52.5	55.5
Solomon Is	1.3	1.5	2.2	6.0	9.7	21.9	51.1	55.0	57.6	65.8
Tonga	29.6	29.6	45.5	49.0	51.2	52.2	52.6	53.4	54.6	64.3
Tuvalu	13.4	16.5	18.4	17.0	10.2	16.3	21.6	28.4	34.4	38.4
Vanuatu	6.1	7.0	11.8	16.0	57.1	71.9	56.7	59.7	50.3	60.4
Average*	4.2	5.7	11.6	19.8	27.2	34.3	40.9	45.5	48.6	51.9

Note: *Weighted by population
Source: ITU 2015

Figure 7.3 Broadband prices (2015)



Source: ITU 2015

For most of the Commonwealth Pacific small states, 2G remains the dominant mobile technology although several markets are seeing a migration to higher speed mobile broadband (3G and 4G) networks. In Fiji, for example, mobile broadband connections accounted for 33 per cent of total connections at the end of 2014, with 4G accounting for 14 per cent of the total connection base. However, some markets such as Tuvalu are yet to launch 3G or 4G networks.

Despite its growth, there is wide variability in the mobile-cellular telephone penetration across countries of the region, with Papua New Guinea at about 45 per cent and Fiji at 100 per cent. In addition, nearly half of the Commonwealth Pacific small states' population, led by PNG, are not yet users of the mobile phone service. This is likely to be for a variety of reasons. One obvious reason is that a large section of the population, particularly in PNG, lives in rural areas where the mobile phone service is not yet available. In addition, many of the states consist of archipelagos of many islands dispersed over hundreds of kilometres, often lacking in supporting infrastructure, such as electricity that is essential for telecommunication. For these reasons, Kiribati and Tuvalu have the lowest mobile subscriptions, at 17.4 and 38.4, respectively. Furthermore, in some parts of the Pacific, the cost of mobile service is so high as to be beyond the affordability of an average person in these areas, especially in the areas of largely subsistence living. For instance, in PNG and the Solomon Islands, the average cost of the mobile broadband service has been estimated to be 29 and 31 per cent of the per capita gross national income, respectively, which is three to four times higher than the average prices of these services in developing countries (Figure 7.3).

Broadband connectivity and internet use

Broadband connectivity infrastructure that enables larger and faster data flows is a basic requirement for satisfactory internet experience. With the expansion of a submarine fibre optics backbone in the Pacific in the last ten years, broadband

Table 7.4 Fixed line broadband per 100 inhabitants

Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Fiji	0.9	1.0	1.4	1.5	1.5	2.7	2.7	1.6	1.2	1.4
Kiribati	0.4	0.4	0.5	0.7	0.8	0.9	0.9	1.0	1.1	1.2
PNG				0.1	0.1	0.1	0.1	0.1	0.2	0.2
Nauru						9.6				
Samoa	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.6	0.7	1.1
Solomon Is	0.1	0.1	0.2	0.3	0.4	0.5	0.5	0.4	0.3	0.2
Tonga	0.6	0.6	0.8	0.7	1.0	1.1	1.2	1.4	1.6	1.7
Tuvalu	1.6	2.6	2.8	3.0	1.0	2.4	4.6	5.6	7.1	9.1
Vanuatu	0.0	0.0	0.1	0.1	0.2	0.2	0.1	0.1	0.1	1.8
Average*	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.4	0.4	0.4

Note: *Weighted by population
Source: ITU 2015

internet availability in the Commonwealth Pacific small states has risen sharply. Concomitantly, the demand for internet services, largely fuelled by expanding interest in web surfing and social networking among the general population, has risen. The expansion of the supply of broadband services and increasing demand for such services has led to a sharp increase in broadband subscriptions in all Commonwealth Pacific small states (Table 7.4). On average, there was a fourfold increase in the fixed line broadband subscriptions between 2005 and 2014. However, in absolute terms, the usage of fixed line broadband in these states has been limited to only one in every 250 inhabitants, compared to one in every two inhabitants using mobile service.

As with the rest of the developing world, the internet penetration within the Commonwealth Pacific small states has increased significantly (27%), from a low of 2.5 per cent in 2005 to about 16 per cent in 2014 (Table 7.5). This sharp increase has been due to the expanding demand for the internet, entertainment and communication. It is also due to the decreasing trend in the internet service cost. The

Table 7.5 Percentage of people using internet

Country	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Fiji	8.5	9.6	10.9	13.0	17.0	20.0	28.0	33.7	37.1	41.8
Kiribati	4.0	4.5	6.0	7.0	9.0	9.1	10.0	10.8	11.5	12.3
Nauru										
PNG	1.7	1.8	1.8	1.2	1.6	1.3	2.0	3.5	6.5	9.4
Samoa	3.4	4.5	4.8	5.0	6.0	7.0	11.0	12.9	15.3	21.2
Solomon Is	0.8	1.7	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0
Tonga	4.9	5.9	7.2	8.1	10.0	16.0	25.0	33.0	35.0	40.0
Tuvalu	0.0	0.0	10.0	15.0	20.0	25.0	30.0	35.0	37.0	37.0
Vanuatu	5.1	5.9	6.8	7.3	7.5	8.0	9.2	10.6	11.3	18.8
Average*	2.5	2.7	3.0	2.8	3.7	3.9	5.5	7.4	10.2	15.9

Note: *Weighted by population
Source: ITU 2015

expansion of the internet infrastructure and service quality has apparently kept pace with the expanding demand for the internet.

While internet use has been expanding, there are wide intra-regional differences. For instance, Fiji has reached an internet penetration of 42 per cent, while Papua New Guinea, the largest country of the region with a population of some 7 million, accounting for nearly three quarters of the region's total population, has reached less than 10 per cent internet penetration. In addition, the percentage of people using the internet is still low at 16 per cent. That is to say nearly 74 per cent of the Commonwealth Pacific small states' population, led by PNG, still do not use the internet.

7.2.3 Costs and affordability

The cost of domestic and international telecom services, including call rates and internet service prices, in the Commonwealth Pacific small states has consistently remained much higher than the world average. This is due to the lack of market competition and relatively high telecom service delivery costs in the region. However, between 2000 and 2015, telecom prices have fallen almost in tandem with the fall in prices in developing countries worldwide. In some of the Commonwealth Pacific small states (e.g. Fiji and Solomon Islands), with relatively larger markets and increased market competition, the price fall has been considerably sharper (Table 7.6).

To gauge the level of affordability, the prices of the telecom services, including fixed line, broadband internet and mobile, have to be compared with average incomes. The Broadband Commission has set a global affordability target price for broadband telecom service at a maximum of 5 per cent of per capita Gross National Income (GNI). Based on ITU data, the price of mobile services in the Commonwealth Pacific small states ranges from 5 per cent in Fiji to 16 per cent of GNI per capita in PNG, compared to the developing countries average of 9 per cent and global average of 6 per cent.

The fixed and mobile broadband services are even less affordable than the basic mobile services (Figure 7.3). Fixed broadband prices, as a percentage of GNI per capita, vary from 5 per cent in Fiji to 266 per cent in Papua New Guinea. This is considerably higher than the global and developing country averages of 18 and 26

Table 7.6 Indicative internet price trend (US$ per month)

Country	Internet price in 1999	Internet price in 2016	Remarks
Fiji	7,755	57 (100GB data and 10MB speed)	Telecom Fiji business internet package, 2016.
Solomon Is	4,816	128 (package rate)	Our Telekom 250 SBD 1GB for 7 days, June 2016.
PNG	3,000	190 (package rate)	HiTRON internet plan 512k/10MB June, 2016.
Samoa	1,905	167 (package rate)	Blue Sky smart home package 2Mbps 20MB, June 2016.

Source: SOPAC 1999 and internet service provider's websites.

per cent, respectively. Similarly, mobile broadband prices, as a percentage of GNI per capita, vary from 6 per cent in Fiji to 31 per cent in Solomon Islands. Although prices for mobile broadband are more affordable, prices are still above the target of 5 per cent of GNI per capita and, except for Fiji, are higher than the global and developing country averages of 6 and 9 per cent, respectively. Fiji's relatively better connectivity and economic situation provides for a better outcome with regard to telecom affordability than the other Commonwealth Pacific small states.

Therefore, although internet charges have fallen sharply during the last ten years, prices are still high enough to be beyond what many in the region can afford. Fixed and mobile broadband connectivity prices are especially high.

7.2.4 ICT applications

The application of ICT in various social, economic, environmental and governance sectors can be leveraged to overcome the unique challenges of Commonwealth Pacific small states, particularly in the areas of public governance, business, education, health, disaster management and climate change.

ICT in government (e-government)

ICT application in government or e-government has been employed the world over to bring in efficiency and effectiveness in public governance. This has been achieved through the development of efficient government processes and public services, as well as use of ICT to promote democratic government, public participation and reduced corruption. Accordingly, many Commonwealth Pacific small states have adopted strategic plans and programmes for the development of e-government.

According to the United Nations Public Administrations Network (UNPAN) E-Government Development Index (EGDI), which gauges e-government readiness and development (e-government systems, e-services and use of internet and web technology for government operations and services), Commonwealth Pacific small states perform poorly (Table 7.7). The average EGDI for Commonwealth Pacific small states is substantially lower than the world average, indicating the poor development of e-government in the region. Except for Fiji, all the other states have an EGDI that is lower than the world average. Between 2012 and 2014, the EGDI ranking of five out of the nine countries fell (Nauru, Papua New Guinea, Solomon Islands, Tuvalu and Vanuatu), while the rest improved (Fiji, Kiribati, Samoa and Tonga). Fiji and Tonga have the highest ranking of the Pacific small states.

None of the Commonwealth Pacific small states rank high on e-government due to the unique challenges small island developing states face, such as their small size and economy, isolation and high cost of providing goods, services and infrastructure – including telecommunications – associated with small populations and geographic dispersion. This poses unique challenges for governments in co-ordinating and delivering services (UNPAN 2014, 27).

The ICT sector in most countries is immature and underdeveloped. Only five countries (Fiji, Samoa, Papua New Guinea, Tonga and Vanuatu) have so far established

Table 7.7 E-government development index

Country	Level of Income	EGDI	2014 Rank	2012 Rank	Change of Rank
Fiji	Upper Middle	0.5044	85	105	↑20
Kiribati	Upper Middle	0.3201	132	149	↑17
Nauru	Upper Middle	0.2776	145	141	↓4
PNG	Lower Middle	0.1203	188	177	↓11
Samoa	Upper Middle	0.4204	111	114	↑3
Solomon Is	Lower Middle	0.2087	170	168	↓2
Tonga	Upper Middle	0.4706	98	111	↑13
Tuvalu	Upper Middle	0.3059	137	134	↓3
Vanuatu	Upper Middle	0.2571	159	135	↓24
Average		0.3206			
World Average		0.4712			

Source: UNPAN 2014

submarine fibre cable access to the global backbone for telephony and the internet. The low levels of access to broadband connectivity have hampered the development of e-government services, economic development, and social cohesion, and placed a brake on the development of technology-based services.

The 2010 Review of the Pacific Regional Digital Strategy (Network Strategies 2010) found that many ICT policies address the need for basic e-government initiatives, but many countries were still grappling with the five evolutionary steps that lead to e-government:

1. Computerising ministries and departments.
2. Establishing networks between ministries and departments.
3. Developing secure email and internet access.
4. Developing websites.
5. Developing applications providing G2B and G2C services.

The Review noted that most countries achieved steps 1, 3 and 4, but only Fiji had achieved all five. Fiji's establishment of an Information Technology and Computing Services Unit in 2000 has facilitated the growth of e-government capacities virtually across all ministries and agencies (Cullen and Hassall 2013).

E-government initiatives have mainly focused on connecting government offices through backbone networks to support internal processes. Development assistance has played a key role, with three networks financed through assistance from China and one from Australia (Table 7.8).

Through development assistance, Fiji developed the Government Network (GOVNET), linking most government agencies in the capital city Suva, as well as in some other locations. A fibre network backbone is used in Suva, while wireless technology is used in other parts of the country. GOVNET allows the government's

Table 7.8 Government networks

Country	Government network	Development partner
Fiji	Fiji Government Network (GOVNET)	RMB 145 (US$18) million loan from China EXIM Bank (2004)
Samoa	Samoa National Broadband Highway (SNBH)	$US20.5 million loan from China EXIM Bank (2011)
Solomon Is	Solomon Is Government (SIG) Connect Network	AUS$3.25 million grant from Regional Assistance Mission to Solomon Islands (RAMSI) (2011)
Vanuatu	Government Broadband Network	US$29.5 million loan from China EXIM Bank (2009)

Source: PRIF 2015

some 36,000 civil servants to exchange information electronically. The government also has a state-of-the-art data centre (PRIF 2015). However, although the basic infrastructure for interagency integration is in existence, most e-government initiatives so far implemented are single agency-specific applications. Similarly, in Samoa and Solomon Islands, the primary focus has been to enhance connectivity for ministries and offices in order to carry out administrative processes more efficiently. However, for Samoa and Solomon Islands, as well as the other Commonwealth Pacific small states, initiatives have been fragmented and incomplete (Table 7.9). Therefore, Fiji's GOVNET approach shows great promise to drive e-government in other countries, with development of guidelines and technical assistance packages to speed up implementation.

ICT in climate change, disaster risk reduction and management

The use of ICT for disaster risk reduction and management is a well-established practice, with existing ICT-based systems for early warning and information

Table 7.9 Status of e-government development

Country	E-government plans	Ministries have websites/ portal	E-services established	Programmes established to digitalise historical records	Programmes established to capture traditional knowledge
Fiji	Yes	Yes	Yes	Yes	Yes
Kiribati	No	Yes	Yes	No	No
Nauru	No	Yes	No	No	No
PNG	Yes	Yes	Yes	Yes	n/a
Samoa	Yes	Yes	Yes	Yes	n/a
Solomon Is	No	Yes	No	No	No
Tonga	No	Yes	Yes	n/a	Yes
Tuvalu	No	Yes	No	No	No
Vanuatu	Yes	Yes	Yes	Yes	Yes

Source: CROP ICT Working Group Secretariat, 2014

dissemination, as well as post-disaster management. The Commonwealth Pacific small states have high vulnerability to the effects of climate change and natural disasters. As such, a number of projects have been undertaken in these countries to establish ICT-based disaster risk reduction and management systems.

In 2014, a pilot project was commissioned in Tonga to establish an early warning system to mitigate the risk of natural disasters in rural communities and manage post-disaster relief efforts more effectively. The multipurpose early warning system uses radio over internet protocol linked broadband circuits and fibre optic communication network infrastructure for dissemination of information to residents in vulnerable and high-risk areas.

Under the sponsorship of ITU, a similar regional project began at the end of 2014, which aims at establishing an integrated ICT system for disaster risk management, climate change and socio-economic development. This ICT system (Smart Initiative for Sustainable Development) brings together the ICT systems for development and disaster risk management, along with supporting connectivity and ICT infrastructure, in a single unified system.

ICT in education (e-education)

The application of ICT in education and skills development is well recognised and appreciated. ICT enables effective and efficient management of the education sector at the national level, as well as the efficient delivery of education, with the integration of technology at the classroom level. For Commonwealth Pacific small states, with limited resources and dispersed populations over expansive island geography, the ICT-based solutions in delivering education remotely through virtual classes are highly appealing. As such, ICT in education has been emphasised by most of these states. To increase the effectiveness of education at the classroom level, various projects and programmes have been implemented to make ICT infrastructure and systems available at the school level (Table 7.10).

Even though the lack of broadband connectivity and internet in many of the Commonwealth Pacific small states has been a stumbling block to the downloading and sharing of educational content, there are encouraging moves to provide basic ICT infrastructure in schools (Table 7.11). While all the secondary schools reportedly have access to computers and internet, the ICT infrastructure and internet may be inadequate. There are reports that the computer labs established in most schools are grossly inadequate, with the computer-to-student ratio up to 100. Many schools also cite the non-availability of the internet, or excessive costs, as challenges for increasing the use of ICT by both students and teachers.[4]

However, new 'offline' approaches are being trialled, where up to a terabyte of educational resources are preloaded onto a microcomputer, powered by a small battery (or a small solar panel) and equipped with a wifi hotspot. The content can be accessed by any device that has an internet browser, e.g. a laptop, tablet or smartphone. Teachers and students then have access to a rich resource of teaching and learning multimedia material without having to pay for internet access.

Table 7.10 Selected ICT in education initiatives

Project/Initiative	Countries	Achievement
ICT and internet in schools	Fiji, Samoa, Tonga	80 per cent of secondary schools have internet, mostly in urban areas.
ICT education courses in secondary schools	Fiji, Samoa, Tonga	In 2002, 86 of the 156 (55%) secondary schools in Fiji offered computer science and information technology education. In Samoa, 14 secondary schools had computer science curriculum in secondary schools.
Share, Engage and Educate project	Fiji	200 computers, as well as robotic kits, digital cameras and data projectors, distributed to schools. Equipment donated by individuals and the Queensland University of Technology in Australia. The Ministry of Education has also distributed over 5,000 laptops and tablets to primary schools.
The School Net project	Samoa	Computers installed in schools with student-to-computer ratios improving between 2008 and 2014, from 139 to 62 in primary schools, and 26 to 13 in secondary schools.
Education Management Information System project	Kiribati, Samoa, Solomon Is	Strengthened school administration and decision-making through better collection and exchange of electronic records.
One Laptop Per Child project	Fiji, Samoa, Tonga, Vanuatu	Distribution of laptops undertaken on an ad hoc basis. The project was not entirely successful.

Source: Adopted from various sources[5]

Table 7.11 ICT infrastructure in schools

Country	Secondary schools have access to computers	Secondary schools have internet access	ICT curriculum included in teacher training
Fiji	Yes	Yes	Yes
Kiribati	Yes	Yes	No
Nauru	Yes	Yes	No
PNG	Yes	Yes	n/a
Samoa	Yes	Yes	n/a
Solomon Is	Yes	Yes	No
Tonga	Yes	Yes	n/a
Tuvalu	Yes	Yes	No
Vanuatu	Yes	Yes	No

Source: CROP ICT Working Group Secretariat, 2014

The University of the South Pacific (USP) is a pioneer in the Pacific region in ICT-based tertiary education. USP caters for over 20,000 students, about half of whom are studying at remote campuses and centres across the Pacific islands through ICT-based distance education. USP Net connects all its 15 campuses with broadband and allows video conference delivery of lectures. The university is aiming to offer all its courses online through its Learning Management System Moodle. USP also established the Teachers' Education Resources and e-Learning Centre in 2011 to support the efforts of national governments in developing e-learning policies, strategies and programmes, as well as the provision of training on the use of ICT in teaching and learning. In addition, USP has supported many regional and national-level initiatives, including ICT curriculum development, development of a Regional Framework for ICT in Education and the Fiji-Pacific Knowledge Hub.

ICT in health

Commonwealth Pacific small states face several challenges in the health sector, including shortages of health staff, specialist health expertise and supporting health infrastructure. To leverage the limited available resources, ICT has been used as a tool to address some of the challenges in the health sector.

Most countries have developed and implemented health information systems at the national and district level, leading to better operational and strategic management of the health sector. Computerisation of patient records and hospital management, including pharmacy and drug supply management, patient management, doctor/nurse scheduling and time management, and early health warning systems using mobile phones, has also resulted in overall improvement in the functioning of the health centres. Uploading of health data and sharing of patient data between hospitals and clinics is facilitating delivery of health services, although often hampered by low bandwidth and lack of connectivity.

Another noteworthy initiative was undertaken by the Fiji School of Medicine, Telecom Cook Islands, and the Pacific Islands Telecommunication Association in partnership with service providers (hospitals and clinicians in the Pacific islands and USA) under the Western Pacific Health Net project. This initiative employed a telemedicine application that facilitated specialist medical diagnosis from doctors overseas within a period of 24 hours after the patient's medical reports, X-rays and scans were sent over the internet.

In addition, the World Health Organisation's (WHO's) Pacific Open Learning Health Net (POLHN), in partnership with Pacific ministries of health, is a notable initiative in using ICT platforms to improve the quality and standards of practice of health professionals.[6] POLHN provides free online courses for health professionals in 40 learning centres across the Pacific, with more than 2,000 health workers trained since 2007.

ICT in business (e-business)

As the ICT connectivity and broadband infrastructure improves, the feasibility of establishing and running profitable technology-based business should also increase. For the technologically and economically advanced Commonwealth Pacific small states,

such as Fiji, business communities through their associations and with support from their respective governments have undertaken several programmes aimed at expanding business investments and technology flows into the region from India, New Zealand, China and Australia, among others. The technical know-how and investment inflows into the region can be expected to lay a strong foundation for ICT-driven business in the region, provided that the policy and infrastructure constraints are mitigated. Similarly, there is potential for many e-commerce opportunities, as the ICT and internet infrastructure expands and local skills develop. These opportunities include e-business operations like call centres, data analysis, business process outsourcing and IT service offshoring, such as that in many parts of Asia and Africa, even in remotely located but well-connected communities in Kenya and Sri Lanka.

There are also some innovative e-commerce initiatives being undertaken by the private sector entrepreneurs in the region. For example Mindpearl,[7] an international call centre company, is active in Fiji, besides other international locations, to provide offshore contacting and call centre services to clients all over the world. Similarly, E-Business Pacific,[8] a regional cloud-based service provider, is in the process of publishing detailed information about Pacific businesses online as a directory that would allow legitimate companies and organisations to broadcast their products and services. Although these innovative initiatives are at present at a very basic level, they have potential to develop into full-blown end-to-end e-commerce enterprises.

7.2.5 ICT strategies, policies and regulations

Most of the Commonwealth Pacific small states have formulated strategies, policies, laws and regulations to develop and regulate the ICT sector (Table 7.12). However, the coverage and implementation status of ICT policies varies across the region. Some countries like Fiji, PNG, Samoa and Tonga have already adopted national ICT policies and two of them (Fiji and Samoa) are in the process of revising their policies, having adopted their first ICT policy some eight years ago. The remaining countries are at various stages of development and implementation (Table 7.12).

Table 7.12 Policy, legal and regulatory environment

Country	National ICT policies	Cyber-crime legislation	Regional strategy to combat cybercrime	Electronic files admissible in court	Data protection legislation	ICT educa-tion Policy	ICT health Policy
Fiji	Yes	Yes	n/a	n/a	No	Yes	Yes
Kiribati	Yes	No	n/a	No	No	No	No
Nauru	No	No	n/a	n/a	No	Yes	n/a
PNG	Yes	No	n/a	n/a	No	Yes	n/a
Samoa	Yes	Yes	n/a	n/a	No	Yes	n/a
Solomon Is	No	No	n/a	No	No	No	No
Tonga	Yes	Yes	n/a	Yes	Yes	Yes	n/a
Tuvalu	No	No	n/a	No	No	No	No
Vanuatu	Yes	Yes	n/a	n/a	No	Yes	n/a

Source: CROP ICT Working Group Secretariat 2014

Over the last 15 years, a number of regional initiatives have been instrumental in laying the foundation for national ICT policy development. With the support of development partners, an E-Pacifika programme was launched during 2002–2003 to raise the level of awareness among the leaders and decision-makers in the region of the need and importance of national ICT policies and strategies.

Significantly, in 2002, at the Forum Communications Policy Meeting, Ministers endorsed the Pacific Regional ICT Policy and Strategy, which was developed by the ICT Working Group of the Council of Regional Organisations of the Pacific (CROP). The Regional ICT Policy and Strategy covered some common areas of concern to all Pacific island countries, such as the lack of connectivity and human resources. It calls for regional and national institutions to work with service providers to ensure universal access to ICT, sets out to enhance regional co-operation in ICT infrastructure development, adoption of global ICT standards, encourages private sector investment in ICT and aims to lessen the financial burden that ICT development can impose on governments and non-government organisations. The regional ICT policy has served as a model for the development of national-level ICT policy and strategy. However, although considerable progress has been made in the development and adoption of national policies and strategies, serious gaps remain, as noted before.

In related developments, in 2005, Pacific Leaders, recognising the importance of a regional approach to ICT sector development, commissioned the development of a Digital Strategy for the Pacific islands. The Digital Strategy was revised in 2010 with the formulation of the Framework for Action on ICT for Development in the Pacific (FAIDP), and further reviewed in 2014. The Regional Digital Strategy, consistent with the regional ICT Policy, emphasised the need to foster a conducive environment for ICT infrastructure investment, connectivity and accessibility, as well as encouraging ICT adoption in government, businesses and society at large. The priority areas of the Regional Digital Strategy included: improving access to communications technology; reducing costs; establishing higher bandwidth connection to the global ICT 'backbone'; removing inappropriate regulatory environments; and attracting higher levels of investment and strengthening ICT skills. Moreover, the digital strategy underscored the need for the development and implementation of ICT policy in each country.

Since the development of the broad regional ICT policies and strategies, many initiatives and projects have been launched during the last ten years to improve the national and regional policy and regulatory environments in the region. For example, the European Commission and ITU launched a project in 2009 to build human and institutional capacity through a range of targeted training, education and knowledge-sharing measures, as well as developing background material for possible harmonised policies for the ICT market.[9] More recently, the Japanese government and USP established the Japan-Pacific ICT Centre,[10] which provides assistance and guidance for the development of ICT security policies, laws and regulations.

However, even though considerable progress has been made at the regional and country level, ICT and digital policies and strategies at the national level are either not fully developed, have coverage gaps or have yet to be adopted and implemented.

In addition, although ICT laws and regulations required for data protection and prevention of cybercrime have been formulated, for most of the Commonwealth Pacific small states the legal and regulatory environment is underdeveloped and incomplete. For example, in Kiribati there is a Copyright Ordinance that provides protection for intellectual property rights but offers no recognisable protection for computer software or programs. Tuvalu faces a similar situation. On the other hand, Fiji has developed a comprehensive cyber security policy, which can serve as a good practice example for replication in other Commonwealth Pacific small states.

ICT laws must form an integral part of the legal regime of each country, not as separate pieces of legislation. While specific laws would be required to regulate e-government, e-commerce and afford protection to intellectual property rights in order to encourage flow of investment and promote domestic innovation, there is a greater need to ensure that existing laws are aligned with the ICT laws to avoid conflict and facilitate enforceability. Apart from ensuring that appropriate laws are in place, it is equally important to ensure that appropriate enforcement and monitoring systems, and institutions are in place.

7.3 Gaps and opportunities

Despite the good progress at the national and regional level, there is still much room for improvement. The following section highlights the gaps and opportunities that currently exist for the expansion of ICT usage, innovation and diffusion, as well as for its application in the various social and economic sectors in the region. It should be noted, though, that regional and national stakeholders are well aware of these gaps and the opportunities that exist, with plans in place to address these areas through a refreshed regional ICT initiative, led by USP through the CROP ICT Working Group. Therefore, implementation of the regional ICT initiative will be key to addressing these gaps and opportunities.

7.3.1 Expanding connectivity and ICT infrastructure

Although ICT connectivity appears to be expanding, wide intra-regional differences exist. Mobile subscriptions have increased across all the Commonwealth Pacific small states, although there is significant disparity in internet penetration. For instance, while Fiji has reached an internet penetration level of 42 per cent, Papua New Guinea, with a population of 7 million, accounting for nearly three quarters of the region's total population, has less than 10 per cent internet penetration.

Similarly, although ICT connectivity infrastructure for mobile services and broadband internet seems to be expanding, wide disparities exist within the region. There are also serious gaps between the demand for ICT connectivity and telecom services, and what is currently being supplied. Large areas of the region are either not connected at all or receive low-quality narrowband telecom services. The World Bank estimates that the total demand for bandwidth in the region is 44Gbps, but only 18 per cent is currently being supplied and the demand for more bandwidth is likely to increase as ICT applications and diffusion expand (World Bank 2015).

ICT connectivity is currently delivered through a combination of mobile, satellite, submarine cables, wireless and fixed networks, and these technologies will continue to serve as the backbone of communications in the region in the future. At present, only five of the nine Commonwealth Pacific small states secure international connectivity through undersea cables. In addition, although fibre optic submarine cables provide the best means of reliable broadband connectivity, most of the region is not connected to the submarine cable network. Despite the arrival of the undersea cable on many islands, the situation has not really improved ICT access for majority of the islands over the last decade. The expensive maintenance of the cable and the cost of distributing its connectivity to most islanders remains a challenge. Moreover, in many places, the undersea cable only provides affordable, quality bandwidth within 5 km of city centres, which means that residents living beyond this coverage are often able to access only expensive and slow packages (CROP ICTWGS 2014).

The high cost of laying and maintaining submarine cables, coupled with the small markets in outlying islands, does not make a good business case for private sector investment. Therefore, the support of the international development institutions, as well as innovative business and investment models, would be necessary to expand the submarine cable infrastructure in the Pacific.

7.3.2 Mix of innovative connectivity technologies

Given the inherent geographical barriers in expanding mobile connectivity throughout all the islands, the growth rate in mobile connectivity is expected to taper off as it reaches its saturation point. As such, a combination of connectivity technologies would need to be followed to reach universal broadband connectivity. This trend is already underway through satellite connectivity, with multiple operators bringing in different and newer technological systems. For instance, 03b Networks has launched a constellation of near earth satellites to provide higher bandwidth and low latency connectivity in some of the islands in the Pacific.[11] ITU's Connectivity Project for Small Island Developing States in the Pacific also uses a mix of connectivity technologies for application in disaster management, climate change mitigation and socio-economic development.

7.3.3 Optimising ICT applications

As a guiding principle, ICT applications must be optimised to the situation at hand as relative priorities will change from country to country and from one period to the next. However, the following areas of ICT applications have universal importance and will continue to be relevant today and the coming years, particularly for the Commonwealth Pacific small states.

ICT for public governance

The fragmented approach of Commonwealth Pacific small states to e-government development (building networks, digitising processes and implementing software applications in a random manner) is suboptimal. A holistic and long-term approach at

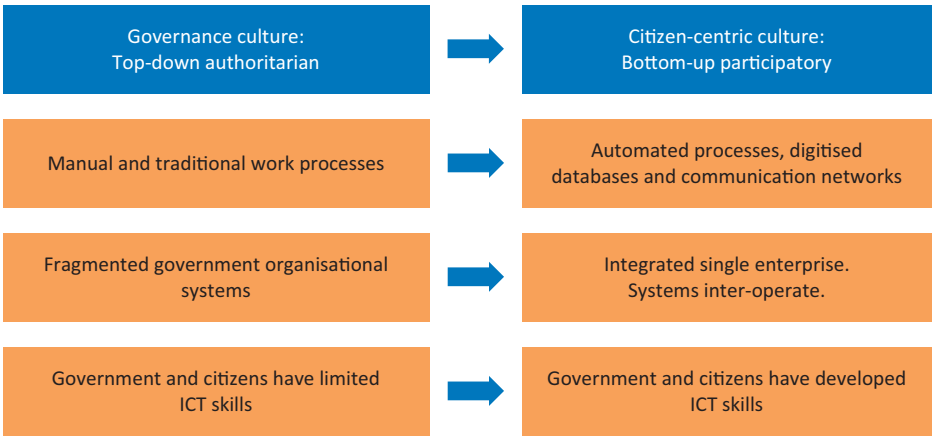
the national level is required. E-government programmes should be seen as a public-sector change management process and not as a mere computerising and digitising exercise. E-government in its widest sense is not only about digitising government processes but encompasses a fundamental change in how the government functions and how public services are delivered in an environment of high-technology usage within and outside the government. E-government can only be successful when the Government, including all its departments and sections, uses ICT optimally in managing government processes and service delivery. Citizens, businesses and other government constituents should also be technically, culturally and mentally prepared to embrace e-government.

Essentially, e-government has to be viewed as a change management programme that seeks to change people, processes and technology (Figure 7.4). The basic requirement for successful e-government is the change of the governance culture from top-down authoritarian to a bottom-up citizen-centric culture. This requires organisational and structural changes in the government that encourage citizen participation and demand horizontal flow of information across agencies and departments, integrating government systems into a unified whole. The government has to work virtually as a single enterprise to be successful as an e-government.

The seven key success factors that can make the difference in e-government development: political commitment, legal and regulatory reforms, institutional and organisational changes, financial and manpower resources, national policy, government reforms and skills and awareness (Figure 7.5), conceptually advocate the importance of a holistic and integrated approach mentioned earlier.

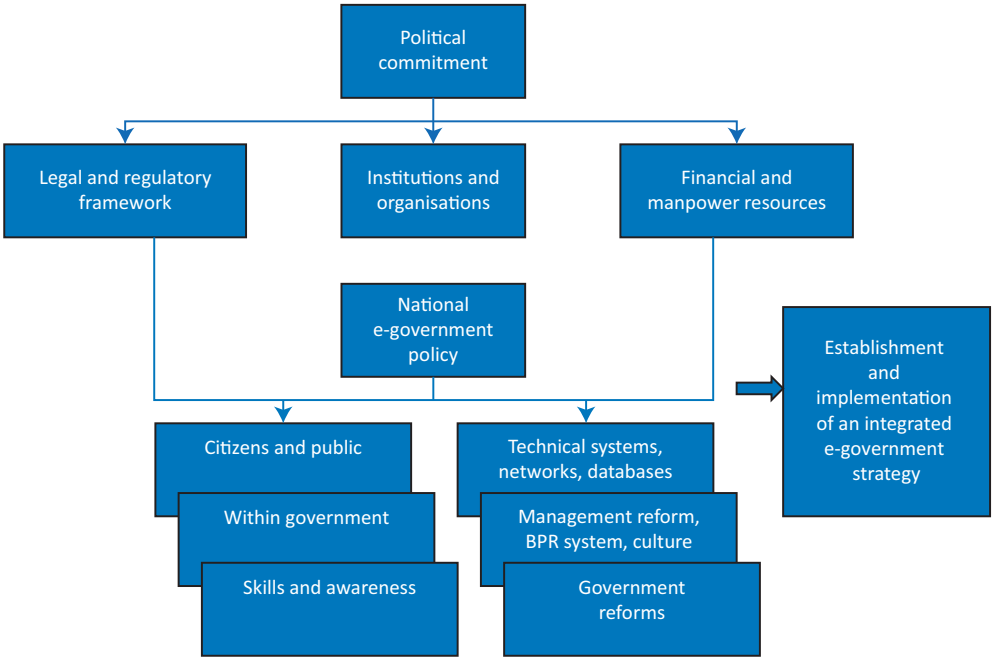
Over the past several years, the Commonwealth Secretariat has assisted with the development of e-government for its member nations. The framework for e-government development formulated by Commonwealth Secretariat (Figure 7.6) emphasises the importance of an integrated approach to e-government development and identifies

Figure 7.4 E-government change management



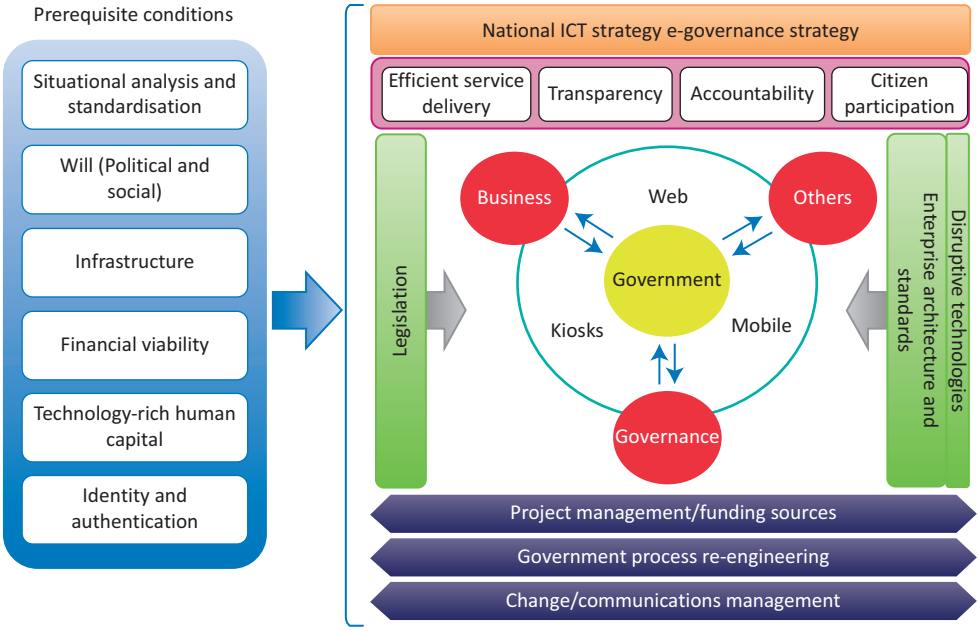
Source: Developed by the author

Figure 7.5 E-government development framework



Source: Adopted from UNPAN E-Government Development in the Pacific

Figure 7.6 E-governance framework



Source: Commonwealth Secretariat

the key critical areas for systematic and optimal e-government development. Besides the technical networks, systems and software issues, the framework underscores the importance of political will, capacity and skills development within the government and outside, as well as laws and regulations. It is crucial that the Commonwealth Pacific small states consider an integrated and holistic approach in e-government development, as advocated by the UN, Commonwealth and other international organisations.

Most of the Commonwealth Pacific small states have developed basic technology infrastructure for e-government, including agency-level hardware, as well as software platforms and networks. While technology adoption is necessary to establish networks and agency-level systems to support e-government, there is an urgent need to develop national technology policies, standards and systems that would ensure interoperability between the individual agency systems. This will enable operation of the national government as a single enterprise in accordance with the designed national systems architecture. Indeed, it is important to also have region-wide uniform technology standards for e-government development and adoption, which will allow for data exchange not only between systems within each country, but also between national systems in the region. The latter is likely to become increasingly a necessity.

The laws and regulations that enable smooth e-government operation include laws on data protection and privacy, and laws that recognise digital formats (documents, signatures). Supporting public infrastructure and certifying authority organisations are also needed to support these laws and regulations. In many Commonwealth Pacific small states, laws on data protection and digital formats have been enacted but underlying systems and the organisational base for their implementation are lacking.

ICT to increase resilience to natural disasters and climate change

For Commonwealth Pacific small states, there is considerable scope for expanding the application of ICT to increase their resilience to natural disasters and climate change. Some of the innovative ICT application areas that could be strategically employed for this purpose are shown in Table 7.13. In particular, governments should consider the development and deployment of an integrated disaster risk reduction (DRR) system that provides early warning to people at risk using variegated technologies, including Geographical Information Systems (GIS) and remote sensing. This system can also be used for post-disaster management rescue and rehabilitation efforts. To obtain optimality, the DRR system should be synergistically aligned with the relevant national e-government systems. Indeed, the DRR systems developed at the national level should be developed as a component part of the broader national e-government system. In addition, the present trends in big data analytics[12] would make it feasible to undertake DRR simulations or climate change modelling under different assumptions in order to increase preparedness and to undertake suitable long-term planning.

Promoting e-education

The application of ICT in education has been established as an effective tool for improving the learning process within schools, as well as overcoming resource

Table 7.13 Possible ICT applications and tools for disaster risk reduction and climate change

ICT Application/Tools	Remarks
National disaster risk reduction, response and early warning systems	A national disaster risk reduction, response and early warning system, integrated as part of the e-government system, similar to systems in place in Bangladesh and South India, which are also highly vulnerable to natural disasters.
Early warning systems based on multiple technology	Early warning system should be based on a combination of technologies, like GIS and remote sensing, that can warn of incoming disasters, supported by dissemination systems based on both traditional (radio, TV, etc.) and modern technologies (mobile phones, web portals, etc.). Online media is increasingly playing an important role in early warning, as demonstrated by Alert Net, a humanitarian news network based around a website that attracts more than 10 million users per year.
Post-disaster relief and response systems	ICT tools and applications can be used to streamline disaster relief and rehabilitation efforts. Normal communication can be damaged due to disaster so emergency communication systems, including radio, wireless, and satellite broadcasting, are vital. Post-disaster GIS maps can be used for planning and assessment of damage. Various collaborative tools can also be employed to manage disaster recovery efforts, such as the Sahana Disaster Management System, a web-based free and open source software collaboration tool, developed and used by the Sri Lanka government after the Indian Ocean tsunami in 2004.
Climate change modelling	ICT tools and technologies can be used to collect and analyse large volumes of data to create and simulate various possible climate change possibilities and building scenarios under various assumptions using big data analytical tools and building suitable climate change algorithms.

Source: Developed by the author from various sources

constraints due to limited school capacity or shortage of teachers through virtual classrooms and remote education. ICT's efficacy is environment-independent as its effectiveness can be seen in the education of girl students in traditional communities of Afghanistan as much as in the remote islands of the Pacific. As ICT-based learning technologies and applications get smarter, coupled with widespread use of mobile devices, there are many opportunities for the Commonwealth Pacific small states to capitalise on ICT application in education to ensure lifelong learning.

Although a number of initiatives have been taken to expand the use of ICT in education, these have been unco-ordinated and random. None of the Commonwealth Pacific small states have a comprehensive ICT in education plan. The availability of computers and internet access is also often implemented through donor assistance and the focus is typically on the use of computers by administrative staff and to compile education statistics.

In order to expand the reach and availability of educational opportunities for each Pacific island citizen, a comprehensive national and regional strategic plan is required to integrate ICT in education, expand ICT literacy in schools and expand remote education and e-learning. The lead that USP has taken in the region to expand ICT in education should be broadened and indeed replicated to establish other similar centres of excellence in ICT education.

With broadband connectivity and internet expected to expand in the years to come, establishing and operating distance education hubs, and conducting virtual and online classes, should become easier. Technological developments in cloud computing, large-scale data centre management, as well as in e-learning and virtual classroom domains (where real classroom experience is being replicated in the online environment), will also make the establishment of large-scale virtual schools, colleges and universities an attractive possibility.

Promoting e-health

While Commonwealth Pacific small states have adopted ICT applications in the health sector to improve its efficiency and effectiveness, there is much more that can be done to maximise the use of ICT for health. Lack of ICT resources, as well as the lack of broadband and reliable connectivity, are major constraints. However, the expansion of broadband connectivity and expansion of both mobiles and the internet across the countries, open up many strategic options for ICT application in health, some of which are shown in Table 7.14.

Promote ICT innovation and diffusion for business and income growth

In the long run, Commonwealth Pacific small states can benefit from encouraging and promoting ICT innovation and diffusion to spur private sector development. Innovations in ICT technology can lead to localised ICT products and services to fuel business growth. Promoting formal research and development in universities, as well as provision of grants and prizes to individuals or small and medium-sized enterprises can help encourage ICT innovation and diffusion. These types of initiatives can develop a dynamic local ICT industry that can cater for local market demands but can also have applicability in the regional or global markets. India's IT industry growth, world-class ICT innovations emerging from Estonia, and Kenya's innovative mobile technology applications are good examples of how countries have promoted ICT through innovation and entrepreneurship.

Technology innovation lays the foundation for increased diffusion of technology, which has the potential for societal transformation and growth. However, Commonwealth

Table 7.14 Possible areas of strategic ICT applications for health

Description of the application	Remarks
SMS push messages and health alerts to the general population	Mobile-based applications that involve individual and mass dispersion of health alerts. Mobile connectivity essential. *Besides SMS application deployment, resource needs are limited.*
Remote health service delivery through telemedicine system deployment	International telemedicine delivery centres in Australia, New Zealand, India and the US could collaborate with telemedicine receiving centres that can be established at strategic locations in the region. At the national level, the same infrastructure and system can be rolled out. *High infrastructure investment and bandwidth requirements.*
National patient database with accessibility to all clinics and hospitals, including data and document sharing between all clinics and hospitals	A central patient data management application with accessibility to all health centres/clinics/hospitals and data sharing between health centres and hospitals. *High infrastructure investment and bandwidth requirements.*
Highly integrated national Health Information Management System (HIMS) interoperable with a Regional HIMS, consistent with WHO standards	National HIMS linked to Regional HIMS with realtime field data capture through mobile devices of the field workers and usage of big data and data analytics tools (ICT technologies that permit capture, management and analysis of large volumes of data) for strategic decision-making.

Source: Compiled by the author

Pacific small states' governments must provide an enabling environment to promote ICT innovation and entrepreneurship, including platforms for joint efforts between the government and the private sector.

ICT also opens up opportunities for increased income to individuals and communities by providing market information and prices to consumers or providing market preferences and needs to producers. For example, through ICT tools, horticulture producers in Southern Bhutan can adjust their supply as they have real-time access to market trends (prices and demand) in Kolkata, their major wholesale market. This has substantially increased the average income of the farmers in Bhutan. Electronic commerce is transforming the business landscape of India, as much as it is opening up new and better market opportunities for producers of tea and coffee in Kenya and Ethiopia.

Similarly, as broadband connectivity and internet infrastructure expands, more businesses and communities in the Commonwealth Pacific small states will be able

to capitalise on ICT tools to find local, regional and international markets to promote their products and services, as well as conduct their businesses online at very low cost, which would increase their incomes. For example, in the tourism sector in Fiji, many small and medium-sized hotel operators increasingly use the internet and other social media platforms to reach out to their markets (e-marketing), as well as for online booking and payments. In addition, with the expansion of broadband internet and mobiles in the Pacific, overseas investors and entrepreneurs from countries like Australia, New Zealand, India and the USA find it profitable to set up nearshore[13] or offshore[14] centres, such as call centre management, data entry, legal backend work or business process management, in Commonwealth Pacific small states that have conducive ICT business environments.

7.3.4 Conducive policies, laws and regulations

Although Commonwealth Pacific small states have made appreciable progress in the development of basic ICT policies, laws and regulations, there are significant gaps. Much more needs to be done to revisit already defined instruments, expand them to fill the gaps, and design appropriate implementation and enforcement institutions, organisational systems and procedures; both at the regional level, as well as at the country level.

For instance, telecommunications and internet development are usually covered under general ICT development policy but should also be covered more comprehensively, through stand-alone policy and regulations of each area. While telecommunications development usually has comprehensive coverage, there are usually no laws and regulations of internet-based content and online media. Laws and regulations are also required for intellectual property rights as they apply to the emerging digital environment. Cyber security is also an emerging area that warrants attention.

E-government related policies, regulations and technical standards are necessary to ensure interoperability within the government, as well as to establish e-service delivery obligations of the government. In this regard, the region may consider developing an E-Government Interoperability Framework, which will, among other things, include technology policies and standards to be adopted and implemented by each Pacific island country. This will ensure technical interoperability within each country and also facilitate integration at the regional level.

In developing policies, laws and regulations, Commonwealth Pacific small states can benchmark against international best practice guidelines and standards adopted in each of the ICT application areas. Examples include UNCTAD model laws, standards and guidelines on e-commerce; National Standards for Quality Online Teaching (developed by the International Association of K-12 e-learning) and ITU E-health Standards and Interoperability, among others.

However, mere development of policies, laws and regulations is not enough. Governments need to also ensure that appropriate organisational systems, procedures and practices are in place to ensure that policies, laws and regulations are effectively implemented. Government staff and officers, including administrative managers,

judges and police personnel responsible for implementation and enforcement of the laws and regulations, should also be appropriately trained.

7.4 The way forward: Looking to 2050

Through the Framework for Pacific Regionalism, the Pacific Islands Forum Leaders have articulated the Pacific's vision, values and objectives, which the nine Commonwealth Pacific small states have committed to:

> *"Our Pacific Vision is for a region of peace, harmony, security, social inclusion and prosperity, so that all Pacific people can lead free, healthy, and productive lives."*

The Pacific's vision, values and objectives aligns well with the achievement of the Sustainable Development Goals (SDGs) by 2030, which Pacific Leaders have also committed to. The Pacific Leaders' Vision thus can be taken as the vision for 2050, with the achievement of the SDGs as the roadmap for getting there. The application of ICT is ubiquitous and cross-cutting as it will facilitate and support the achievement of the SDGs, and, in the process, fulfil the Leaders' Vision for the region.

Despite their unique challenges, Commonwealth Pacific small states have made noticeable strides in developing and adopting ICT infrastructure and technology. However, there are remaining gaps in ICT infrastructure, connectivity and applications, as well as weaknesses in the strategies, policies, and regulations in place. Addressing these gaps will be critical to take optimal advantage of the opportunities that ICTs can open up for these countries' sustainable development up until 2050. Active, systematic and long-term strategic intervention is called for to overcome the gaps and weaknesses that currently exist and to prepare these countries to dynamically absorb technologies as they develop and advance towards 2050.

7.4.1 Global ICT trends

Within the next three decades, ICT is expected to be radically different from what it is today. According to Moore's Law, the capacity of semiconductor chips doubles every 24 months, while the cost halves in the same period. Moore's Law has been validated by the developments in technology in the last two decades. Therefore, there is no reason to doubt that Moore's Law will hold in the next three decades. Much of the current research on ICT is likely to produce products and services that are unimaginable at present, while currently expensive technologies should be within the reach of most people in the years to come. The likely developments in ICT in the coming decades will have far-reaching impact on the Commonwealth Pacific small states as elsewhere in the world.

The size and cost of semiconductor chips are progressively decreasing, as their computing power increases. Current semiconductor chips are close to the size of an atom, with research now focused on quantum computing or the development of chips that use the subatomic energy states for data computations. The capacity and speed of computing, including data processing, would increase a thousandfold with quantum

computers, and these computers should be available in the coming decades. At the extreme of semiconductor research is the idea of organic computing or developing chips with organic matter rather than silicon.

In the area of telecommunications, rapid progress is being made in satellite, microwave and fibre optics technologies. By 2050, there is expected to be enormous development in satellite and related technologies, including vastly expanded bandwidth and new spectrum coding technologies that will double or triple bandwidth of existing satellites, and launch costs are likely to decline substantially. The next generations of satellite systems will usher in a new paradigm in universal and bidirectional access, including television, internet and new media. Similarly, current research point to fibre optics networks with an enormous increase in data transmission capacity per unit cost and intelligent fibre optics networks with self-configuring capabilities.

There are also advancements in database technology, where research is centred on data mining from diverse and disparate databases, automatic data tuning and database administration, and at the cutting edge, the clustering of large-scale databases. Cloud computing[15] will likely form the basis of the next major wave of technology innovation that would significantly impact human society. With the developments in cloud computing and database research, virtually all the software applications and databases in the future will exist in remote large-scale data centres in the cloud. Major IT corporations, including Google and Microsoft, are investing heavily in cloud computing.

In addition, human computer interaction and security technologies, such as voice recognition, face recognition and interactive voice, are developing fast. This should increase information security, as well as make it easier for users to interact with their computing devices.

One of the most significant developments in the technology scenario of the future can be expected to occur in the convergence of technologies. Future technologies are likely to be platform- and domain-independent with a high degree of overlap with each other. The communications, media, entertainment and ICT-based service technologies will converge with artificial intelligent agents managing them in an integrated manner. Human intervention can be expected to be minimal. The trend in convergence of technologies is already in evidence, with the very basic level of a present-day smart mobile device doing multiple tasks. This trend is likely to accelerate in the years to come.

While it is impossible at this stage to say with certainty what technologies and tools would be available by 2050, the present trends in technology research provide an indication for the future. It can be said with a high degree of probability that 2050 will likely be characterised by high-speed data transmission networks, large-scale remote data centres housing both databases and applications, data processing in computing devices at mind-boggling speeds, which are likely to be integrated with other personal devices, and the proliferation of voice-based and visual human computer interaction. In such a technology scenario, what looks impossible today may be routine in 2050.

In order to take advantage of the opportunities of both current and future technologies, Commonwealth Pacific small states must address the gaps and weaknesses in their existing ICT ecosystems. Necessary changes need to be made today to facilitate dynamic adoption and absorption of technologies as they emerge in the years and decades to come.

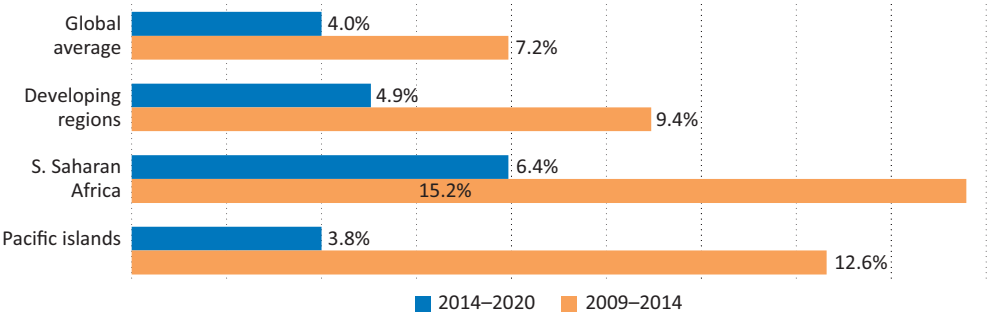
7.4.2 Regional ICT trends

In the last five years, Pacific islands have witnessed a high and robust growth in mobile penetration. The 2015 GSMA Mobile Intelligence Report stated that the Pacific islands recorded relatively rapid unique subscriber growth, reaching 4 million in 2014, up from 2.3 million in 2009, a compound annual growth rate of 12 per cent, which is well ahead of the global and developing region average (Figure 7.7). However, in the years to 2020 growth is expected to slow significantly to 3.8 per cent, largely due to difficulties in extending connectivity to the outlying regions and islands, and the challenge of affordability in a region with widespread poverty. The annual mobile growth expected in the years to 2020 will be below the global and developing region average (GSMA 2015).

Although some of the countries in the region have adopted 3G technology for mobile connectivity, 2G currently remains the dominant technology. This situation is expected to change significantly as 3G and 4G broadband technologies are adopted (Figure 7.8). The GSMA Mobile Intelligence Report 2015 estimates that the majority of the mobile connections in the Pacific islands would be broadband in the next five years. By 2020, the share of 3G and 4G would rise to 30 and 18 per cent, respectively. However, compared to the average growth of developing countries, the Pacific islands will lag behind to some extent.

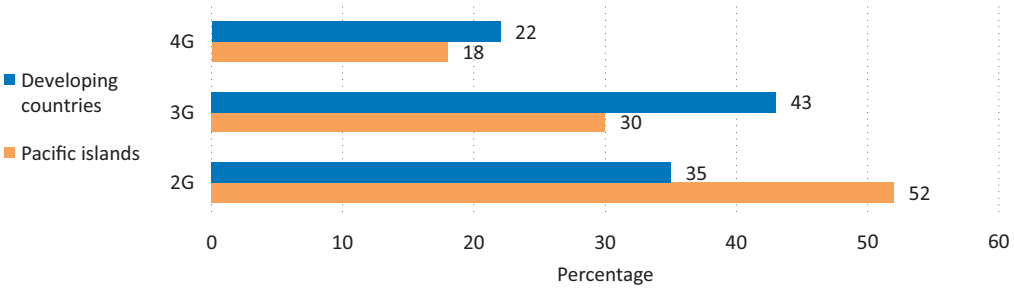
The growth of 4G is expected to be significant, rising from only 1 per cent of the total mobile subscriptions in 2014 to nearly 20 per cent by 2020. However, 4G penetration is expected to be dominated by just two countries in the region – Fiji and PNG. For example, by 2020, 4G subscriptions are expected to overtake 3G subscriptions in Fiji, accounting for 38 per cent of the regional 4G connections.

Figure 7.7 Annual mobile growth to 2020



Source: GSM Mobile Intelligence Pacific Report 2015

Figure 7.8 Mobile broadband connectivity to 2020



Source: GSM Mobile Intelligence Pacific Report 2015

Smartphone penetration in the region is also showing an increasing trend. The GSMA Mobile Intelligence Report 2015 estimates that by 2020, there will be 4.9 million smartphone connections, up from only 1.3 million at the end of 2014.

On the whole, the mobile ecosystem is fast developing and expanding in the Pacific island countries, contributing significantly to the economy and social well-being of the region. The GSMA Mobile Intelligence Report estimates that in 2014, the mobile technology sector contributed US$1.8 billion in value added terms, a contribution of approximately 4.7 per cent of the region's GDP, and provided employment to over 27,000 people in Pacific island countries. Going forward, the social and economic impact of the mobile technology is forecast to increase significantly in the years to come. The GSMA Report projected that by the year 2020, the contribution of the mobile industry to Pacific island countries' economies would increase to 6.2 per cent of GDP.

These trends to 2020 give an idea of the trends likely towards 2050.

7.5 Recommendations

The Commonwealth Pacific small states have made significant progress in the development of ICT and connectivity infrastructure, ICT diffusion and usage, ICT applications and policies, laws and regulations. However, there are many gaps and weaknesses in the policies, legal and regulatory environment and technology ecosystem of the region that need to be addressed, including on cyber security. Similarly, the application of ICT for governance, social and economic development, delivery of public services, business, education and health, and indeed for disaster risk reduction, appears to be expanding. However, the development of ICT application and systems in the region has been largely ad hoc and piecemeal, which means there is a need for more systematic and holistic planning and deployment. These challenges are currently being addressed by a refreshed regional ICT initiative, spearheaded by USP through the CROP ICT Working Group. The following recommendations, therefore, are focused on a few critical areas that can still be considered to prepare the region for a technology-driven knowledge-based society in 2050.

7.5.1 Integrated approach to ICT infrastructure & services development

The gaps in ICT connectivity infrastructure, consisting of large areas of the region either disconnected or with telecom and internet services of lower quality and bandwidth, often at prices that a large proportion of people cannot afford, can best be addressed by a mix of communications technologies. Thus, it will be important to develop and expand connectivity infrastructure by a strategic mix of communication technologies, including rolling out integrated end-to-end connectivity and service projects in partnership with private sector operators, while ensuring universal services to all parts of the region and fair profits to private sector partners.

There is a universal trend among telecom operators, as with other IT service providers, to vertically integrate their services and to expand the mix of their services as their margins in their traditional business fall. For instance, telecom companies provide value added services to supplement their telecom revenues. In the years and decades to come, this trend is likely to increase. As service providers are made responsible for the provision of end-to-end services, private operators may be more willing to establish infrastructure even in areas of low profitability, since revenue and profits would be generated in multiple services and products that use the established infrastructure.

7.5.2 Regional E-Government Resource Centre

In order to effectively develop e-government policies and standards, including e-government interoperability frameworks, technical standards and guidelines for adoption at the national level, it is recommended that a Regional E-Government Resource Centre is established. The Centre could also provide skills development and advisory services to national governments. In addition, it could complement or be integrated with the work of USP's Pacific Islands Centre for Public Administration.

E-government development should be viewed as a government reform programme rather than a mere digitising and software systems exercise. Its development should be holistic and should strategically cover all its technical and non-technical key result areas as defined in the e-government development framework.

7.5.3 Scaling up and replication of ICT application

ICT application development and optimisation should largely remain national but with regional support where required. In developing ICT applications, including e-government, e-education and e-health, among other areas, the guiding principle should be optimisation of such applications to the needs of the country or the region following a holistic and integrative approach. There are currently many good initiatives across the Commonwealth Pacific small states that should be scaled up and replicated, such as Fiji's GOVNET (e-Government) and cyber security approaches (ICT strategies, policies & regulations), the multipurpose early warning system piloted in Tonga (ICT in climate change, disaster risk reduction and management), USP Net (e-education), Pacific telemedicine project (e-health) and E-Business Pacific (e-business). It is also recommended that an ICT Innovation Fund is established to

provide grants for ICT research and prizes for ICT innovations by individuals and institutions. More importantly, the fund will technically and financially support the commercialisation of regionally and/or nationally developed innovative ICT products and services.

Notes

1 This chapter benefited from valuable comments from the University of the South Pacific (Ian Thompson, Kisione Finau) and the Commonwealth Secretariat (Anthony Ming, Resina Katafono and Denny Lewis-Bynoe).
2 Satellite communication systems are subject to international agreements and regulations. The International Telecommunication Union regulates frequency use and defines 'bands'. The C band is the first frequency band to be used for satellite communication.
3 WiMAX (Worldwide Interoperability for Microwave Access) is a family of wireless communication standards, which provide last mile connectivity as an alternative to cable and digital subscriber line.
4 SEE Project 2014; TRR (2014);Triesten Technologies 2009; OLPC Vanuatu (see http://wiki.laptop.org/go/OLPC_Vanuatu).
5 *Ibid.*
6 See http://www.wpro.who.int/southpacific/programmes/pacific_initiatives/polhn/en/
7 See www.mindpearl.com
8 See www.ebusinessfiji.com
9 Source: ITU website, http://www.itu.int/ITU-D/projects/ITU_EC_ACP/icb4pis/index.html.
10 USP (2009), USP Japan-Pacific ICT Centre. 1st PacCERT Working Group Meeting, 25 November 2009.
11 See https://www.o3bnetworks.com/
12 Big data analytics tools and data-based predictive technologies can be employed to process large volumes of data on different variables such as temperature change, sea levels, forest cover and cover emissions to develop predictive scenarios of the situation based on different assumptions in order to provide insight to decision-makers and leaders and assist national and regional planning. Recently, UN Global Pulse launched a Big Data Climate Challenge to crowdsource projects that use big data to address the economic dimensions of climate change. http://fortune.com/2014/06/23/big-data-climate-change-map-sea-levels/
13 Nearshoring refers to the transfer of backend operations to offshore locations which are located nearby.
14 Offshoring refers to transfer of backend operations to overseas locations which may or may not be nearby.
15 Cloud computing refers to the practice of using a network of remote servers hosted on the internet to store, manage and process data, rather than a local server or a personal computer.

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