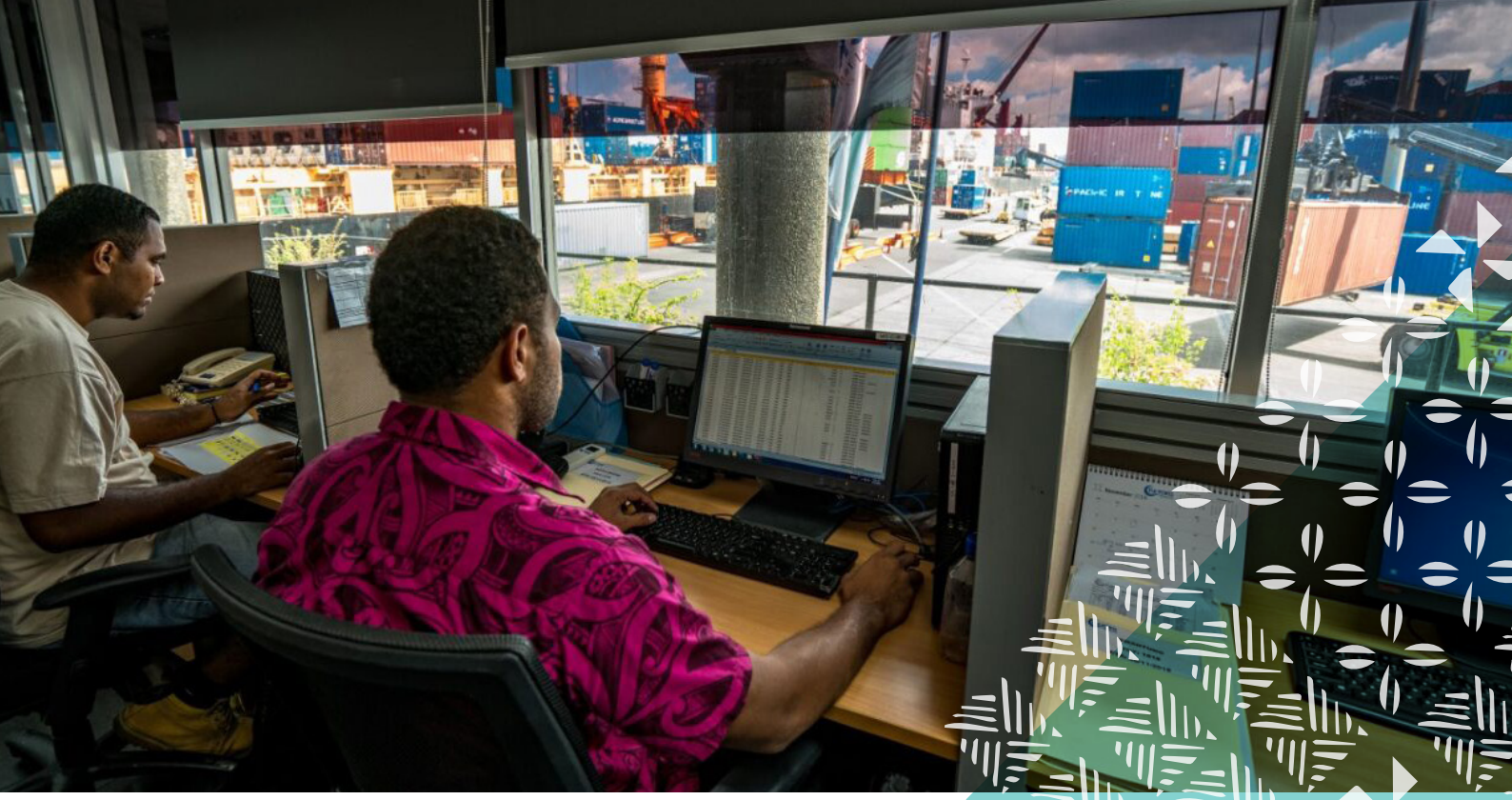

Regional Interventions to Strengthen Digital Readiness and Resilience

in Pacific Island Countries

Pacific Region Infrastructure Facility

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PRIF Coordination Office
c/o Asian Development Bank
Level 12, FHL Tower,
Corner of Gordon St and Thurston St,
Suva, Fiji

Phone: +679 3318101
Email: enquiries@theprif.org
Website: www.theprif.org

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Abbreviations

cm	Centimeters
ENSO	El Niño Southern Oscillation
GNSS	Global navigation satellite system
GPS	Global positioning system
H	Critical water depth
Hs	Significant wave height
IG	Infragravity (waves)
LiDAR	Light detection and ranging
m	Meters
mb	Millibar (unit of atmospheric pressure)
mm	Millimeters
NbS	Nature-based solutions
PIC	Pacific island country
RTK	Real-time kinematic
SSP	Shared Socioeconomic Pathway
UAV	Unmanned aerial vehicle
WACOP	Changing Waves and Coasts in the Pacific (project)

1. Executive Summary

The Pacific Region Infrastructure Facility (PRIF) has engaged Dr. Paul Twomey and Professor Patrick Sharry of Argo Pacific to conduct a significant technical assistance project titled "Regional Interventions to Strengthen Digital Readiness and Resilience in Pacific Island Countries" (TA-10214 REG). This initiative aims to identify common Information and Communication Technology (ICT) infrastructure challenges across Pacific Island Countries (PICs) and recommend high-priority regional interventions that could strengthen digital readiness and resilience.

The project responds to a critical regional need. While Pacific Island nations have made notable progress in implementing digital infrastructure and regulatory reforms, the region faces unique challenges due to geographic isolation, vulnerability to natural disasters, and limited resources. Economic growth in PICs has historically lagged behind other developing regions, with per capita income significantly lower than comparable small island states in other regions. Foreign assistance plays a disproportionately large role in the Pacific economy, with substantial investment (nearly $1.2 billion since 2014) directed toward communications infrastructure.

1.1 Project Objectives and Approach

The purpose of this technical assistance (TA) project is to leverage the capacity and capability that has been (or soon will be) delivered by international connectivity to identify a prioritized short list of regional projects that will maximize the overall benefit of ICT across the Pacific Island countries. The primary objectives are to:

1. Identify common challenges where regional solutions may be appropriate
2. Identify options and shortlist best prospects
3. Work with regional stakeholders to validate challenges, options, and prospects, and identify next steps

The report adopts a systems approach to address this complex challenge, recognizing that the digital environment is fast-moving with new technologies, opportunities, and risks continuously emerging. A detailed exploration of the impact of system dynamics in ICT can be found at Annex One. This project does not start from a blank slate but builds on a decade of significant investment in digital infrastructure in the Pacific and related research.

Their approach is shaped by three important inputs:

- Identifying what has been achieved through previous interventions
- Mapping the ecosystem to understand connections between investments and outcomes
- Working with stakeholders to identify potential projects that might drive the next tranche of value

The report maps the interconnected nature of:

1. Connectivity and data infrastructure (international and domestic connectivity, data infrastructure)
2. Protocol and standards infrastructure (DNS management, digital public infrastructure)
3. Enabling regulation (modernized telecommunications regulations, data protection, cybersecurity frameworks)
4. Public and private sector digitization (government services, digital entrepreneurship)
5. Cross-cutting elements (security and skills development)

Further the report shows how these ICT features contribute to economic outcomes and whole of government policy objectives. Annex Two provides a literature review of how ICT investment contributes to economic development, particularly in the Pacific.

This systems view recognizes that successful digital transformation requires understanding how different components interact and identifying strategic intervention points where modest investments can trigger outsized positive effects across the entire ecosystem.

The report asses the current state of digital development across the Pacific, combining quantitative data analysis with qualitative stakeholder input to create a comprehensive understanding of the digital landscape. This identifies critical gaps in the ecosystem.

The ecosystem mapping component represents the digital economy as an interconnected system with multiple layers, creating a foundation for identifying dependencies and leverage points. This mapping enables the visualization of both vertical dependencies (where one layer enables the next) and horizontal interconnections (where elements within a layer interact), providing a comprehensive view of the entire digital ecosystem.

The quantitative investment flow analysis examines historical investment patterns to identify imbalances and gaps in funding allocation. By categorizing investments according to the ecosystem mapping framework, the analysis reveals significant concentrations in physical infrastructure, alongside minimal investments in protocol standards, enabling regulation, and supporting ecosystem development.

The status assessment employs a systematic evaluation of each ecosystem component using a four-tier classification system. Components assessed as "red" indicate significant problems needing dedicated attention due to fundamental gaps or critical barriers. "Orange" components have some effort underway but require substantially more resources, while "yellow" indicates problem-solving is underway but needs continued support. "Green" components are those where problems have been largely addressed, though ongoing investment and maintenance may be required.

1.2 Consultation and Stakeholder Engagement

The research team has conducted extensive stakeholder consultation, including:

- Presentations and participation at the Wellington Forum of the Pacific Internet Multistakeholder Forum
- Engagement with representatives at PRIF week
- Consultation at the Data X Pacific Blue conference
- Discussions with participants at PITA week and other regional cable infrastructure events
- Reviews of published reports by international organizations (ADB, World Bank, UNESCO, UNDP, USAID, ITU, UN ESCAP, Commonwealth Secretariat, UNCTAD and others)
- Survey of present and proposed ODA projects in Pacific Island Countries compiled by the OECD, several donor countries, the Asian Development Bank, World Bank and regional Internet Community.

Throughout March 2025, Dr. Twomey held detailed briefings with representatives from key stakeholder departments, including connectivity and infrastructure policy branches and cyber security teams. The analysis and outcomes of the report were shared with Pacific Island ICT officials, country code operators, Internet Service Providers (ISPs), academics and civil society at the Pacific Island Multistakeholder Forum and the Pacific Internet Governance Forum held consecutively in Apia, Samoa in June 2025.

1.3 Key Findings and Gap Analysis

The analysis has identified several critical gaps in the region's digital ecosystem:

1. **Domestic Connectivity:** While submarine cable investments have improved international connectivity, domestic connectivity remains challenging, with approximately 18% of Pacific Islanders lacking access to local connectivity, and 59% not using existing mobile connectivity.
2. **Data Infrastructure:** Limited consensus exists on cloud infrastructure approaches, with some nations preferring national solutions while others see benefits in regional approaches.
3. **Protocol Management:** Significant underinvestment in ccTLD operations and domain name infrastructure creates security vulnerabilities and limits local digital ecosystem and economy development.
4. **Enabling Regulation:** A substantial regulatory bottleneck exists across areas including cybersecurity frameworks, digital payments, and central bank policies on fintech.
5. **Digital Public Infrastructure:** The benefits of digital identity and delivery of services (government and private) are increasingly appreciated across PIC governments. But the consequences for domestic, regional or a hybrid model of adoption have not been fully explored. This discussion is necessary to ensure the optimisation of ODA investment.

1.4 Five Proposed Regional Interventions

Based on the analysis, the report identifies five high-potential regional interventions that target critical leverage points within the digital ecosystem. Each proposal includes comprehensive information on background, objectives, implementation approach, resource requirements, and expected outcomes.

The **Pacific ccTLD Registry Local Infrastructure and Digital Economy project** addresses the fundamental need for robust, secure, and locally managed country code Top-Level Domain (ccTLD) registry infrastructure. The proposal outlines a comprehensive approach combining physical infrastructure investments with capacity building and regional cooperation. The physical infrastructure component centers on a standardized "DNS in a Shed" platform including DNS servers, registry databases, backup systems, and Internet Exchange Points. This is complemented by extensive capacity building through technical training programs and business ecosystem development activities. The project would deliver multiple benefits including improved domain name accessibility, reduced dependency on offshore infrastructure, enhanced disaster resilience, and the development of local digital service ecosystems.

The **Pacific Cyber Health Monitoring and Measurement Initiative** aims to ensure that ISPs and ccTLD registry operators follow security best practices through systematic monitoring and measurement. Drawing on public health methodologies, this initiative would establish standardized metrics, data collection frameworks, and analytics dashboards to track cybersecurity posture across Pacific Island nations. The project includes comprehensive measurement infrastructure to collect data on cybersecurity practices, an analytics platform to transform this data into actionable intelligence, enhanced DNS abuse management processes, and extensive mitigation and capacity building components. This systematic approach would significantly improve the security posture of Pacific networks while building sustainable local capabilities for ongoing security management.

The **Multistakeholder Initiative for Local Community Connectivity** addresses the challenge of last-mile connectivity in remote areas through community-driven approaches. This project recognizes that connectivity challenges in remote Pacific communities require solutions that extend beyond purely technical or commercial considerations. The initiative would develop sustainable models that consider cultural factors related to land access and community engagement, skills development at the local level, appropriate technology solutions,

and community ownership structures. This multistakeholder approach engages communities as active participants rather than passive recipients, creating models that can be replicated across thousands of villages throughout the Pacific.

The **Augmented Legal Advisory and Legislative Drafting Support Project provides** intensive legal assistance to address the regulatory bottlenecks that currently impede digital economy development. This 12-month project would provide expert legal advisory and legislative drafting assistance to local Attorneys General, working closely with the Commonwealth Secretariat to develop regional legislative templates while providing direct support for country-specific adaptation. The project would assist with modernizing telecommunications regulations and support the development of frameworks for data protection, digital identity, electronic transactions, and FinTech. This targeted intervention recognizes that enabling regulation represents a critical prerequisite for digital economy development but requires specialized expertise that may not be readily available within government legal services in smaller nations.

The **Regional Digital Public Infrastructure Assessment** would determine where regional approaches to Digital Public Infrastructure (DPI) would be beneficial, balancing national sovereignty concerns with the potential efficiency gains of regional solutions. This strategic review would evaluate potential for regional approaches to digital payments, shared identity systems or interoperability standards, regulatory harmonization, and service areas where regional scale offers significant advantages. The assessment would help guide future investments by identifying where national approaches are essential for sovereignty and where regional coordination might deliver better outcomes due to economies of scale.

1.5 Expected Outcomes and Benefits

The proposed projects would significantly enhance digital sovereignty across the Pacific region by giving nations greater control over their digital assets and infrastructure. Local management of domain registries, improved security practices, and appropriate regulatory frameworks would reduce dependency on external systems while preserving distinctive national digital identities.

Improved disaster resilience represents another critical benefit, particularly in a region prone to cyclones, earthquakes, and other natural disasters. With properly designed local infrastructure, internal communications could continue functioning even during international connectivity disruptions, providing crucial resilience during crises. This capability would transform the internet from a vulnerability during disasters to a valuable tool for coordination and recovery.

The interventions would drive economic growth by creating new opportunities for businesses through improved digital infrastructure and enabling frameworks. Local businesses would benefit from more affordable and accessible domain names, enhanced security for digital transactions, improved connectivity in underserved areas, and clear regulatory frameworks for digital operations. These improvements would support the development of e-commerce, digital services, and other innovative business models appropriate to the Pacific context.

Perhaps most importantly, the proposed interventions would maximize returns on existing infrastructure investments by addressing the critical middle-layer gaps that currently prevent the full realization of benefits from submarine cable connectivity. By creating the necessary enabling environments, regulatory frameworks, and human capabilities, these projects would unlock further the potential of previous investments while creating foundations for sustainable digital development.

2. Overseas Development Assistance ICT Investment in Pacific Island Countries

2.1 Overview of ICT Investment in ICT

Since 2014, nearly USD $1.2 billion has been granted to Pacific Island Countries specifically for communications and digital infrastructure development. This significant investment reflects growing recognition of digital connectivity as a key economic growth driver in the region.

2.1.1 Distribution by Country

Analysis of funding allocation reveals that while the larger countries receive the highest absolute amounts, smaller nations benefit disproportionately on a per-capita basis:

- **Papua New Guinea** has received the largest total allocation at approximately $426 million, representing nearly 38% of all regional ICT investment
- **Solomon Islands** ranks second with $170.7 million
- **Kiribati** has secured $109.2 million despite its relatively small population
- **Fiji**, despite being a regional hub, has received only $11.8 million, reflecting potentially different priorities or funding sources

The data also indicates approximately $30.6 million has been allocated to regional initiatives that span multiple countries, supporting cross-border digital integration efforts. Details are in the table below.

Table 1: Communications Funding 2014-2024 – Transaction value (current $US)

Location	Total Funding	Population[a]	Per Capita Funding
Cook Islands	$40,026,031	15,539	$2,575.84
Fiji	$11,812,330	907,363	$13.02
Kiribati	$109,187,017	126,745	$861.47
Marshall Islands	$31,453,898	54,294	$579.33
Federated States of Micronesia	$52,680,155	106,367	$495.27
Nauru	$15,937,790	12,111	$1,315.98
Niue	$14,177,201	1,486	$9,540.51
Palau	$48,421,920	17,996	$2,690.70
Papua New Guinea	$510,257,597	9,690,196	$52.66
Regional Initiatives	$30,556,271	N/A	N/A
Samoa	$41,037,570	203,158	$202.00
Solomon Islands	$170,710,222	778,472	$219.29
Tonga	$3,040,435	98,775	$30.78
Tuvalu	$86,797,362	10,955	$7,923.08
Vanuatu	$22,068,345	322,409	$68.66
	$1,118,164,145	**12,344,866**	

[a] Mid-2024 estimate, Pacific Data Hub
Source: OECD, DFAT, PIFM community survey, Pacific Data Hub.

2.2 Investment Distribution Patterns

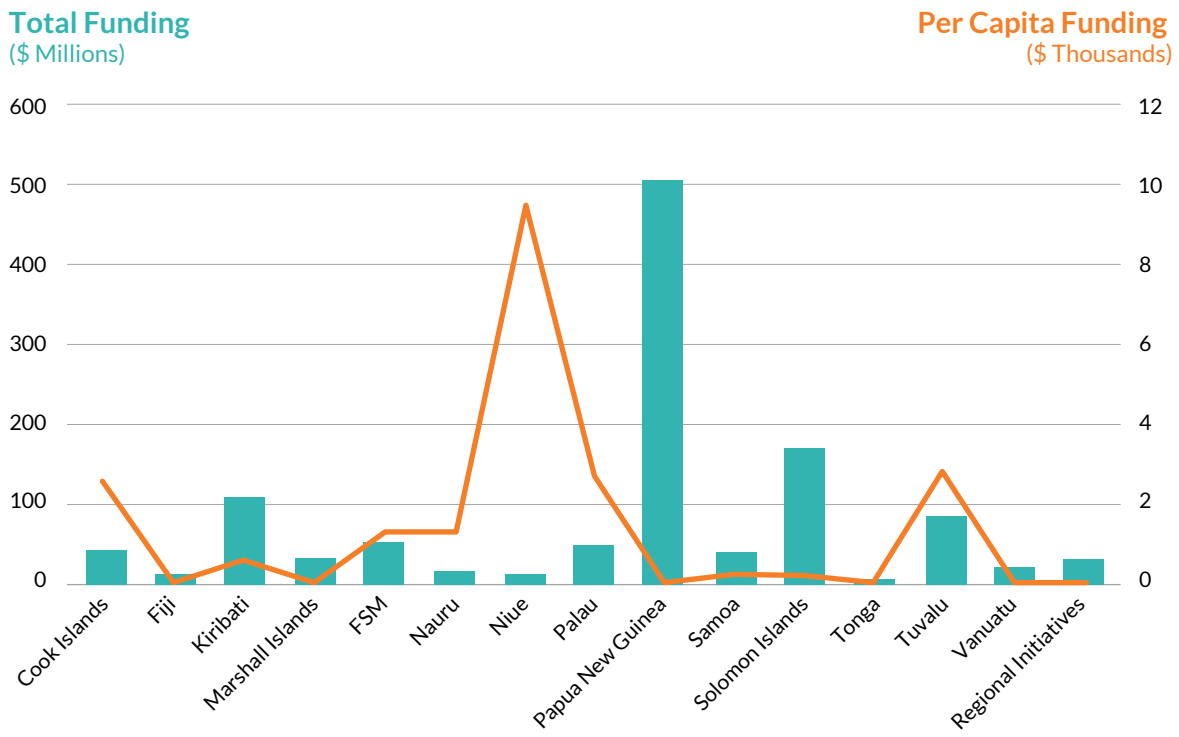
The investment distribution shows notable patterns:

- **High variation in per capita funding:** Smaller islands receive substantially higher per capita investment (Niue: $9,540, Tuvalu: $7,923, Palau: $2,690) compared to larger nations like Fiji ($13) and PNG ($53)
- **Cable investments drive disparities:** Submarine cable projects connecting small population centers naturally create high per capita investment figures
- **Geographic challenges persist:** Despite significant investment, the region's remoteness, dispersed populations, and climate vulnerability continue to impact implementation and sustainability

As noted earlier, economic impact studies validate these investments, with research showing measurable economic growth correlation with ICT investment in Pacific economies.

Investment Distribution is illustrated in the following chart.

Figure 1: ODA Funding for Communications 2014-24
Cables to small countries drive related high-levels of per capita investment



Source: OECD, PIFM community survey, Pacific Data Hub

2.3 Investment Focus Areas

Our analysis reveals three primary focus areas for donor funding in the Pacific ICT sector:

2.3.1 Connectivity & Data Infrastructure (Over $950 million)

- **International Connectivity:** Approximately $450 million allocated to submarine cable systems connecting islands to global networks
- **Domestic Connectivity:** Around $500 million for in-country networks, particularly addressing remote community access
- **Data Infrastructure:** Emerging investment in cloud services, content delivery networks (CDNs), and environmental sensor networks
- **Key challenge:** Electricity supply reliability remains a significant constraint, particularly in remote communities

2.3.2 Security Infrastructure (Over $58 million)

- **National and enterprise security systems:** Focus on government and critical infrastructure protection
- **Network security:** Building capacity for ISPs and telecommunications providers
- **Cyber health monitoring:** Public-facing network infrastructure security assessment
- **Consumer security:** Growing recognition of end-user security needs

2.3.3 Digitization of Public Sectors (Est. $420+ million)

Calculation Methodology for Public Sector Digitization Investment Estimate

The $420 million estimate for digitization of public sectors was derived using a proportional allocation methodology based on broader public sector investment data. According to the documentation:

- The estimate assumes approximately 10% of the $4,199 million total investment for public sector policy development and related research has been allocated to digital components (source: OECD).
- This calculation excludes education and training investments
- The estimation is supported by ADB reporting that "nearly half of new projects in 2023 included a digital component"

This methodology acknowledges the challenge in isolating specific digital transformation components within broader public sector reform initiatives. The 10% allocation figure represents a conservative estimate based on observed patterns in project documentation and stakeholder consultations.

Patterns of Digitization Investment

Current assessment indicates that while significant investment has occurred in government service digitization, including substantial software development components, there remain gaps in enabling regulatory frameworks, particularly around digital IDs, payment systems, and data sharing. Progress is also hampered by central bank policy uncertainties regarding mobile financial services in several Pacific nations.

3. System Dynamics of ICT Investment in Pacific Island Countries: Component Interactions and Economic and Strategic Outcomes

The Pacific Islands region represents a unique environment for information and communications technology (ICT) development, characterized by geographic isolation, small population sizes, vulnerability to natural disasters, and varying levels of economic development. While substantial investments have been made in telecommunications infrastructure—particularly submarine cables connecting many islands to the global internet—these physical connections alone are insufficient to develop thriving local digital economies.

This analysis examines the system dynamics of ICT investment in Pacific Island Countries (PICs), focusing on how various components interact with and reinforce each other to contribute to broader economic and strategic goals. The framework identifies key intervention points where targeted investments can create multiplicative effects across the digital ecosystem while addressing critical gaps in current infrastructure and capabilities.

3.1 The ICT System Dynamics Framework

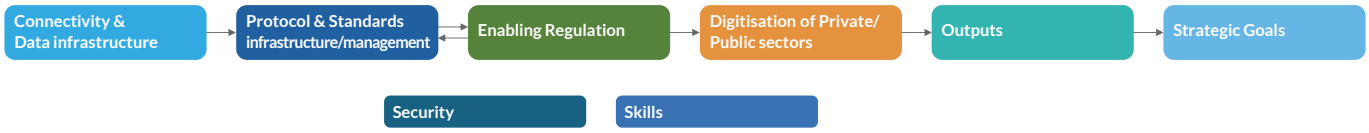
The ICT system in Pacific Island Countries functions as an interconnected ecosystem where investments in foundational components enable the development of more sophisticated digital services and capabilities. This progressive development pathway can be conceptualized as a series of building blocks, each dependent on the preceding components and enabling those that follow:

1. **Connectivity & Data Infrastructure** - The foundational physical components
2. **Protocol & Standards Infrastructure/Management** - The governance and technical standards layer
3. **Enabling Regulation** - The legal and policy frameworks
4. **Digitization of Private/Public Sectors** - The application and adoption layer
5. **Outputs** - The economic and social benefits
6. **Strategic Goals** - The ultimate national development objectives

Supporting these progressive components are two cross-cutting capabilities that underpin the entire system:

- **Security** - Protection of digital assets, services, and users
- **Skills** - Human capabilities needed at various levels of specialization

Figure 2: ICT System Dynamics Framework



The framework illustrates how investment in each step contributes to the attainment of the next, creating a developmental cascade that ultimately delivers economic and social benefits. Through this lens, we can better understand how specific investments contribute to national development goals and where critical gaps exist in the current digital ecosystem.

3.2 Connectivity and Data Infrastructure

3.2.1 International Connectivity

Submarine cables now connect many Pacific Island nations to the global internet, dramatically increasing bandwidth capacity and reducing costs compared to satellite-only connections. However, these connections face significant vulnerabilities:

Redundancy & Climate Resiliency: Most PICs rely on single submarine cables without adequate backup systems, creating significant vulnerability. When these cables are damaged—as occurred in Tonga following the 2022 volcanic eruption—entire countries can lose external connectivity for extended periods. Climate change exacerbates these risks through increased frequency and severity of extreme weather events that can damage landing stations and related infrastructure.

Cable Repairs: The remote location of Pacific islands creates significant challenges for cable repair operations. The closest cable repair vessels are often stationed thousands of kilometers away, resulting in repair times measured in weeks or months rather than days. This extended repair time amplifies the economic impact of outages, with some estimates suggesting losses of 3-5% of annual GDP during major disruptions.

3.2.2 Domestic Connectivity

While international cables address external connectivity, many Pacific nations still face challenges with internal communications infrastructure:

Redundancy & Climate Resiliency: Domestic network infrastructure often has limited redundancy and faces high exposure to climate-related events. Communications towers on vulnerable coastlines, equipment in flood-prone areas, and lack of backup systems create significant operational risks.

Electricity Supply: Power supply reliability remains a fundamental challenge for digital infrastructure. Intermittent electricity in many areas, particularly on outer islands, limits the effectiveness of communications equipment and increases operating costs through reliance on diesel generators and other backup systems.

Geographic Coverage: A significant digital divide exists between urban centers and remote communities. While towns and cities increasingly enjoy reliable broadband access, remote and rural areas often have limited or no connectivity, widening socioeconomic disparities.

3.2.3 Data Infrastructure

Beyond connectivity, data infrastructure represents a growing area of importance:

Cloud Infrastructure: Most Pacific nations rely on overseas cloud services, creating latency issues, higher costs, and potential sovereignty concerns. Decisions about cloud strategy—whether to develop local capacity, regional hubs, or rely on international providers—have significant economic implications.

Distributed Content Delivery: The distribution of content and services within networks significantly impacts user experience and bandwidth utilization. Content Delivery Networks (CDNs) remain underdeveloped in most PICs, resulting in inefficient use of expensive international bandwidth.

Environmental Sensor Networks: Climate monitoring and early warning systems increasingly rely on networked sensors, creating additional infrastructure requirements and opportunities for data-driven resilience planning.

3.3 Protocol and Standards Infrastructure/ Management

This critical layer of the ICT system establishes the governance frameworks and technical standards that enable effective digital services and operations.

3.3.1 DNS and ccTLD Management

Country Code Top-Level Domains (ccTLDs) represent a crucial component of digital sovereignty and national identity online. However, most Pacific ccTLDs operate at very small scales (fewer than 10,000 domains per country) and face significant challenges:

Infrastructure Challenges: Many Pacific ccTLD registries operate with minimal technical infrastructure, often lacking redundancy, security features like DNSSEC, and integration with global DNS systems. This limited infrastructure reduces reliability and increases vulnerability to outages and attacks.

Business Operations Issues: Manual registration processes, high costs, and limited payment options create significant barriers to adoption. While registering a .com domain takes minutes and costs under $10, some Pacific ccTLDs require paperwork, in-person visits, and fees ranging from hundreds to thousands of dollars.

Registrar/Services Ecosystem Limitations: The lack of a developed ecosystem of registrars and service providers limits innovation and accessibility. Without integration with popular global platforms (like Wix, Shopify, Google Workspace), local domains remain technically challenging to use, pushing businesses toward international alternatives.

3.3.2 Digital Public Infrastructure

The concept of "Digital Public Infrastructure" (DPI) has emerged as a critical framework for developing foundational digital systems that enable wider economic participation:

Digital ID & Sign-on: Secure, interoperable digital identity systems provide the foundation for government services, financial inclusion, and trusted online transactions. Many Pacific nations are in early stages of digital ID development, with significant technical and policy decisions ahead.

Digital Payments: Electronic payment systems, mobile money platforms, and banking interfaces represent critical infrastructure for e-commerce and financial inclusion. The regulatory and technical architecture of these systems significantly impacts their accessibility and effectiveness.

Data Sharing Standards: Frameworks for secure, permissioned data sharing between government agencies and with the private sector enable more efficient service delivery and innovation. These standards involve complex privacy, security, and interoperability considerations.

3.4 Enabling Regulation

The regulatory environment provides the legal and policy frameworks that shape digital development, influencing both investment decisions and adoption patterns.

Modernizing Telecoms Regulations: Many Pacific nations operate under telecommunications regulatory frameworks designed for monopoly fixed-line services rather than competitive, multi-service digital environments. Updating these regulations, including their application to Low Earth Orbit (LEO) satellite services, represents a critical prerequisite for market development.

Data Protection & Cross-Border Flows: Balancing data protection with enabling cross-border data flows

presents significant regulatory challenges. Frameworks must protect citizen privacy while avoiding isolation from global digital services and economies.

Cybersecurity Frameworks: National cybersecurity strategies and legal frameworks establish responsibilities, capabilities, and protocols for protecting critical infrastructure and responding to incidents. These frameworks require regular updating to address emerging threats.

Financial Technology Regulation: Regulations governing electronic transactions, taxation, FinTech innovations, and regulatory sandboxes significantly impact digital commerce development. Central bank policies on mobile money and digital financial services particularly influence adoption patterns and business models.

Consumer Protection, Intellectual Property, and Competition Policy: These complementary regulatory domains establish the trust and fairness necessary for thriving digital ecosystems. Without adequate protections, consumers and businesses may be reluctant to participate in digital commerce.

3.5 Digitization of Private/Public Sectors

With foundational infrastructure and regulatory frameworks in place, the actual digitization of organizations and services can advance:

Government Services: Digital government initiatives improve service delivery while reducing costs, though implementation challenges remain substantial. Interoperability between agencies, integration with identity systems, and maintenance of legacy systems all present significant technical and organizational obstacles.

Digital Entrepreneurship: Support for technology startups and digital business models varies significantly across the region. Access to capital, technical expertise, and appropriate regulatory environments all influence entrepreneurial growth.

Education: Digital transformation in education encompasses infrastructure in schools, digital skills development, and adaptation of curriculum. The COVID-19 pandemic highlighted both the necessity and challenges of digital education in Pacific contexts.

SME and Consumer Adoption: The largest gap in many digital strategies involves helping ordinary businesses and citizens effectively leverage digital tools. Advisory services that support adoption by small enterprises and consumers represent a critical but often overlooked component of digital transformation.

3.6 Economic Outputs

The investments across these layers collectively contribute to measurable economic outcomes:

Productivity Improvement: Digital technologies enable more efficient business operations, government services, and resource utilization. These efficiency gains translate directly into economic output while often reducing environmental impacts.

Employment Growth: The digital sector creates direct employment in ICT services while enabling job creation in digitally-enhanced traditional sectors. Without appropriate skills development, however, these employment benefits may accrue primarily to urban areas and higher-skilled workers.

Trade Growth: Digital connectivity enables new export opportunities in services, tourism, and niche products. E-commerce platforms can help overcome traditional barriers of distance and scale faced by Pacific exporters.

GEDI Outcomes: Gender, Equity, Disability, and Inclusion outcomes represent critical measures of how digital benefits are distributed. Intentional policies and designs are necessary to ensure that digital transformation reduces rather than reinforces existing inequalities.

3.7 Strategic Goals

These economic outputs ultimately contribute to broader national development objectives:

Economic Growth: Digital transformation can drive inclusive economic growth through new business models, enhanced productivity, and improved access to markets and services. This growth potential is particularly significant for geographically isolated economies.

Well-being: Digital technologies can enhance well-being through improved healthcare access, education opportunities, social connectivity, and cultural expression. The relationship between digital technology and well-being, however, depends significantly on how technologies are deployed and governed.

Climate Change Resilience: Digital systems play an increasingly important role in climate resilience through improved early warning systems, more efficient resource management, and enhanced coordination during disasters. When properly designed, local digital infrastructure can maintain critical communications even when international connections are disrupted.

3.8 Cross-Cutting Foundations: Security and Skills

Two critical capabilities underpin the entire digital ecosystem:

3.8.1 Security

Network Security: Protection of core network infrastructure remains a fundamental requirement for stable digital operations. Without adequate security, all services built on this infrastructure remain vulnerable.

National/Regional Cyber Public Health: Beyond traditional cybersecurity approaches, a "public health" perspective examines network-level patterns and interventions. This approach complements enterprise-focused cybersecurity by addressing ecosystem-wide vulnerabilities and threats.

National/Enterprise Cybersecurity: Traditional cybersecurity focuses on protecting specific organizations and systems from attacks. In resource-constrained environments like most PICs, pragmatic approaches that prioritize critical assets and capabilities are essential.

SME/Consumer Security: Small businesses and individuals often lack the resources and expertise for sophisticated security measures. Simplified tools, guidance, and support services adapted to Pacific contexts can help address these vulnerabilities.

3.8.2 Skills

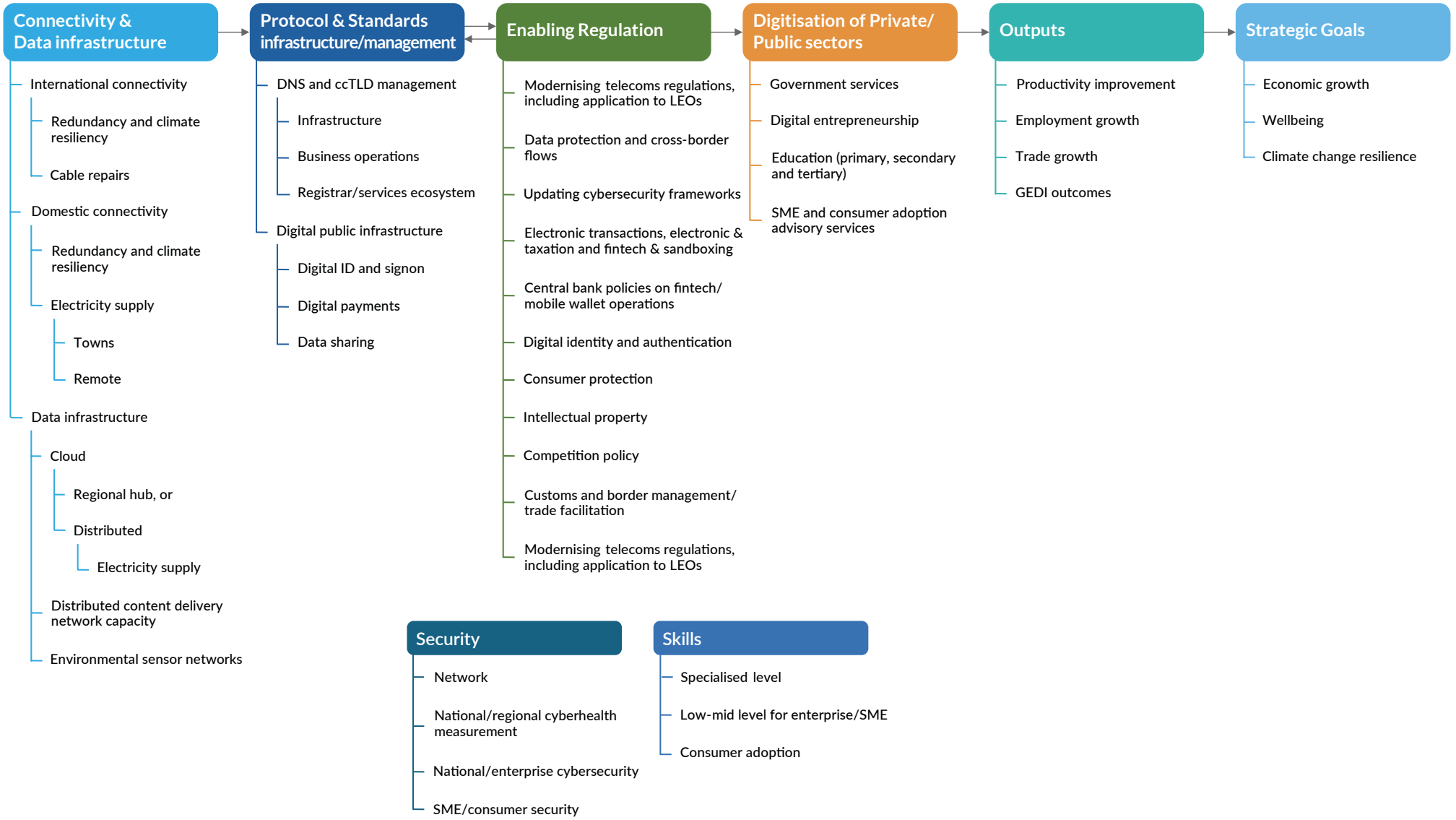
Skills development must address multiple levels of capability:

Specialist Level: Advanced technical capabilities in network engineering, security, software development, and data management remain scarce across the Pacific. Regional approaches to specialist development, including shared training programs and certification pathways, can help address this gap.

Entry-Level/Mid-Level for Enterprise/SME: Practical skills for applying digital technologies in business contexts represent a critical need. These capabilities enable organizations to effectively adopt and leverage digital tools without requiring deep technical expertise.

Consumer Adoption: Basic digital literacy and confidence form the foundation of inclusive digital societies. Without these fundamental capabilities, advanced infrastructure and services will benefit only a small segment of the population.

Figure 3: ICT in the Pacific is an ecosystem of interconnected capabilities underpinning improved economic growth, well being and climate change resilience



3.9 Reinforcing Interactions Between Components

The power of the system dynamics framework lies in understanding how components reinforce and enable each other, creating multiplicative effects from targeted investments:

3.9.1 Protocol-Infrastructure Reinforcement

Investments in DNS and ccTLD infrastructure support the development of local digital identities and enhance domestic data flows. Well-managed ccTLDs connect local businesses to the global internet while maintaining digital sovereignty. When properly implemented, this infrastructure also provides crucial resilience during natural disasters or submarine cable outages by maintaining local communications even when international connections are disrupted.

The relationship extends in both directions—improved data infrastructure enhances the performance and reliability of domain registry systems, while effective DNS management improves the efficiency of data routing and local content delivery.

3.9.2 Regulatory-Protocol Feedback Loops

Regulatory frameworks significantly influence the development and operation of technical standards. Data protection laws shape data sharing practices, cybersecurity frameworks drive security protocol implementation, and financial regulations determine digital payment architectures.

Conversely, technical capabilities influence what can be practically regulated—regulations requiring technical capabilities beyond current infrastructure may prove ineffective or counterproductive. This bidirectional relationship requires close coordination between technical and regulatory communities, something frequently lacking in Pacific contexts where regulatory development often occurs without sufficient technical input.

3.9.3 Digital Adoption-Infrastructure Dynamics

The adoption of digital services by businesses and consumers creates demand for improved infrastructure while also generating revenue that can support infrastructure investments. This virtuous cycle, however, depends on threshold levels of both quality and adoption—infrastructure must be reliable enough to support business-critical applications, while adoption must reach levels that justify infrastructure expansion.

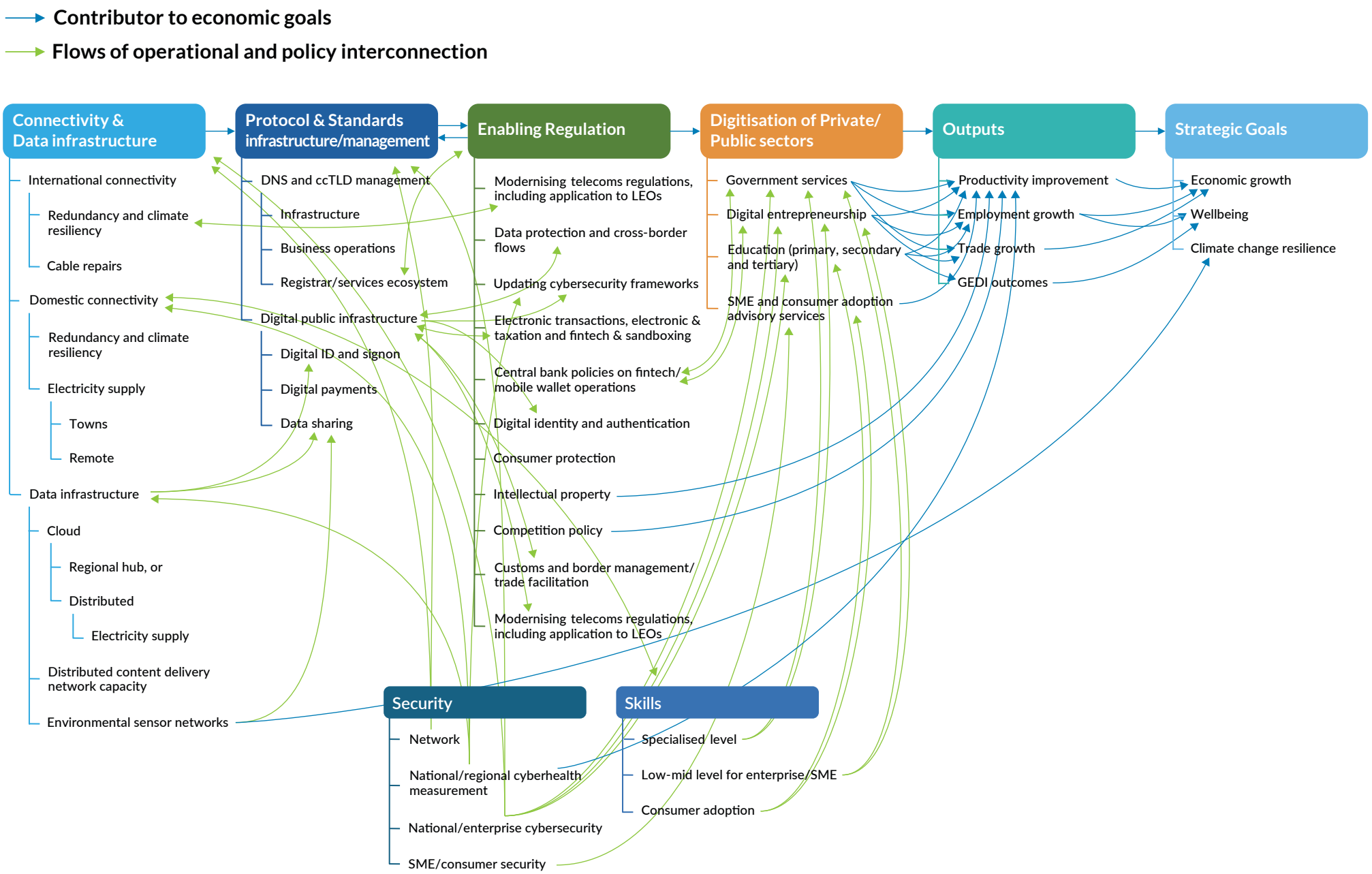
Where either component falls short, negative cycles can emerge. Poor infrastructure discourages adoption, reducing revenue for further infrastructure investment. Similarly, low adoption levels may not justify infrastructure investments, perpetuating quality issues. Breaking these negative cycles often requires targeted interventions that address both sides simultaneously.

3.9.4 Security-Trust-Adoption Relationships

Security capabilities directly influence trust in digital systems, which in turn affects adoption rates. When security incidents occur regularly or are highly visible, they undermine confidence in digital services and discourage adoption by risk-averse businesses and consumers.

This relationship highlights why security cannot be treated as an optional add-on but must be integrated throughout the digital ecosystem. Basic security capabilities represent a prerequisite for sustainable digital development rather than a luxury to be addressed after infrastructure is deployed.

Figure 4: It is all interconnected



3.9.5 Skills-Value Realization Connection

The full value of digital investments can only be realized when complemented by appropriate skills development. Even the most advanced infrastructure and applications deliver limited benefits if users lack the capabilities to effectively utilize them.

This connection emphasizes the importance of balanced investment approaches that couple technical infrastructure with human capacity development. Skills development programs should align with infrastructure deployment timelines, ensuring capabilities exist to leverage new technological possibilities as they emerge.

3.10 Implications for Pacific Digital Investment Strategy

Understanding the system dynamics of ICT in Pacific Island Countries offers important insights for more effective digital development strategies:

1. **Balanced Investment Approaches:** Effective strategies must balance investments across the full system rather than focusing exclusively on physical infrastructure or applications. Connectivity investments deliver limited value without corresponding development of protocols, regulations, and skills.
2. **Sequencing and Dependencies:** The framework highlights critical dependencies between components, informing proper sequencing of interventions. Addressing fundamental gaps in connectivity, electricity reliability, and basic regulatory frameworks often must precede higher-level digital initiatives.
3. **Resilience Emphasis:** The particular vulnerability of Pacific nations to natural disasters and climate impacts necessitates stronger emphasis on resilience in digital infrastructure design. Local DNS infrastructure, domestic Internet Exchange Points, and backup power systems deliver disproportionate value during crises.
4. **Regional Cooperation Opportunities:** Many Pacific nations face similar challenges but lack scale for certain investments individually. Regional approaches to infrastructure sharing, technical standards development, and specialized skills development can create viable solutions that respect national digital sovereignty while achieving necessary scale.
5. **Integration of Traditional Knowledge:** Effective digital strategies must integrate with Pacific cultural contexts and traditional knowledge systems rather than simply importing external models. This integration enhances relevance, adoption, and ultimately the development impact of digital investments.

By understanding these system dynamics, stakeholders can design more holistic and effective interventions that address fundamental gaps while leveraging the reinforcing relationships between components. This approach transforms digital development from a series of disconnected technical projects into a coherent strategy for enhancing Pacific economic resilience, social well-being, and climate adaptation capabilities.

4. Investment Priorities for Pacific Island Digital Economy Development: Analysis and Strategic Projects

The analysis presented in the documents provides a comprehensive framework for identifying investment priorities in Pacific Island Countries' digital economies. This approach combines quantitative data on past investments with qualitative stakeholder feedback and systems thinking to identify critical gaps in the digital ecosystem.

The methodology employs a systems view of modern ICT as an interconnected ecosystem that links various components from connectivity infrastructure through to economic and social outcomes. By visualizing this system as a flow chart—from connectivity and data infrastructure, through protocol/standards infrastructure, enabling regulation, digitization of sectors, outputs, to strategic goals—the analysts have created a holistic framework for assessment.

Historical investment patterns reveal a significant imbalance: while substantial resources have been deployed for physical infrastructure and government services, critical middle-layer components have received minimal funding. This has created a "hole in the middle" where enabling services, protocols, standards, and regulatory frameworks remain underdeveloped despite their essential role in translating infrastructure investments into economic and social benefits.

4.1 Assessment Methodology for Digital Economy Investment Priorities

The prioritization methodology employed in the assessment of Pacific Island Countries' digital economy investment needs represents a sophisticated multi-layered approach that merges systems thinking with evidence-based analysis and stakeholder consultation. This methodology warrants further examination to understand its nuanced approach to investment decision-making.

4.1.1 The ICT Ecosystem Mapping Framework

The foundational element of the prioritization methodology is the comprehensive ecosystem mapping that visualizes the digital economy as an interconnected system with multiple layers:

1. **Connectivity & Data Infrastructure** - The physical layer including international connectivity, domestic connectivity, and data infrastructure
2. **Protocol & Standards Infrastructure/Management** - The operational layer including DNS and ccTLD management, business operations, registrar/services ecosystem
3. **Enabling Regulation** - The policy layer covering telecommunications regulation, data protection, cybersecurity frameworks, digital identity
4. **Digitisation of Private/Public Sectors** - The application layer including government services, digital entrepreneurship, education
5. **Outputs** - The performance layer measuring productivity improvement, employment growth, trade growth
6. **Strategic Goals** - The outcomes layer including economic growth, well-being, and climate change resilience

These layers are supported by two cross cutting capabilities:

1. **Security** - The systems and capabilities to ensure not only responses to enterprise level cyberattacks, but also to provide security for networks and consumer/small business cybersecurity awareness. It also provides for national or regional measurement of cyber health metrics for the performance of ISPs and ccTLD operators.
2. **Skills** - The availability of expert level talent, entry level ICT support talent for enterprises and SMEs, and consumer support skills

This framework, as illustrated in Figure 4, allows for the visualization of both vertical dependencies (where one layer enables the next) and horizontal interconnections (where elements within a layer interact). The mapping enables identification of both direct and indirect impacts of investment decisions, recognizing that interventions at one point in the system create ripple effects throughout.

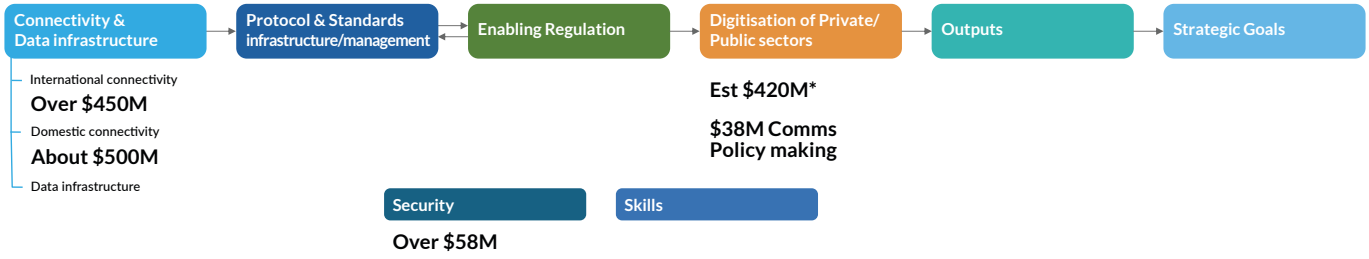
4.1.2 Quantitative Investment Flow Analysis

The methodology incorporates a detailed analysis of historical investment patterns to identify imbalances and gaps:

- Collection and analysis of Official Development Assistance (ODA) data since 2014
- Categorization of investments according to the ecosystem mapping framework
- Identification of funding concentrations and gaps across the ecosystem layers
- Correlation analysis between investment patterns and digital development outcomes

This quantitative analysis revealed the significant imbalance in funding allocation, with approximately $950 million invested in connectivity infrastructure. There is also estimated to have been another $450 million in investment in ICT aspects of public policy making in the PICs. This expenditure compares to minimal investments in protocol standards, enabling regulation, and supporting ecosystem development. This creates what "a hole in the middle" – where crucial enabling components remain underfunded despite their critical role in translating infrastructure into outcomes.

Figure 5: Investment in ICT since 2024 by the ODA community for the PICs has mostly focused on connectivity, cybersecurity and digitization of public sector



Source: OECD, DFAT, PIFM community survey, Argo analysis.
*Assuming 10% of the $4,199M investment for Public Sector policy making and related research, not including education and training (ADB reports nearly half of new projects in 2023 included a digital componet).

4.1.3 Status Assessment and Gap Analysis Methodology

The methodology applies a systematic assessment of each ecosystem component using a four-tier classification system based on extensive stakeholder consultation:

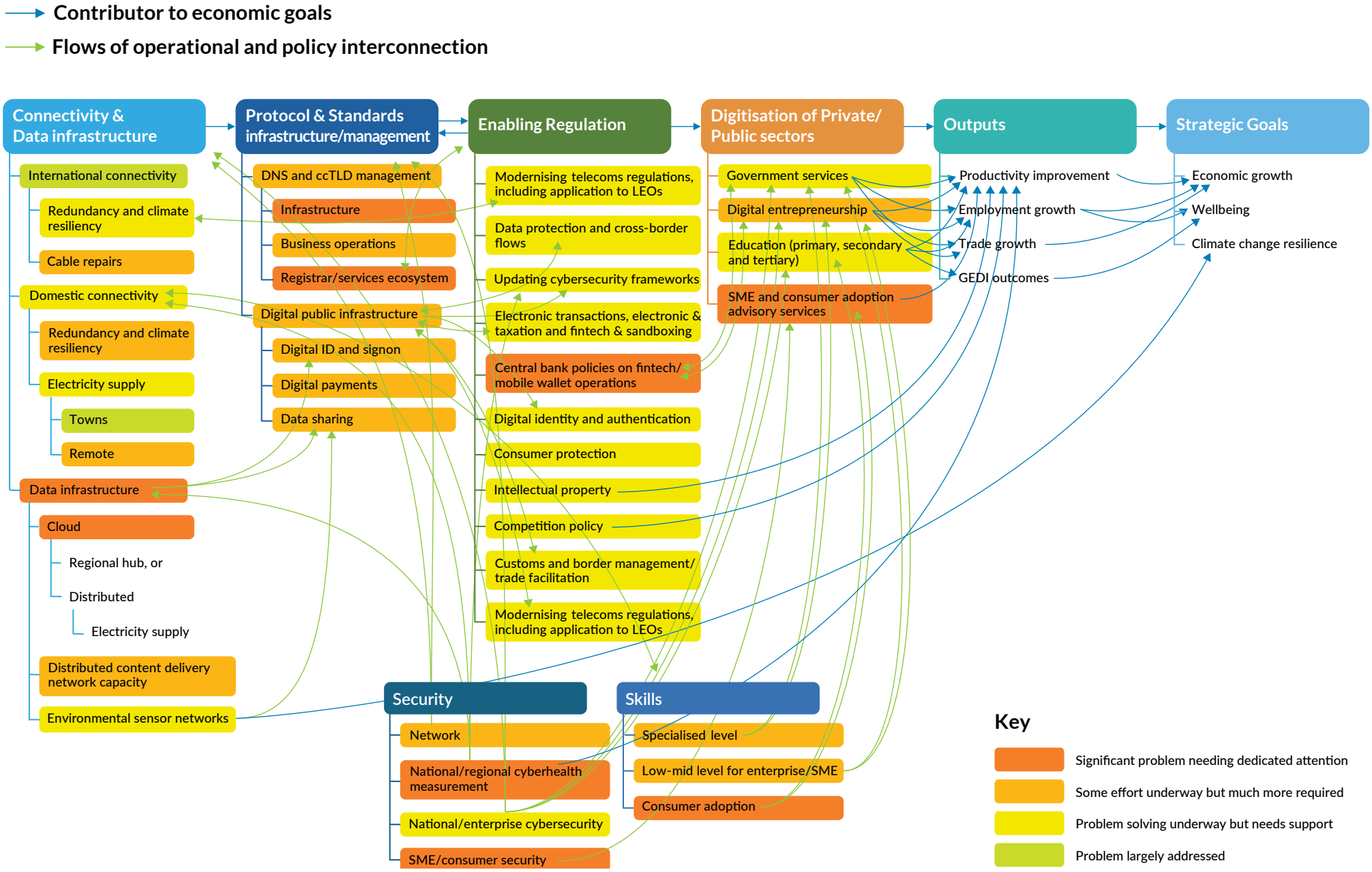
- **Red (Significant problem needing dedicated attention):** Issues requiring immediate intervention due to fundamental gaps or critical barriers
- **Orange (Some effort underway but much more required):** Areas where initial work has begun but substantial additional resources are needed
- **Yellow (Problem solving underway but needs support):** Components where progress is evident but continued support is necessary for sustainability
- **Green (Problem largely addressed):** Areas where the fundamental challenges have been overcome, though ongoing maintenance may be required.

This assessment was conducted through:

1. Document review and expert analysis of existing reports and studies
2. Stakeholder consultations with government officials, telecommunications providers, technical experts, and civil society representatives
3. Validation workshops where initial assessments were reviewed and refined by regional stakeholders
4. Iterative refinement based on feedback and additional data collection

The resulting status map provides a visual representation of the digital ecosystem's development state, highlighting the critical middle-layer gaps despite progress in connectivity infrastructure.

Figure 6: How far along the track are we?



4.1.4 Theory of Change and Systems Dynamics Application

The prioritization approach is anchored in a robust theory of change that examines both prerequisite conditions and potential impacts:

1. **Enabling Conditions Analysis:** A systematic assessment of what foundational elements must be in place for higher-order objectives to be achieved. This involves:
   - Mapping dependencies between ecosystem components
   - Identifying critical path elements that enable multiple downstream outcomes
   - Recognizing feedback loops where improvements in one area reinforce or enable improvements in others
2. **Investment Leverage Assessment:** Evaluation of where limited resources can generate the greatest system-wide impact through:
   - Identification of high-leverage intervention points where modest investments can trigger significant systemic improvements
   - Analysis of reinforcing feedback loops that can create virtuous cycles of improvement
   - Recognition of potential resistance points where system dynamics might counteract intervention efforts
3. **Sustainability Analysis:** Assessment of what conditions must exist for benefits to be maintained beyond initial investment periods, including:
   - Evaluation of ongoing operational requirements and associated costs
   - Identification of revenue generation potential and business model viability
   - Analysis of capacity requirements for long-term operations and maintenance

This systems-thinking approach recognizes that linear, siloed investments often fail to deliver sustainable outcomes in complex ecosystems, while strategically targeted interventions at key leverage points can catalyze broader system transformation.

4.1.5 Stakeholder Prioritization Input

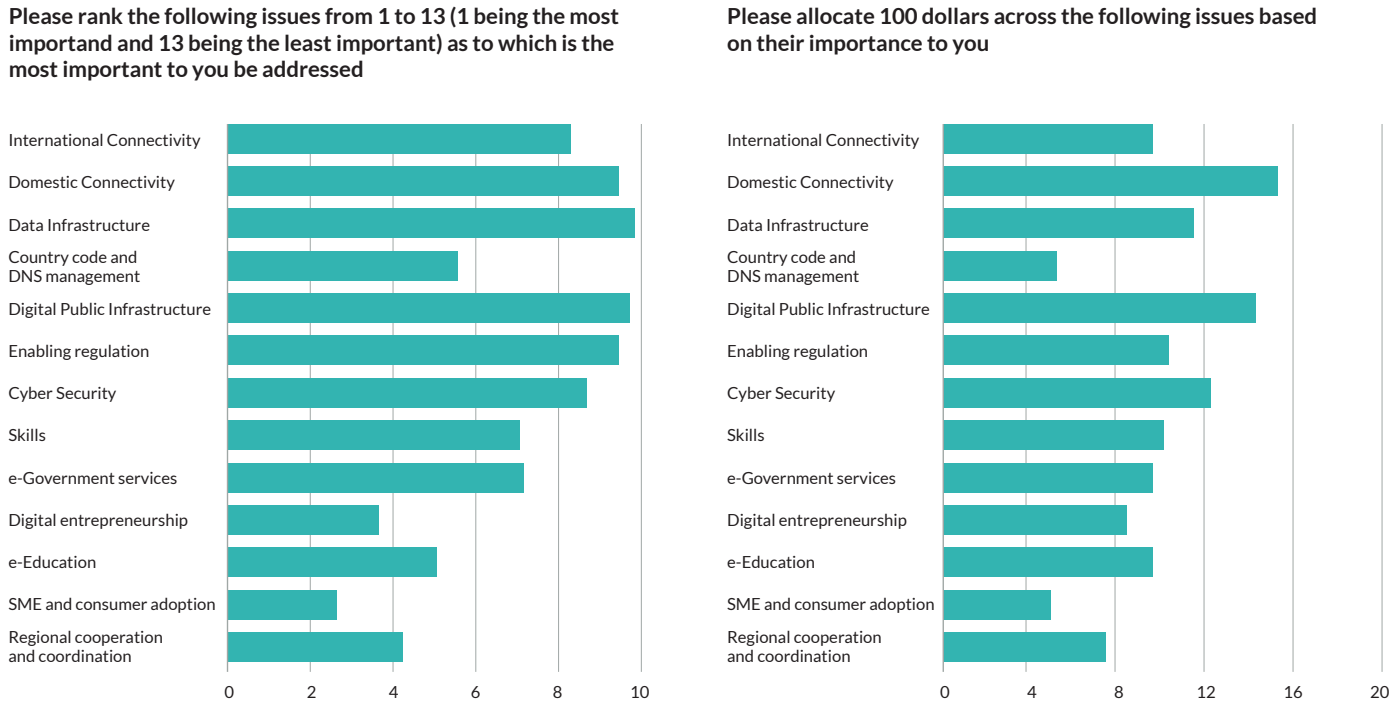
The methodology incorporates structured stakeholder prioritization exercises to ensure alignment with regional perspectives and priorities:

1. **Consultation meetings:** Inputs received during 2024 Pacific Internet Multistakeholder Forum (including Pacific Island Country ccTLD managers, network operators, some PIC technology officials and the main ODA donors for the Pacific) were included
2. **Ranking Exercise:** During the 2025 Data X Blue Pacific meeting, 26 officials from across Pacific Island Countries completed a structured ranking of 13 digital economy components based on perceived importance
3. **Resource Allocation Simulation:** Officials were asked to allocate a hypothetical $100 across different issue areas to reveal implicit prioritization through budget allocation decisions
4. **Qualitative Input Collection:** Open-ended responses were collected in one-on-one interviews and workshop sessions regarding rationales for prioritization decisions and contextual factors influencing priorities

This stakeholder input revealed several key insights:

- Domestic connectivity ranked higher than international connectivity, reflecting the growing recognition of last-mile challenges
- Data infrastructure and digital public infrastructure received significant priority, indicating awareness of their enabling role
- Country code and DNS management received priority scores mostly from technically aware participants, reflecting their awareness of the DNS' systemic importance

Figure 7: Twenty-six officials attending Data X Blue Pacific identified the importance of domestic connectivity, data & network infrastructure/DPI, enabling regulation, security and skills



4.1.6 Multi-criteria Decision Analysis

The final prioritization methodology synthesizes these various inputs through an implicit multi-criteria decision framework that considers:

1. **System Leverage Potential:** The degree to which an intervention addresses a component that enables multiple other elements of the ecosystem
2. **Gap Severity:** The assessed severity of current deficiencies in a component (red/orange/yellow/green rating)
3. **Investment Efficiency:** The expected impact relative to required investment (acknowledging that not all components require equal funding)
4. **Stakeholder Priority Alignment:** The degree to which potential interventions align with expressed stakeholder priorities
5. **Strategic Goal Contribution:** The expected contribution to higher-order strategic goals including economic growth, well-being, and climate resilience
6. **Implementation Feasibility:** Practical considerations regarding the ability to successfully implement potential interventions

This multi-dimensional analysis supports the identification of investment priorities that offer the optimal balance of systemic impact, stakeholder support, and implementation feasibility.

4.2 Applied Prioritization in Project Selection

The application of this methodology led to the identification of five strategic projects that target critical leverage points within the digital ecosystem:

1. **The ccTLD Registry Infrastructure Project** addresses a critical red-rated component (DNS and ccTLD management) that enables multiple subsequent elements including digital public infrastructure, registrar/services ecosystem, and local content development.
2. **The Cyber Health Monitoring Initiative** targets a fundamental enabling condition (security) that supports trust and reliability across the entire ecosystem while addressing a significant gap in systematic measurement and accountability.
3. **The Community Connectivity Initiative** confronts the persistent orange-rated challenge of remote connectivity while addressing cultural and social dimensions that technical solutions alone cannot resolve.
4. **The Legal Advisory support** tackles the enabling regulation layer identified as a critical prerequisite for multiple subsequent digitization initiatives, addressing a significant skills and capacity gap.
5. **The Regional DPI Assessment** examines potential economies of scale in digital public infrastructure that could maximize the efficiency of limited regional resources while respecting sovereignty requirements.

Each project was selected based on its position at a critical leverage point within the system, addressing components rated red or orange in the status assessment, aligning with stakeholder priorities, and offering favorable impact-to-investment ratios.

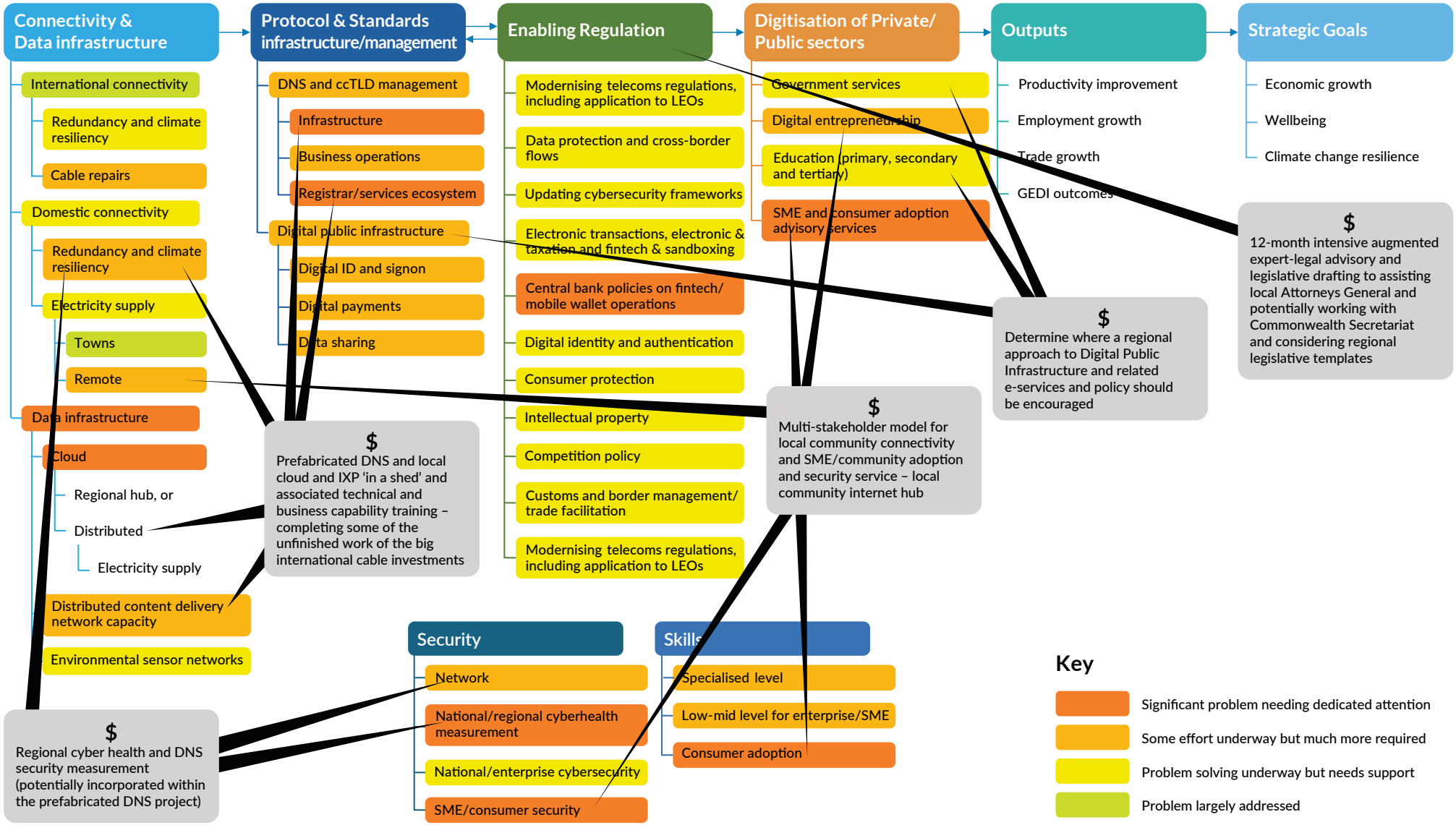
4.3 The Five Strategic Projects for Pacific Digital Economy Development

The application of this methodology led to the identification of strategic projects that target critical leverage points within the digital ecosystem.

Each project was selected based on its position at a critical leverage point within the system, addressing components rated red or orange in the status assessment, aligning with stakeholder priorities, and offering favorable impact-to-investment ratios.

Based on this comprehensive analysis, five strategic projects have been identified that target the critical middle layers of the digital ecosystem while offering systemic impacts across multiple domains.

Figure 8: Feedback from stakeholders suggests five projects.
The projects will address multiple points of need and drive progress at a system level.



Note: Some projects indicate that a multistakeholder approach will best achieve outcomes at scale. Stakeholders include multiple ministries, donors, carriers/ISPs, private sector, civil society groups and ccTLD/technical community.

Develop Pacific ccTLD Registry Local Infrastructure and Digital Economy

This project addresses the fundamental need for robust, secure, and locally managed country code Top-Level Domain (ccTLD) registry infrastructure, which forms a critical part of a country's digital sovereignty and economic development. The project proposes a "DNS in a Shed" standardized platform with both physical infrastructure components and capacity building elements:

- Physical infrastructure (authoritative nameservers, DNS resolvers with DNSSEC validation, registry databases, backup systems)
- Resilience infrastructure (backup power, alternative connectivity, security measures)
- Internet Exchange Point equipment
- Optional local cloud capacity
- Technical training programs (registry operations, DNS management, cybersecurity)
- Business ecosystem development (registrar support, business onboarding, user forums)

This approach would deliver multiple benefits including improved domain name accessibility and affordability, reduced dependency on offshore infrastructure, enhanced disaster resilience, and the development of local digital service ecosystems. By enabling internal communications to continue even when international connections are disrupted, this infrastructure transforms the internet from a vulnerability during crises to a valuable tool for coordination and recovery.

4.3.1 Pacific Cyber Health Monitoring and Measurement Initiative

This project aims to ensure that ISPs and ccTLD registry operators follow security best practices through systematic monitoring and measurement. Rather than focusing solely on incident response, this initiative would establish baseline security standards, implement measurement protocols, and provide accountability mechanisms for network operations.

The initiative would focus on:

- Establishing metrics for "cyber public health"
- Creating monitoring systems for network operations security
- Providing transparency and accountability through regular reporting
- Developing capacity for security implementation and maintenance
- This approach provides donors and stakeholders with assurance that investments in digital infrastructure are protected and maximized through appropriate security practices, while also building regional capacity to maintain secure digital environments.

4.3.2 Multistakeholder Initiative for Local Community Connectivity

This project addresses the challenge of last-mile connectivity in remote areas through community-driven approaches that consider local social, cultural, and economic factors. Beyond the technical aspects of connectivity, this initiative would develop sustainable models that account for:

- Cultural factors related to land access and community engagement
- Skills development at the local level
- Sustainable business models for ongoing operations
- Technology solutions appropriate to geographic and social contexts
- Community ownership and participation

This multistakeholder approach recognizes that connectivity challenges in remote Pacific communities require solutions that extend beyond purely technical or commercial considerations and must engage with communities as active participants rather than passive recipients.

4.3.3 Augmented Legal Advisory and Legislative Drafting Support

This 12-month intensive project would provide expert legal advisory and legislative drafting assistance to local Attorneys General to address the regulatory bottlenecks that currently impede digital economy development. The project would:

- Work with Commonwealth Secretariat to develop regional legislative templates
- Provide direct support to draft country-specific legislation and regulations
- Assist with modernizing telecommunications regulations
- Support development of frameworks for data protection, digital identity, electronic transactions, and FinTech

This targeted intervention recognizes that enabling regulation represents a critical prerequisite for digital economy development but requires specialized expertise that may not be readily available within government legal services in smaller nations.

4.3.4 Regional Digital Public Infrastructure Assessment

This project would determine where regional approaches to Digital Public Infrastructure (DPI) and related e-services would be beneficial, balancing national sovereignty concerns with the potential efficiency gains of regional solutions. The assessment would:

- Evaluate potential for regional approaches to digital payments
- Explore options for shared identity systems or interoperability standards
- Assess regulatory harmonization opportunities
- Identify service areas where regional scale offers significant advantages

This strategic review would help guide future investments by identifying where national approaches are essential for sovereignty and where regional coordination might deliver better outcomes due to economies of scale.

4.4 Balanced and Strategic Investment for Maximum Impact

The analysis and proposed projects represent a carefully balanced approach to digital economy development in Pacific Island Countries. Rather than simply replicating infrastructure investments that have dominated past funding, these projects target critical gaps in the digital ecosystem's middle layers—the connections that translate physical infrastructure into economic and social benefits.

By addressing country code domain infrastructure, security practices, community connectivity models, regulatory frameworks, and regional coordination, these initiatives promise to unlock the value of existing infrastructure investments while building the foundations for sustainable digital economies. The approach recognizes both the unique challenges of Pacific Island contexts and the need to balance national sovereignty with regional cooperation, offering a comprehensive framework for maximizing returns on digital economy investments.

These five strategic projects, which are explored in detail in the following chapters, require relatively modest investments compared to major infrastructure projects, could significantly accelerate digital transformation across the Pacific region by addressing the systemic barriers that currently prevent the full realization of benefits from existing connectivity investments.

5. Project Proposal for Developing Pacific ccTLD Registry Local Infrastructure and Digital Economy

The Pacific Islands region has seen substantial investment in telecommunications infrastructure, most notably through submarine cables connecting many of the islands to the global internet. However, cables alone are insufficient to develop thriving local digital economies across Pacific Island nations. A critical missing piece is the development of robust, secure, and locally managed country code Top-Level Domain (ccTLD) registry infrastructure, along with its supporting ecosystem of registrars and resellers of e-commerce services, that enables businesses and government services to establish effective online presences.

The issues limiting the optimal operation of the regions ccTLDs are not just recognised by the technical and business community. Governments are also paying more attention. For instance, the Fijian National E-Commerce Strategy for 2025-29 notes:

> Ongoing issues with the management and upkeep of the fj domain requires a review of its management, infrastructure and customer management capability. Outages have prompted companies, including VitiKart, to move away from the fj domain, citing latency issues Addressing these challenges is crucial because the fj domain is integral to Fiji's branding.[1]

This project proposal addresses these gaps by suggesting a comprehensive approach combining both the local physical infrastructure investments with capacity building and with regional cooperation. This investment will help support the digital development to deliver the economic and social growth promised by the physical connectivity provided by submarine cables.

5.1 Current Situation and Challenges

5.1.1 Limited Scale and Operational Barriers of Pacific ccTLDs

As Chart XX below shows, most Pacific region ccTLDs operate at a very small scale, with fewer than 10,000 domain names registered per country. This limited scale creates a significant barrier to development and establishes a challenging environment for building sustainable digital ecosystems. The small number of registrations means the fixed costs of operating registry systems must be spread across fewer domains, driving up costs and creating a negative cycle that further limits adoption.

The manual registration processes that persist in many Pacific ccTLDs represent a significant operational challenge. Unlike modern registry systems that allow for immediate domain registration and activation, these manual processes often involve paperwork, in-person visits, or other cumbersome steps that can delay registration by days or even weeks. In contrast, registering a .com domain can be completed in minutes through online interfaces, creating a strong disincentive for businesses to use local domains.

The high costs associated with registering domains through Pacific ccTLDs creates another significant barrier to adoption. Domain registration costs can run into hundreds or even thousands of dollars in some Pacific nations, compared to less than $8 for a .com domain. For small businesses with limited resources, this price differential makes local domains unattainable, pushing them toward global alternatives or, more commonly, toward simply establishing a presence on overseas social media platforms rather than developing their own websites.

1 Fiji Ministry of Trade, Co-operatives, Small and Medium Enterprises, and Communications. (2024). *Fiji National E-Commerce Strategy 2025–2029. Suva, Fiji: Government of Fiji*, p14.

Table 2: Pacific country code TLDs

Country		Registrations*	Retail Range of Prices***	ccTLD Manager	State of CCTLD policy**	Notes
Australia	**.au**	5,683,302	$9.88 to $116.10	.au Domain Administration(auDA)	Comprehensive	
Cook Islands	**.ck**	1,021	$158.32 to $349.99	Telecom Cook Islands ltd.	Comprehensive	
Federated States of Micronesia	**.fm**	111,182	$67.98 to $169.99	FSM Telecommunicatios Corporation	Limited/none	
Fiji	**.fi**	4,924	$116.10 to $349.99	The University of the South Pacific IT Services	Limited/none	2025: Fijian government announces review of underlying issues leading to service disruptions and propose recommendations for management adjustments, alongside necessary upgrades to both hardware
Kiribati	**.ki**	940	$844.38 to $1,150	Ministry of Information, Communications and Transport (MICT)	Limited/none	
Marshall Islands	**.mh**	25		Office of the Cabinet	Limited/none	This TLD cannot currently be registered by the public
Nauru	**.nr**	535	$633.28 to $912.50	CENPAC NET	Limited/none	
New Zealand	**.nz**	950,562	$16.68 to $89.30	Internet NZ	Comprehensive	
Niue	**.nu**	1,316,791	$15.99 to $100.00	The IUSN Foundation	Partial	Controlled by a Swedish entity mostly selling to Scandinavia contrary to wishes of present Nuie government See https://icannwiki.org/.nu
Palau	**.pw**	296,066	$0.70 to $43.99	Micronesia Investment and Development Corporation	Limited/none	Has found global usage and is promoted as the “professional web”, catering to professional and businesses worldwide.
Papua New Guinea	**.pg**	2,982	$260.00	PNG DNS Administration Vice Chancellor Office The Papua New Guinea University of Technology	Partial	
Samoa	**.ws**	7,835,73	$5.98 to $117.00	Government of Samoa Ministry of Foreign Affairs & Trade	Limited/none	Global Domains International promoted .ws internationally as an abbreviation for “WebSite” and is mainly used as an alternative to .com.
Solomon Islands	**.sb**	2,892	$49.99 to $114.50	Solomon Telekom Company Limited	Limited/none	
Tokela	**.tk**	27,534,342	$6.92 to $260.00	Telecommunicatios Tokelau Corporation (Teletok)	Limited/none	By 2002 deal, Dutch company marketed .tk allowing anyone to register .tk domain names for free, along with ads. It has also led to a reputation for being associated with malicious activities including scams, phishing, and spam. Symantec, a cyber security company, reported in 2013 that the .tk domain accounted or 21.5% of the world’s phishing attacks. See: https://www. technologyreview.com/2023/11/02/1082798/ tiny-pacific-islandglobal-capital-cybercrime/
Tonga	**.to**	59,357	$20.70 to $142.48	Government of the Kingdom of Tonga	Comprehensive	
Tuvalu	**.tv**	778,223	$9.98 to $129.00	Ministry of Justice Communications and Foreign Affairs	Partial	Tuvalu entered into a series of partnerships registry operators to market and manage the .tv extension to, international media industry. Some sources claim that the licensing of the .tv domain has becomes a significant source of income for Tuvalu, contributing to about 10% of the national annual gross incomes. https://en.wikipedia.org/wiki/.tv
Vanuatu	**.vu**	2,779	$51.99 to $257.01	Telecommunications and Communications and Broadcasting Regulator (TRBR)	Limited/none	

Source: * https://domainnamestat.com/; ** UNCTAD: Gap Analysis of Cyber laws in Pacific Small Island Developing States, March 2025; Argo Pacific
***https://tld-list.com/ In USD$ for initial registration (often cheaper than renewals)

The limited integration of Pacific ccTLDs with popular global service providers represents another critical challenge. Modern website building platforms like Wix, Squarespace, and Shopify have revolutionized how small businesses establish online presences by providing intuitive, code-free solutions for website creation. Similarly, professional email services from Microsoft and Google have become standard tools for business communications. However, because Pacific ccTLDs lack the scale and technical infrastructure to integrate with these platforms, local businesses face significant technical barriers to using their local domain names with these popular services.

The inadequate local support for businesses seeking to establish an online presence compounds these challenges. Beyond simply registering a domain, businesses need assistance with website development, hosting, security, and other technical aspects of establishing an effective online presence. In many Pacific nations, this support ecosystem is underdeveloped, leaving businesses without the guidance and assistance they need to effectively leverage digital tools. This lack of support particularly affects smaller businesses and those in less urban areas, widening the digital divide within these countries.

5.1.2 Technical and Infrastructure Challenges

The technical infrastructure supporting Pacific ccTLDs faces several critical vulnerabilities that undermine their effectiveness and reliability. These challenges reflect not only resource limitations but also historical patterns of development that have often neglected local infrastructure in favor of connections to global systems.

The limited redundancy in Pacific ccTLD infrastructure creates significant operational risks. Most registry systems lack proper backup systems, alternative power sources, or geographically distributed operations. This absence of redundancy means that equipment failures, power outages, or other local disruptions can completely disable registry operations. Given the frequency of natural disasters in the Pacific region, this vulnerability is particularly concerning, as infrastructure failures are most likely to occur precisely when communication systems are most needed.

Cybersecurity vulnerabilities represent another critical risk for Pacific ccTLD infrastructure. Many systems use outdated software, lack modern security protocols, and have limited monitoring capabilities. The implementation of security features like DNSSEC (Domain Name System Security Extensions) is limited across the region, leaving domain systems vulnerable to various forms of attack including DNS spoofing and cache poisoning. These vulnerabilities not only threaten the operations of the registry systems themselves but also potentially expose users of those domains to security risks, undermining trust in local digital systems.

The isolation of Pacific ccTLD systems from global DNS infrastructure limits their visibility and accessibility worldwide. Modern DNS relies on a distributed network of servers to provide reliable and low-latency resolution of domain names. However, many Pacific ccTLDs have limited presence on global DNS networks, resulting in slower resolution times and reduced reliability for users outside the region. This isolation not only affects the user experience but also reduces the attractiveness of these domains for businesses seeking to reach international audiences.

The risks to operational continuity during disasters or infrastructure failures represent perhaps the most significant technical challenge. Many Pacific Island nations depend entirely on submarine cables for international connectivity, creating a single point of failure. When these cables are damaged—as happened in Tonga following a volcanic eruption—the entire country can lose connectivity to the outside world. However, with properly designed local infrastructure, internal communications could continue even during such outages, allowing access to government resources, local communications, and critical information. The current dependence on off-island infrastructure for basic domain operations undermines this potential resilience.

5.1.3 Economic and Social Impact

The technical and operational limitations of Pacific ccTLDs have far-reaching economic and social consequences that extend beyond the immediate challenges of domain registration and management. These impacts affect the broader development of digital economies and societies in the region.

The limited development of digital economies in Pacific Island nations is partly attributable to the challenges businesses face in establishing credible online presences. Without effective websites under local domains, businesses struggle to participate in e-commerce, reach new markets, or offer online services. This limitation is particularly significant in the context of the global trend toward digital commerce and services, leaving businesses in the region at a competitive disadvantage and limiting economic growth opportunities.

The high cost and technical barriers to establishing websites with local domains result in less locally relevant online content. This scarcity of local content creates a cycle where limited local information drives users toward global platforms, further reducing incentives for local content development. The lack of local content particularly affects cultural preservation, education, and access to locally relevant information, limiting the social benefits of digital connectivity.

The economic leakage that occurs when businesses rely on offshore platforms and services represents a missed opportunity for local economic development. Rather than supporting local digital service providers, web developers, and IT professionals, businesses often turn to international providers, reducing local employment opportunities and economic benefits. This pattern reinforces dependence on external systems and limits the development of local digital capabilities.

5.2 Cybersecurity Risks of Present Pacific TLD Model

The Pacific Islands' country code Top-Level Domains (ccTLDs) have emerged as significant vectors for cybersecurity threats globally, disproportionately affecting their reputation despite their small geographic size. An analysis of DNS abuse patterns reveals concerning trends that stem from specific registration policies and economic factors.

5.2.1 High-Rate Abuse ccTLDs in the Pacific Islands

Several Pacific Island ccTLDs demonstrate extraordinarily high levels of DNS abuse, particularly for phishing activities:

.tk (Tokelau)

Tokelau's ccTLD presents an extreme case of DNS abuse, with phishing domains per capita reaching 462,098 times higher than Germany's .de ccTLD[2]. The .tk domain has become one of the world's most populous TLDs despite Tokelau's tiny population, with domain registrations at one point contributing one-sixth of Tokelau's income3. According to CleanDNS data for 2022-2023, .tk domains represented the highest concentration of abuse reports among Pacific Island ccTLDs, showing particularly high volumes of phishing activity..pw (Palau)

The .pw ccTLD exhibits phishing domain registrations per capita 20,286 times higher than .de.[4] It registers over seven standard deviations above the average global rate of phishing registrations, indicating an extreme statistical outlier. This makes .pw domains particularly risky from a cybersecurity perspective.

2 Comparative DNS Abuse Study, ICANN Security and Stability Advisory Committee (SSAC), March 2023
3 Bahr, E., "The Economics of a Small Island ccTLD: Case Studies from Tokelau and Niue," Journal of Pacific Internet Governance, Vol. 4, No. 2, 2021
4 Pacific Islands DNS Abuse Monitoring Report, Pacific Islands Telecommunications Association (PITA), 2023.

.ws (Samoa)

While less severe than .tk and .pw, Samoa's ccTLD still shows elevated levels of malicious domains, with phishing domains per capita 11.44 times higher than Germany's .de.[5]

5.2.2 Root Causes of DNS Abuse in Pacific Island ccTLDs

Several key factors contribute to these elevated abuse levels:

Free or Low-Cost Registration Policies

The most significant factor enabling abuse is the free or extremely low-cost domain registration offered by certain Pacific Island ccTLDs. Freenom, which until 2024 managed .tk, .ga, .cf, .ml, and .gq (the first four appearing on top phishing TLD lists), provided free domain registrations. This policy made these domains highly attractive to cybercriminals seeking disposable infrastructure for attacks.

As Unit 42 research confirms, "TLDs offering free domain registration are among the top preferred TLDs for phishing domains".[6]The .tk domain specifically "became popular by providing free domain registrations, where the source of income for the TLD operator is through advertisement rather than domain registration fees".[7]

Lack of Stringent Registration Restrictions

The absence of strong verification requirements or registration restrictions makes these domains easy targets for exploitation. Unlike more secure ccTLDs such as .de, where registration costs are higher and verification processes more thorough, many Pacific Island ccTLDs have minimal barriers to registration.

Security Resource Limitations

The high rate of compromised (rather than intentionally malicious) domains in some Pacific regions points to another issue: limited security resources. For TLDs like .zw (Zimbabwe), researchers found "a significant portion of the malicious domains in these TLDs are not registered with malicious intent but are compromised instead".[8] This pattern likely extends to some Pacific Island domains, where limited resources for cybersecurity result in vulnerable hosting infrastructures.

5.2.3 Types and Distribution of Abuse

According to CleanDNS data for July: 2022-July 2023, abuse in Pacific Island ccTLDs breaks down as follows:[9]

- Spam: 48.4% of abuse reports
- Phishing: 42.1% of abuse reports
- Malware: 7.4% of abuse reports
- Other (including botnet activity): remainder

The data shows a total of 245,131 abuse records spanning 97,804 unique domains, indicating significant concentration of malicious activity. Moreover, the abuse is not evenly distributed - .tk domains show dramatically higher abuse volumes than other Pacific ccTLDs.

5 Ibid.
6 Szurdi, J., "A Peek into Top-Level Domains and Cybercrime," Unit 42 (Palo Alto Networks), November 11, 2021, p. 4.
7 Ibid, p. 10.
8 Ibid, p. 14.
9 Presentation to the Pacific Internet Multistakeholder Forum, Brisbane, September 2023.

5.2.4 Broader Implications

The concentration of DNS abuse in Pacific Island ccTLDs has several concerning implications:

Reputational Damage

The association with spam or DNS abuse can shape somebody's views of that entire nation, just based upon that reputation with a ccTLD. This creates an unfair reputational burden on small island nations.

Cybersecurity Impact

The abuse of these domains contributes significantly to global phishing infrastructure. With nearly half of the abuse reports relating to phishing, these domains represent a substantial threat vector for credential theft and social engineering attacks.

Mitigation Challenges

While some TLD operators implement anti-abuse policies, the sheer volume of registrations can make enforcement challenging. Some registries have attempted to mitigate abuse through manual verification or machine learning-based detection systems and collaboration with law enforcement, but the problem persists.

5.3 Resilience Risks of Present Pacific TLD Model

The challenges to disaster resilience are particularly significant in a region prone to natural disasters. During cyclones, tsunamis, earthquakes, or volcanic eruptions, communication becomes critical for coordination, information sharing, and recovery efforts. However, the current infrastructure often fails precisely when it's most needed, as damage to cables or power systems can disable communication networks. With properly designed local ccTLD and Internet exchange point infrastructure, internal communications could continue even during international connectivity disruptions, providing crucial resilience during disasters.

This resilience means that during disasters:

- Government websites remain accessible with critical information
- Local email communications can continue functioning
- Essential services can maintain online presence
- Communities can coordinate response efforts even without external connectivity

With proper local infrastructure including backup power and satellite connectivity options, internet services within the country can continue operating even when submarine cables are damaged. This capability transforms the internet from a vulnerability during crises to a valuable tool for coordination and recovery.

5.4 Benefits of Developing Pacific ccTLD Infrastructure

5.4.1 Economic Benefits

The development of robust Pacific ccTLD infrastructure would provide significant economic benefits at multiple levels, creating opportunities for businesses, consumers, and the broader economy. These benefits extend beyond the technical aspects of domain management to impact economic development more broadly.

When consumers can easily identify and support local businesses through recognizable local domains, more economic activity remains within the country. This local identification helps businesses market themselves

effectively to local consumers and enables consumers to make informed choices about supporting local enterprises. The "buy local" movement can be significantly enhanced when businesses have a clear local identity online through their domain names. This localization becomes particularly important in tourism-dependent economies where visitors seek authentic local experiences and products.

The reduced transaction times associated with local businesses represent another significant benefit. When goods and services are sourced locally rather than internationally, delivery times decrease dramatically, enhancing customer satisfaction and reducing logistics costs. This efficiency advantage applies not only to physical goods but also to services, where local providers can offer faster response times and more personalized attention than distant alternatives. For time-sensitive needs, this localization provides a competitive advantage to businesses using local domains.

The availability of local support systems for products and services purchased from local businesses enhances consumer confidence and satisfaction. When issues arise with purchases, consumers can access local support rather than dealing with overseas entities, potentially across different time zones and languages. This local support infrastructure not only improves the customer experience but also creates employment opportunities within local service sectors. The accountability provided by local presence enhances trust in online transactions, encouraging greater participation in the digital economy.

Perhaps most significantly for the sustainability of ccTLD operations, the potential revenue generation from properly managed domains could transform the financial viability of these systems. International brands often register their names across multiple domains for brand protection (defensive registrations). With improved accessibility and integration with global registration systems, Pacific ccTLDs could capture this revenue stream, potentially generating around $200,000 annually per country. This income could fund ongoing operations, technical improvements, and further digital development initiatives, creating a sustainable model for continued growth.

5.4.2 Supporting Local Economic Development and Digital Identity

The economic benefits of well-managed ccTLDs extend throughout local communities in multiple ways:

Business Visibility and Competitiveness

Local businesses using ccTLDs enjoy enhanced visibility both online and in search results. As Google explicitly acknowledges, "Generally speaking the local country code domain names tend to do better because Google Search promotes content local to the user."[10] This search optimization advantage helps level the playing field between small local businesses and large international competitors.

In markets where global digital giants have advantages of scale, ccTLDs provide local businesses with a competitive edge through their geographic specificity. A small business in Fiji with a .fj domain may stand out to local consumers over an international company using a generic .com domain. This visibility helps preserve local economic activity and supports community-based businesses.

Domain Name Availability

The ccTLD space offers significantly greater availability of desirable domain names compared to saturated global TLDs like .com. This availability allows businesses to secure memorable, brand-relevant domain names that might be unavailable in global TLDs.

For entrepreneurs in developing markets, this represents a meaningful opportunity to establish professional digital identities without resorting to unwieldy or hard-to-remember domain alternatives. A business can secure short, memorable domains like "shop.fj" rather than lengthy, hyphenated alternatives in the crowded .com space.

10 Mueller, J., "Country Code Top Level Domains (ccTLDs)," Google Search Central Blog, June 2019

Search Engine Visibility and Local Relevance

The improved search engine visibility provided by local ccTLDs offers another practical benefit. The SEO advantages of ccTLDs extend beyond simple preference in search rankings. They serve as geographic indicators that help search engines and AI tools deliver locally relevant content to users. Major search engines like Google provide a "ranking boost" to sites using country-specific domains when targeting specific countries.

This improved visibility benefits:

- Local businesses seeking customers in their region
- Government agencies sharing important information
- Community organizations promoting local initiatives
- Educational institutions reaching prospective students
- Healthcare providers offering local services

The improved discoverability creates a virtuous cycle where local content becomes more visible, encouraging further local content creation. This process helps build a richer ecosystem of locally relevant information resources serving community needs.

5.4.3 Supporting Local Content Development and Cultural Preservation

ccTLDs create focal points for developing local content, information, and services relevant to a country's citizens. This localization is particularly important for preserving cultural heritage, languages, and perspectives that might otherwise be marginalized in global digital spaces.

For Pacific Island communities with rich cultural traditions and, in some cases, unique languages, ccTLDs provide an online space clearly identified with national identity. This clear association encourages the creation and preservation of digitally expressed cultural identity—from traditional knowledge to contemporary cultural expressions.

Local businesses and organizations using ccTLDs are more likely to create content specifically tailored to local audiences, addressing their particular needs and preferences. This localization extends beyond language to include culturally appropriate imagery, references, and values that resonate with the community.

5.4.4 Creating Digital Identity and Building Trust

ccTLDs serve as powerful symbols of national digital identity. Just as a country's flag represents its sovereignty in the physical world, a ccTLD (such as .fj for Fiji, .vu for Vanuatu, or .sb for Solomon Islands) establishes a distinct national presence in the digital landscape. This digital identity is particularly valuable for smaller nations whose international visibility might otherwise be limited.

The trust factor cannot be overstated. When local users see a website with their national domain extension, it immediately signals local relevance and legitimacy. This trust extends beyond mere perception—it represents a tangible business advantage. Consumers are more likely to engage with and purchase from businesses that appear to be local, understanding their specific needs and cultural context.

For Pacific Island nations, whose communities often have strong cultural identities and local traditions, this trust dimension is particularly significant. Websites under local ccTLDs are seen as part of the community fabric rather than external commercial entities, fostering a sense of connection and belonging.

5.4.5 Facilitating Regulatory Compliance and Legal Protection

ccTLDs help businesses comply with local regulations and legal requirements. Some countries require businesses to use a local domain extension to operate legally within their jurisdiction. This alignment with local regulatory frameworks provides clarity for both businesses and consumers regarding applicable laws and consumer protections.

Using a local ccTLD also provides consumers with greater assurance regarding legal recourse should problems arise. This legal clarity benefits both sides of commercial transactions:

- Consumers gain confidence knowing local consumer protection laws apply
- Businesses operate within clear legal frameworks appropriate to their market
- Regulatory authorities can more easily monitor and enforce standards
- Dispute resolution can follow established local processes

5.4.6 Technical and Practical Benefits

Beyond the economic advantages, enhanced ccTLD infrastructure would provide numerous technical and practical benefits that improve the functionality and utility of the local internet ecosystem.

The improved availability of relevant domain names represents a significant practical advantage for local businesses. In global TLDs like .com, where over 100 million domains are already registered, finding short, memorable, and relevant domain names has become extremely difficult. Local ccTLDs offer a much less crowded namespace where businesses can secure domains that closely match their business names or describe their offerings.

Perhaps the most critical technical benefit is the resilience during disasters enabled by properly implemented local infrastructure. With local DNS servers, registry systems, and exchange points, internal internet communications could continue functioning even when international connections are disrupted. Government websites could remain accessible, local email systems could continue operating, and critical information could still be disseminated.

Increased Security and Reliability

Implementing modern security protocols like DNSSEC provides protection against various forms of DNS-based attacks, including cache poisoning and DNS spoofing. These security enhancements benefit not only the registry operators but all internet users in the country.

The proposed redundant design with backup power, multiple connectivity options, and distributed operations would dramatically improve reliability, reducing downtime and service disruptions. This reliability builds confidence in local digital services and encourages greater adoption by businesses and consumers.

Internet Exchange Points and Local Traffic

The integration of Internet Exchange Points (IXPs) with ccTLD infrastructure would transform the routing of internet traffic within countries. By enabling local internet service providers to exchange traffic directly rather than routing through international connections, IXPs reduce latency, lower costs, and improve user experience.

This local traffic exchange becomes particularly valuable during international connectivity disruptions, allowing continued internal communications even when external links are unavailable. The economic benefits are also significant, as local traffic exchange reduces dependence on expensive international bandwidth.

5.4.7 Building Human Capital and Digital Skills

The capacity building components associated with ccTLD development provide lasting benefits to local communities through knowledge transfer and skills development. The technical training in registry operations, DNS management, cybersecurity, and related fields develops valuable expertise that extends beyond domain management to broader IT capabilities.

These skills development initiatives create career pathways in technology fields, helping to retain talented individuals who might otherwise seek opportunities abroad. The "train-the-trainer" approach ensures sustainable knowledge transfer, creating multiplier effects throughout the local IT community.

The business ecosystem development activities—supporting local IT companies to become registrars, providing business onboarding support, and marketing assistance—build entrepreneurial capacity and service provision capabilities. These newly developed businesses represent economic diversification beyond traditional sectors, creating higher-value employment opportunities.

5.4.8 Enhancing Regional Cooperation and Integration

The proposed shared Pacific ccTLD aggregator would facilitate greater digital cooperation among Pacific Island nations, creating mutual benefits through economies of scale while preserving individual national digital identities. This regional approach allows smaller nations to access sophisticated infrastructure and global connections that would be economically unfeasible individually.

The cooperation extends beyond technical systems to include knowledge sharing, policy development, and collective bargaining with global service providers. This collaborative approach strengthens each country's position while building regional digital capabilities and shared expertise.

5.5 Proposed Solution Components

The proposal outlines a comprehensive approach with two main components: physical infrastructure upgrades and capacity building initiatives, supported by a framework for regional cooperation. This multi-faceted approach recognizes that technical solutions alone are insufficient without the human capacity and institutional arrangements to sustain them.

Invest in Pacific region ccTLD registry infrastructure

Implement a common Pacific registry infrastructure framework that can:

- Leverage international standards (e.g. EPP registry-registrar protocols, DNSSEC
- Support large global registrars that are used by large Internet service companies
- Support local IT companies to provide registration services - local payment options
- Keep the cost per name down
- Provide a reliable, stable and resilient DNS infrastructure - connect into global network of reliable DNS nameservers for maximum resiliency
- Provide protections from cyber security attacks and various forms of DNS abuse
- Able to continue operation during natural disasters including loss of international cable connection.

5.5.1 Physical Infrastructure: "DNS, Local Cloud and IXP in a Shed"

The core of the physical infrastructure component is what stakeholders have been termed "DNS, local cloud and IXP in a shed" - a standardized, repeatable platform that can be deployed across Pacific Island nations. This approach draws on lessons from other infrastructure sectors, where standardized, modular solutions have successfully addressed challenges in remote and resource-constrained environments.

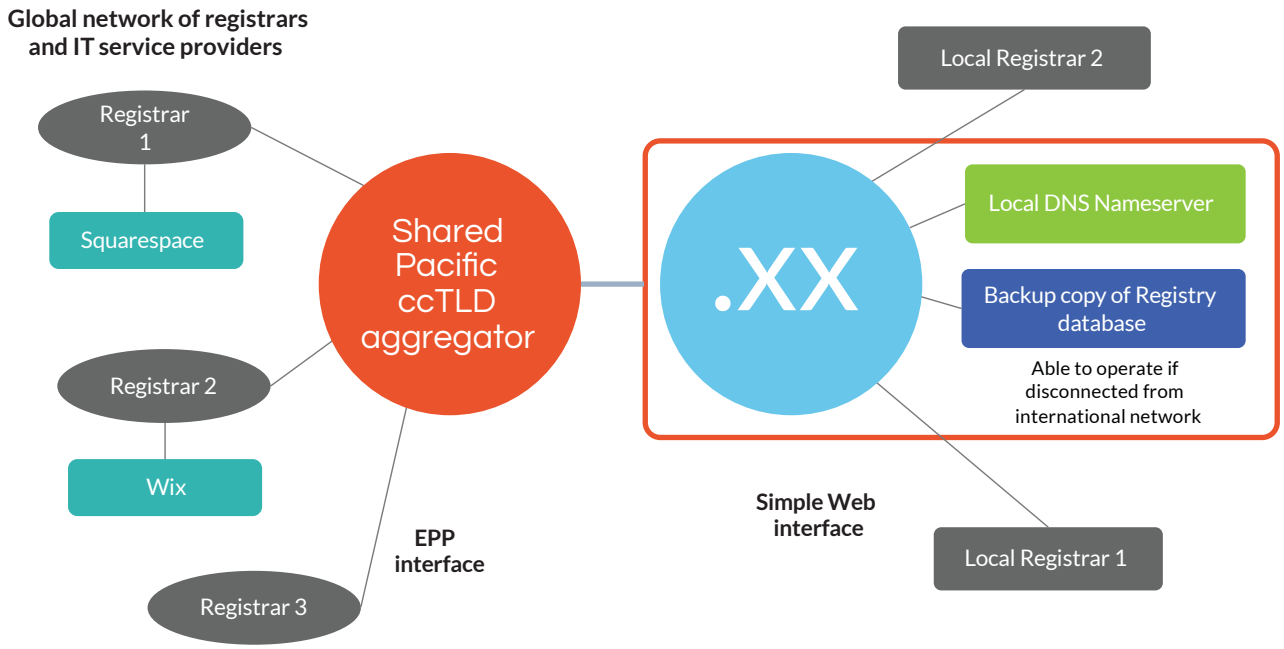
The DNS authoritative nameserver represents the technical heart of the ccTLD system, holding the authoritative records that map domain names to the corresponding IP addresses. By establishing local authoritative nameservers, Pacific Island nations would gain greater control over their domain systems and reduce dependency on overseas infrastructure. These servers would be configured to international standards, ensuring compatibility with global DNS systems while maintaining local control. The redundant design would ensure continued operation even during equipment failures or maintenance periods.

The implementation of DNS public resolvers with DNSSEC validation would enhance security for all internet users in the country. These resolvers convert human-readable domain names into machine-readable IP addresses, and by implementing DNSSEC validation, they would verify the authenticity of DNS responses, protecting users from various forms of DNS-based attacks.

The establishment of local registry databases would transform the management of domain registrations from what are often paper-based systems to modern digital databases. These databases would maintain records of all registered domains, their owners, and their configuration, enabling efficient management and updating of domain information. The digitization of these records would not only improve operational efficiency but also enable new services and capabilities that depend on programmatic access to registry data.

The implementation of comprehensive backup systems for registry databases and software would ensure operational continuity even during equipment failures or disasters. These redundant systems would include both local backups for rapid recovery and off-site backups for protection against catastrophic local events.

Figure 9: Upgrading Pacific CCTLD Registry Local infrastructure



The establishment of Internet Exchange Points (IXPs) would transform the routing of internet traffic within the countries. By enabling local internet service providers to exchange traffic directly rather than routing it through international connections, IXPs would reduce latency, lower costs, and improve the user experience for local internet users.

This would be building on the experience of Papua New Guinea and Fiji which each established national IXPs in 2017 with the assistance of the Internet Society and APNIC. Thes technical partners are also presently working to assist Samoa establish a national IXP. The benefits of a national deployment were shown by the 10% decrease of Internet services price in PNG and Internet latency in Fiji between local operators improving significantly from 60ms to 2ms.[11]

Upgrading local ccTLO Registry Local Infrastructure to also support the hosting of a local Internet Exchange Point (IXP) will deliver technical, economic, and disaster-resilience benefits.

Improved Internet Performance

- local IXPs reduce latency by keeping traffic within the country instead of routing it through international networks
- By minimising the number of network hops, IXPs reduce congestion and packet loss, ensuring smoother and more reliable local Internet performance.

Cost Savings

- Local traffic exchange reduces the need for expensive international bandwidth.

Increased Resilience During Natural Disasters

- Allow communication to continue even when international links are disputed. E.g. During Haiti's 2021 earthquake, the local XP enabled critical communication and coordination.
- Provide redundancy by enabling ISPs to switch between local and international routes in case of outages.

Support for Local Content and Businesses

- XPs encourage the hosting of local content within the country improving access speed and reliability.

Autonomy and Security

- By keeping traffic tocal, IXPs reduce exposure to potential surveillance or interferance durig international routing.
- Reduce points of failure associated with submarine cables or satelllte links.

The resilience infrastructure components, including backup power systems and alternative connectivity options, would ensure continued operation during various disruption scenarios. Battery systems with solar charging would provide immediate backup during power outages, while diesel generators would offer longer-term power during extended outages. Satellite connectivity through systems like Starlink would provide alternative communication paths when submarine cables are damaged.

The optional local cloud capacity would address growing demand for local data storage and processing, particularly for government services. By including rack space for local cloud services within the infrastructure, the proposal would enable gradual development of local cloud capabilities without requiring separate facilities.

11 See https://etradeforall.org/courses/capacity-building-workshop-strengthening-digital-connectivity-infrastructure-and-internet

Figure 10: Prefabricated DNS and Local cloud and IXP "in a shed"

Source: Illustrative diagrams from DXN. https://dxn.solutions

5.5.2 Capacity Building and Ecosystem Development

The technical training component would develop the human capacity necessary to operate and maintain the enhanced infrastructure. Training programs for registry operations would ensure local staff can effectively manage the technical aspects of ccTLD operation, including database management, DNS configuration, and security monitoring. This knowledge transfer would reduce dependency on external technical support and build sustainable local capacity.

Training on DNS management would develop specialized skills in configuring and maintaining DNS systems, ensuring reliable domain resolution and implementing security features like DNSSEC. Given the central importance of DNS to internet operations, these specialized skills would be particularly valuable for ensuring reliable and secure internet service.

Cybersecurity training would address the growing threats to internet infrastructure worldwide. This training would cover threat detection, vulnerability management, incident response, and recovery procedures. By developing local cybersecurity expertise, the program would enhance the protection of critical infrastructure and build capacity to respond effectively to security incidents.

The train-the-trainer programs would develop local training capacity, enabling sustainable knowledge transfer beyond the initial project period. By identifying promising local IT professionals and developing their training skills, the program would create a multiplier effect, allowing knowledge to spread throughout the local IT community.

The business ecosystem development components would address the commercial aspects of ccTLD operation and utilization. Supporting local IT companies to become ccTLD registrars would create a distribution channel for domain registrations while also developing local businesses. These registrars would provide registration services with local payment options, making domains more accessible to local businesses and individuals.

The business onboarding support would help local businesses establish effective online presences using local ccTLDs. This support would go beyond simple domain registration to include guidance on website development,

hosting, security, and online marketing. By helping businesses realize tangible benefits from their online presence, this support would drive demand for local domains and contribute to digital economic development.

The development of local user forums would create communities where users could exchange ideas, solve problems, and learn from each other. These communities would provide peer support, reducing dependency on formal training or external assistance.

The marketing support for ccTLD operators would help them effectively promote their domains and build awareness of the benefits of using local ccTLDs. This marketing assistance would include strategy development, content creation, and campaign execution, helping registry operators effectively communicate their value proposition to potential users.

5.5.3 Regional Cooperation Framework

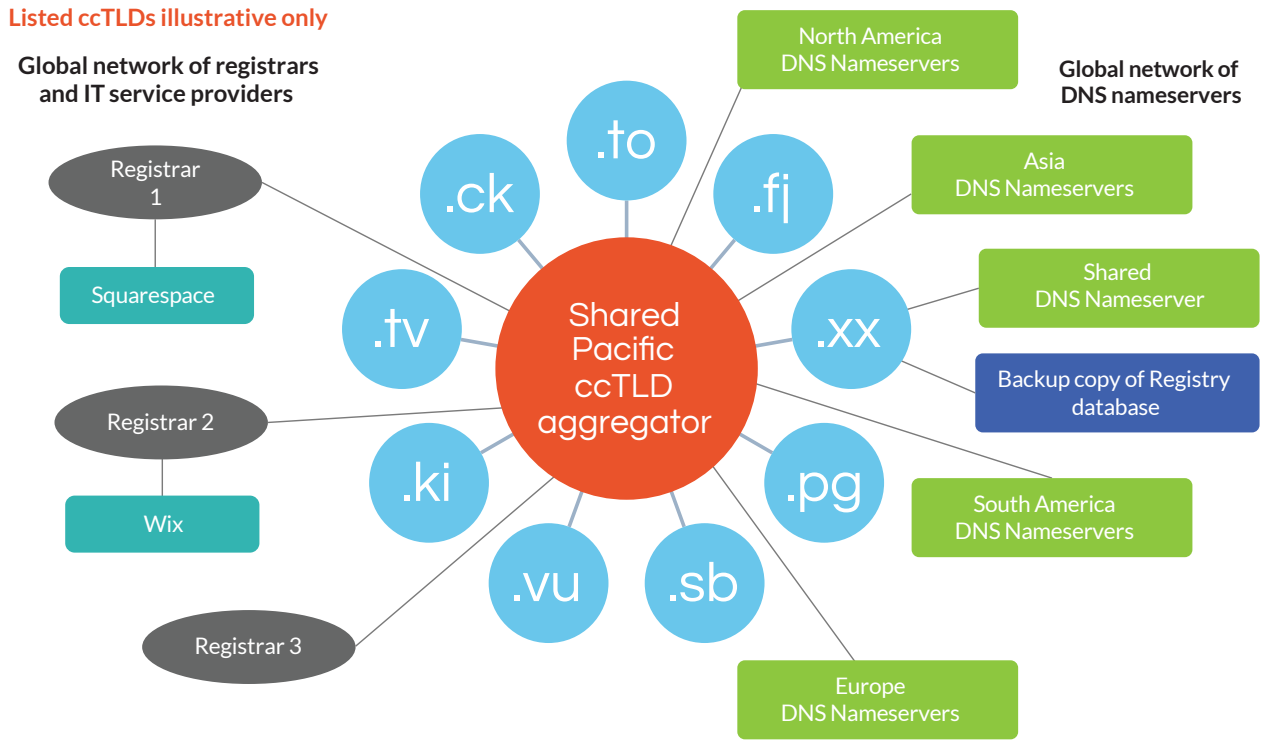
The shared Pacific ccTLD aggregator would serve as a central infrastructure component connecting multiple Pacific ccTLDs to global systems. This aggregation would enable economies of scale that individual ccTLDs could not achieve alone, allowing them to integrate with global registrars and service providers. The aggregator would serve as a single point of connection for global registrars like GoDaddy, reducing the technical barriers to offering Pacific ccTLDs through these platforms.

The connection to global DNS infrastructure would ensure reliable and low-latency domain resolution worldwide. By establishing presence on DNS servers across North America, Europe, Asia, and South America, Pacific ccTLDs would provide fast resolution times for users around the world.

The shared infrastructure would reduce costs through economies of scale in equipment, maintenance, and operations. Rather than each country independently establishing international connections and infrastructure, the shared approach would distribute these costs across multiple participants.

The implementation of consistent security practices across participating ccTLDs would raise security standards regionwide. By sharing security technologies, expertise, and monitoring capabilities, participants would benefit from collective security improvements.

Figure 11: Building a Global-scale Pacific ccTLDs Registry infrastructure



5.6 Implementation Approach

The implementation would follow a methodical, phased approach designed to build capacity progressively while delivering tangible benefits at each stage:

5.6.1 Assessment and Planning Phase

This would involve detailed evaluation of current infrastructure, processes, and capabilities in each participating country. This assessment would identify specific needs, challenges, and opportunities, allowing for customization of the standard approach to each country's context. The planning would establish clear milestones, responsibilities, and success metrics for the implementation.

5.6.2 Infrastructure Deployment Phase

This would involve the physical installation of equipment and systems with appropriate redundancy and security measures. This deployment would be coordinated with local telecommunications providers, government agencies, and other stakeholders to ensure integration with existing systems.

5.6.3 Training and Capacity Building Phase

This would develop local technical and business capabilities through structured training programs, mentoring, and practical experience. This capacity building would begin before infrastructure deployment and continue throughout the implementation, ensuring local staff can effectively operate and maintain the new systems from day one.

5.6.4 Integration with Global Systems Phase

This would establish connections with global registrars, DNS infrastructure, and service providers. This integration would make Pacific ccTLDs available through mainstream registration platforms and ensure reliable resolution worldwide.

5.6.5 Ongoing Support and Maintenance Phase

This would provide continued technical assistance and knowledge transfer beyond the initial implementation. This support would gradually transition from external expertise to local capacity, ensuring sustainable operations.

5.6.6 Implementation Costs and Resource Allocation

The estimated cost of approximately $1 million per country would be strategically allocated between hardware/infrastructure components and skills/business capability development to ensure a balanced approach that addresses both immediate technical needs and long-term sustainability. The cost allocation would generally follow this distribution:

Physical Infrastructure and Hardware Components (60% of total budget)

- DNS Infrastructure Equipment: $250,000
  - Authoritative nameservers for the local ccTLD and redundant systems (can hold DNS for other ccTLDs in region)
  - Public resolvers with DNSSEC validation capability
  - Registry database servers and storage
  - Backup and disaster recovery systems
- Resilience Infrastructure: $180,000

    - Backup power systems (batteries, solar panels, generators)
    - Alternative connectivity options (satellite equipment (e.g.Starlink), redundant networking)
    - Physical security measures
    - Environmental controls (cooling, humidity management)
- Internet Exchange Point Equipment: $120,000
    - Switching infrastructure
    - Routing equipment
    - Monitoring systems
    - Interconnection facilities
- Optional Local Cloud Capacity: $50,000
    - Rack space and equipment for initial cloud deployment
    - Computing resources for government services
    - Storage systems for local data repositories

Skills and Business Capability Development (40% of total budget)

- Technical Training Programs: $150,000
    - Registry operations training
    - DNS management and security implementation
    - Cybersecurity training
    - System administration and maintenance
    - Train-the-trainer development
- Business Ecosystem Development: $130,000
    - Registrar development support
    - Business onboarding programs
    - E-commerce and website development workshops
    - Digital marketing training
    - Payment systems integration
- Community Development and Outreach: $70,000
    - User forum development and facilitation
    - Public awareness campaigns
    - Educational materials development
    - Community engagement events
    - Stakeholder coordination
- Marketing and Promotion: $50,000
    - Brand development for ccTLD
    - Marketing strategy development
    - Content creation for awareness campaigns
    - Promotional materials
    - International outreach for defensive registrations

This balanced allocation ensures that infrastructure improvements are matched with the human capacity needed to maximize their value and sustainability. The phased implementation would allow for adjustments to this allocation based on specific country needs and ongoing assessment of the most effective interventions.

For smaller Pacific Island nations, a modified cost structure might be implemented with greater emphasis on shared regional resources, while larger nations might allocate more funding to country-specific infrastructure. This flexible approach recognizes the diverse sizes, needs, and capabilities of different Pacific Island countries while maintaining the core components necessary for success.

5.7 Expected Outcomes and Benefits

The implementation of this proposal would yield significant outcomes and benefits across multiple timeframes, from immediate improvements in infrastructure reliability to long-term transformations of digital economies.

5.7.1 Short-term Benefits

- Improved infrastructure reliability, reducing downtime and disruptions
- Lower registration costs, making local domains more accessible
- Increased registrations, improving financial sustainability and relevance of local domains

5.7.2 Medium-term Benefits

- Enhanced local content development, providing more relevant information and services
- Business growth enabled by effective online presences
- Revenue generation from domain registrations, creating sustainable funding
- Reduced dependency on offshore infrastructure, enhancing resilience and local control

5.7.3 Long-term Benefits

- Development of thriving local digital ecosystems
- Greater digital sovereignty, enhancing countries' ability to shape their digital futures
- Stronger digital connections between Pacific Island nations
- Broader economic benefits from increased digital participation

5.7.4 Revenue Growth for ccTLD Operators

The financial sustainability of ccTLD operations represents a critical factor in their long-term success. The implementation of this proposal would create multiple revenue streams that would transform ccTLD operations from cost centers to sustainable enterprises.

Defensive Registration Revenue

International brands typically register their trademarks across multiple domains to protect their brand identity. With improved accessibility and integration with global registration systems, Pacific ccTLDs could capture this revenue stream from multinational corporations seeking to protect their brands. Analysis of comparable small-nation ccTLDs suggests this could generate approximately $150,000-$200,000 annually per country from corporate defensive registrations alone.

Tiered Pricing Models

Modern registry systems enable implementation of tiered pricing models that balance accessibility with revenue optimization. For example:

- Premium domains (single words, generic terms): $100-$500 annually
- Standard business domains: $20-$50 annually
- Individual/personal domains: $5-$15 annually
- Educational/non-profit domains: Discounted rates

These tiered structures ensure affordability for local users while capturing appropriate value from commercial entities, creating a more balanced revenue model than current flat-rate high pricing.

Value-Added Services

Beyond basic domain registration, ccTLD operators could offer additional services that generate revenue while adding value for users:

- Enhanced security packages (DNSSEC, certificate management)
- Domain portfolio management for businesses
- Website analytics and performance monitoring
- Local web hosting and email services
- Consulting services for online presence optimization

Revenue Growth Projections

Based on analysis of comparable ccTLDs that have undergone similar transformations, the following revenue growth pattern could be expected:

- Year 1: 100-200% increase from baseline (primarily from reduced costs and improved access)
- Year 2-3: 50-75% annual growth (from increasing local adoption and international defensive registrations)
- Year 4-5: 25-40% annual growth (from value-added services and ecosystem expansion)
- Year 5+: Sustained 10-20% annual growth (from ongoing market development)

By year 5, a typical Pacific ccTLD could sustainably generate $200,000-$300,000 annually, sufficient to fund ongoing operations, technology updates, and continued market development while contributing to broader digital economy initiatives.

5.7.5 Communication Resilience During Disasters and Cable Disruptions

The enhanced local infrastructure would transform disaster response and resilience capabilities in Pacific Island nations, providing critical communication abilities even when international connections are severed. This resilience addresses a significant vulnerability in the current infrastructure model.

Internal Communication Continuity

When submarine cables are damaged—as happened in Tonga following the 2022 volcanic eruption that severed the country's only international cable—the enhanced local infrastructure would enable continued internal communications including:

- Government emergency communications systems
- Local email exchange between domestic addresses
- Access to locally hosted websites with critical information
- Local news and information dissemination
- Coordination between emergency response agencies
- Financial system operations for local transactions

For a practical example, during the Hunga Tonga–Hunga Ha'apai volcanic eruption and tsunami, Tonga lost all international connectivity for 38 days. With the proposed infrastructure, while international communications would still be disrupted, internal digital communications could have continued, dramatically improving the coordination of relief efforts, distribution of emergency information, and maintenance of basic government services.

Partial External Communication Through Alternative Pathways

The resilience infrastructure components would provide limited but critical external communication capabilities during cable disruptions through:

- Satellite connectivity options (e.g., Starlink terminals at key infrastructure points)
- High-frequency radio data links for essential communications
- Prioritized message routing for emergency communications
- Cache servers with critical external information stored locally

Real-time Disaster Information Management

During disasters, the local infrastructure would support:

- Distribution of real-time threat updates (tsunami warnings, storm tracking)
- Operation of emergency management dashboards
- Coordination of evacuation procedures
- Remote medical consultations within the affected country
- Resource allocation tracking and management
- Documentation of damage for assessment and recovery planning

Critical Service Maintenance

Essential digital services could continue operating, including:

- Banking and payment systems for local transactions
- Hospital and healthcare information systems
- Public safety communication networks
- Utility management systems
- Education platforms for emergency information
- Government administrative systems

Economic Impact of Improved Resilience

The economic benefits of this disaster resilience are substantial:

- Reduced economic losses during connectivity disruptions
- Faster recovery times following disasters
- Lower insurance costs through improved risk management
- Enhanced business continuity for local enterprises
- Preservation of critical data and records
- Continued operation of local digital economy activities

Analysis of past cable disruptions suggests that even a single major disruption event can result in economic losses of 3-5% of annual GDP.[12] The improved resilience could reduce these losses by 40-60%, representing a substantial return on investment beyond the normal operational benefits.

In regions where natural disasters are frequent and cable repairs can take weeks or months; this resilience represents not merely a technical improvement but a fundamental transformation in national security and social stability during crisis events.

5.8 Conclusion

The "Develop Pacific ccTLD Registry Local Infrastructure and Digital Economy" proposal represents a comprehensive approach to addressing a critical gap in the digital infrastructure of Pacific Island nations. By focusing on both physical infrastructure and capacity building, it addresses the technical, operational, and economic challenges that have limited the effectiveness of Pacific ccTLDs.

The proposed solution would not only improve the resilience and security of ccTLD operations but would also create opportunities for local businesses, reduce costs, and foster the development of local digital economies. The regional cooperation component would help achieve economies of scale while respecting the sovereignty and unique needs of each participating country.

With estimated costs of approximately $1 million per country for both infrastructure and capacity building, this represents a significant but achievable investment that would complement and enhance the value of existing submarine cable investments in the region. The potential economic and social benefits—particularly the creation of sustainable local digital ecosystems and improved disaster resilience—make this proposal a compelling opportunity for donor support.

By implementing this proposal, Pacific Island nations would gain greater control over their digital futures, reduce dependency on external platforms, and create pathways for local businesses to participate more fully in the global digital economy while preserving their distinctive national digital identities. The initiative would transform submarine cable investments from mere connectivity into true enablers of local digital economic development, creating lasting value for Pacific communities.

12 World Bank Group, "Pacific Resilience Program: Economic Impact Assessment of Submarine Cable Disruptions," Regional Research Report, 2022.

6. Project Proposal for Pacific Cyber Health Monitoring and Measurement Initiative

This proposal outlines a comprehensive cyber health monitoring and measurement system for Pacific Island countries to ensure Internet Service Providers (ISPs) and registry operators follow security best practices. Drawing on the public health model and the Internet Infrastructure Health Metrics Framework (IIHMF) developed by leading academics[13] the CyberGreen Institute[14] and Google[15], this initiative aims to establish standardized metrics, data collection frameworks, and analytics dashboards to track cybersecurity posture across Pacific Island nations. By implementing systematic monitoring and providing actionable intelligence on critical internet infrastructure components, this project should address significant cybersecurity vulnerabilities affecting Pacific digital infrastructure, reduce DNS abuse, improve security protocol implementation, and support evidence-based policy making.

6.1 Current Challenges in Pacific Cybersecurity

Despite multi-million-dollar investments in Pacific Island telecommunications networks by donors, governments, and investors, there is currently no systematic way to measure whether network operators are adopting cybersecurity best practices. This creates significant risk to these investments and to the security of Pacific digital ecosystems.

Several Pacific ccTLDs have become havens for cybercriminal activity. According to Palo Alto Networks data, the Tokelau (.tk) domain had become by 2021 one of the world's most abused TLDs, with phishing domains per capita reaching 462,098 times higher than Germany's .de ccTLD. Similarly, Palau's .pw domain exhibits phishing registrations 20,286 times higher than normal rates. Even Samoa's .ws domain shows elevated levels, with phishing domains per capita 11.44 times higher than Germany's .de domain[16].

The region faces several critical challenges. Stakeholders lack comprehensive insights into the security practices of ISPs and registry operators across Pacific nations. Without proper measurement frameworks, it's impossible to assess current status, identify vulnerabilities, or track improvements. Essential security protocols such as DNSSEC, DMARC, and TLS are inconsistently deployed across networks in the region, creating a patchwork of security capabilities that leaves significant gaps.

Many operators leave equipment in default settings that can serve as amplifiers in DDoS attacks. These open services create significant systemic risk that affects the entire internet ecosystem. Policymakers lack reliable data for setting security priorities and assessing the effectiveness of interventions, hampering their ability to make informed decisions about resource allocation and regulatory approaches. Limited local capacity for security monitoring and incident response means vulnerabilities often go undetected or unaddressed.

13 See Sedenberg, Elaine, and Deirdre Mulligan. "Public Health as a Model for Cybersecurity Information Sharing." Berkeley Technology Law Journal, vol. 30, no. 3, 2016, pp. 1687–1740, http://dx.doi.org/10.15779/Z38PZ61. Slupska, Julia, and Mariarosaria Taddeo. "Generative Metaphors in Cybersecurity Governance." *The 2019 Yearbook of the Digital Ethics Lab*, edited by Christopher Burr and Stefania Milano, Springer, 2020, https://doi.org/10.1007/978-3-030-29145-7_2. Wash, Rick. "Folk Models of Home Computer Security." Proceedings of the Sixth Symposium on Usable Privacy and Security, 2010, pp. 1-16. Wolff, Josephine. "Cybersecurity as Metaphor: Policy and Defense Implications of Computer Security Metaphors." 2014 TPRC Conference Paper, Mar. 2014.

14 See CyberGreen. "The Cyber Green Initiative: Concept Paper Improving Health through Measurement and Mitigation: Cyber Green Initiative Concept Paper." 2014, https://www.jpcert.or.jp/research/GreenConcept-20141117_en.pdf.

15 Bill Reid. Security Advisor, Office of the CISO, Google Cloud and Taylor Lehmann, Director, Office of the CISO, Google Cloud: "Cyber Public Health: A new approach to cybersecurity", July 20, 2024, https://cloud.google.com/blog/products/identity-security/cyber-public-health-a-new-approach-to-cybersecurity

16 See https://unit42.paloaltonetworks.com/top-level-domains-cybercrime/

6.1.1 Cybersecurity Risks in Pacific ccTLDs

Pacific Island ccTLDs face particularly severe challenges that damage both security and reputation. According to CleanDNS data for 2022-2023, abuse in Pacific Island ccTLDs breaks down as 48.4% spam, 42.1% phishing, 7.4% malware, and the remainder including botnet activity. With 245,131 abuse records spanning 97,804 unique domains, there is significant concentration of malicious activity.

Some Pacific ccTLDs have offered free or extremely low-cost domain registrations, making them attractive to cybercriminals seeking disposable infrastructure for attacks. Research confirms that "TLDs offering free domain registration are among the top preferred TLDs for phishing domains." The absence of strong verification requirements or registration restrictions makes these domains easy targets for exploitation, unlike more secure ccTLDs where verification processes are more thorough.

The association with cybercrime creates an unfair reputational burden on small island nations, affecting how they are perceived globally. This reputational damage extends beyond the digital realm to impact broader perceptions of these nations in international contexts.

6.1.2 DNS Abuse Management Challenges

The management of DNS abuse presents specific challenges for Pacific Island ccTLDs. Many ccTLDs in the region lack proper naming policies or complaint mechanisms, creating environments where malicious activities can flourish. Without standardized abuse reporting and response mechanisms, registry operators struggle to identify and address problematic domains efficiently.

According to CleanDNS, which currently manages abuse for over 33 million domains and 320+ top-level domains globally, effective DNS abuse management requires both proactive monitoring and responsive handling of reported issues[17]. Their evidence-based approach has achieved over 99.9% accuracy when actioning abusive domains, demonstrating that effective management is possible with the right systems and expertise.

Currently, many Pacific ccTLDs lack the infrastructure to proactively monitor daily registrations for unusual activity, such as contact names that don't correlate to the domain name holder or unusual email addresses. They also face challenges in accessing and reviewing DNS threat intelligence feeds that could help identify potentially malicious domains for investigation.

6.2 Proposed Solution: The Cyber Public Health Approach

This initiative should implement a comprehensive monitoring system drawing on public health methodologies to track and improve regional cybersecurity posture. Just as public health focuses on population-level interventions to prevent disease, cyber public health focuses on systemic risks that affect the entire internet ecosystem, especially at the country level.

The Internet Infrastructure Health Metrics Framework (IIHMF) should serve as the foundation for this work. The IIHMF provides a set of models and metrics to measure and score the health of six critical internet infrastructure components: DNS (Domain Name System), Routing, Open Services, Email Security, Security Certificates, and Security Protocols and Services.

This framework shifts the focus from individual security (the medicine approach) to population-level measurements and interventions (the public health approach). By measuring these components at scale, the initiative can identify systemic issues that affect entire networks and regions, rather than focusing solely on individual systems or organizations.

17 See https://cleandns.com/

6.2.1 Project Components

1. Measurement Infrastructure

The measurement infrastructure should collect comprehensive data on cybersecurity practices and vulnerabilities across Pacific Island networks. This should include the development of detailed DNS abuse tracking metrics to identify patterns and trends in phishing, malware, and spam distribution. The system should also implement vulnerability scanning to identify default configurations and passwords that create security risks.

Monitoring of security protocol adoption rates for technologies like DNSSEC, DMARC, and SPF should be established across critical infrastructure to track security improvements over time. The initiative should create DDoS vulnerability assessment frameworks to quantify amplification risks from misconfigured services. Baseline network hygiene indicators for ISPs and registry operators should be established, along with comprehensive email security measurements covering TLS implementation and email authentication configurations.

To collect this data, the initiative should deploy automated scanning infrastructure across the Pacific region to continuously monitor security practices. Real-time monitoring systems for critical infrastructure components should be implemented alongside passive DNS analysis capabilities to detect abuse patterns. Active protocol testing should verify security implementations, while configuration assessment tools should identify vulnerable settings. Standardized incident reporting mechanisms should be designed for stakeholders to report potential security issues.

2. Analytics and Dashboard System

The analytics platform should transform collected data into actionable intelligence for stakeholders at regional and national levels. Regional dashboards should provide real-time status visualization showing the security posture of Pacific networks. Trend analysis and forecasting capabilities should help identify emerging issues before they become widespread problems.

Country-level comparative tools should benchmark performance across the region, creating healthy competition for security improvements. Protocol adoption tracking should show progress in implementing security technologies across the region. Detailed vulnerability mapping should help prioritize remediation efforts, while incident correlation tools should identify related security events. Regular comprehensive summaries documenting internet infrastructure health across Pacific Island Countries should provide stakeholders with actionable insights.

For individual countries, the system should create detailed national metrics dashboards customized for each country's unique needs and infrastructure. ccTLD performance tracking tools with abuse monitoring should be provided to registry managers, helping them identify and address problematic domains. ISP security scoring systems should encourage continuous improvement in network security practices.

The platform should monitor critical infrastructure status with alert mechanisms for urgent security issues. Remediation efforts should be tracked to measure progress and demonstrate the effectiveness of security interventions. Resource allocation guidance based on identified priorities should help countries maximize the impact of limited security resources.

3. Enhanced DNS Abuse Management

A core component of this initiative should be the implementation of robust DNS abuse management processes across Pacific ccTLDs, combining detection, verification, remediation, and tracking to significantly reduce malicious domain usage.

The system should aggregate reports from multiple sources including cyber security companies, carriers, individual reports from abuse forms, trusted partners, and reputable blocklists. It should also implement algorithm-based detection on raw data to proactively identify suspicious patterns. All incoming reports should be standardized and enriched with records, snapshots, DNS data, and other relevant information to provide complete context for analysis.

Each Pacific ccTLD should receive a customized abuse management process aligned with their specific policies and registration requirements. This should include proactive monitoring of daily registrations to identify suspicious patterns before they can cause harm. The system should cross-reference registrations against threat intelligence feeds and historical abuse patterns to flag potentially problematic domains for review.

When verified abuse is detected, the system should facilitate rapid response through standardized communication channels and clearly defined action processes. Registry operators should receive comprehensive evidence packages documenting the abuse, enabling them to take appropriate action with confidence. The system should track the full lifecycle of abuse reports, including response times and outcomes, to measure effectiveness and drive continuous improvement.

In addition to reactive handling, the initiative should develop preventative measures based on abuse trends and patterns. This may include registration policy recommendations, verification procedures for high-risk registrations, and technical controls to limit abuse potential. Domain reputation systems should also be incorporated to help identify problematic registrants who repeatedly engage in abusive activities.

Training and documentation for registry operators should ensure they have the knowledge and tools to effectively manage abuse within their domains. This includes guidance on evidence evaluation, appropriate response measures, and establishing effective abuse policies that balance openness with security.

4. Mitigation and Capacity Building

Building local capability to respond to identified issues is crucial for sustainable improvement. The initiative should deliver specialized workshops on the Internet Infrastructure Health Metrics Framework and its applications to build understanding of the cyber public health approach. Training programs for local technical staff should focus on interpreting monitoring data and implementing security improvements to address identified vulnerabilities.

Security implementation guides for DNS, routing, and open services remediation should provide practical steps for addressing common issues. Incident response training should focus on the most common vulnerabilities in the region, building practical skills for local security teams. Technical communities of practice should be established to share knowledge across the region and foster collaborative problem-solving.

The initiative should develop targeted campaigns to address specific vulnerabilities identified through monitoring. ccTLD abuse management processes using CleanDNS methodologies should be implemented to reduce malicious domain usage. ISP-focused improvement initiatives should address routing security and DDoS prevention, while collaborative security response mechanisms should be established for regional threats.

Regional collaboration should be fostered through a Pacific cyber health working group to coordinate response efforts. Shared resources for incident response and vulnerability management should maximize the impact of limited regional capabilities. Peer review mechanisms for security improvements should help validate and improve remediation efforts, while regional recognition programs should acknowledge cybersecurity excellence and encourage continuous improvement.

6.3 Implementation Approach

The implementation should follow a methodical, phased approach designed to build sustainable monitoring capability while delivering immediate security improvements.

6.3.1 Phase 1: Assessment and Baseline Establishment (3-6 months)

The initial phase should begin with a comprehensive scanning of Pacific Island networks to establish baseline security metrics. This should provide a clear picture of the current state and identify priority areas for improvement. Existing security protocols and implementations across the region should be documented to understand the current landscape. Priority vulnerabilities requiring immediate attention should be identified, and stakeholder capabilities and resources for remediation should be mapped.

The Internet Infrastructure Health Metrics Framework should be adapted to the specific context of Pacific Island nations, ensuring it addresses the unique challenges and infrastructure characteristics of the region. Initial focus areas should be selected based on identified priorities, with particular attention to DNS, Routing, and Open Services as foundational components. Measurement methodologies suitable for Pacific infrastructure should be developed, taking into account connectivity challenges and distributed geographies. Initial benchmarks for comparison should be established to track progress over time.

Stakeholder engagement is critical to success, and the cyber public health approach should be introduced to key stakeholders through workshops and briefings. Working relationships with network operators, registry managers, and policymakers should be established to ensure collaborative implementation. Data sharing and remediation agreements should be developed to facilitate effective action on identified issues. Champions for security improvements should be identified in each country to drive local engagement and adoption.

6.3.2 Phase 2: Infrastructure Development (6-9 months)

During the second phase, scanning and monitoring infrastructure should be deployed across the region to enable continuous assessment of security practices. Data collection frameworks should be implemented to gather relevant metrics on key security indicators. Secure data storage and analysis capabilities should be established to protect sensitive information while enabling effective analysis. Measurement systems should be tested and calibrated to ensure accuracy and reliability.

Regional and country-specific dashboards should be created to visualize security data for different stakeholders. Visualization tools for complex security data should make information accessible and actionable for non-technical users. Reporting templates should be developed for different stakeholder needs, ensuring information is presented in useful formats. Usability testing with key stakeholders should refine interfaces to maximize utility and adoption.

Initial mitigation planning should identify priority remediation activities based on the initial scans, focusing on high-impact, low-cost improvements. Guidance materials for addressing common vulnerabilities should be developed to support local remediation efforts. Action plans for high-risk issues should establish clear steps for addressing critical vulnerabilities. Coordination mechanisms for regional response should be established to facilitate collaborative security improvements.

6.3.3 Phase 3: Operational Implementation (9-18 months)

Full-scale monitoring across all six IIHMF components should be launched during this phase, providing comprehensive visibility into regional cybersecurity posture. Continuous scanning and assessment processes should be implemented to track changes and identify new issues as they emerge. Regular reporting to stakeholders should begin, providing actionable insights for security improvements. Trend analysis and

forecasting capabilities should be established to identify emerging security challenges.

Targeted mitigation efforts should implement DNS abuse management processes for Pacific ccTLDs, significantly reducing malicious domain usage. Support for remediation of open service vulnerabilities should help reduce DDoS amplification risks. Assistance with routing security improvements should enhance the integrity of regional network traffic. Email security enhancements should reduce phishing effectiveness and improve communication reliability.

Capacity building should deliver training programs for technical staff to enhance local security capabilities. Communities of practice for specific security domains should create sustainable knowledge-sharing networks. Hands-on remediation support should help address complex security issues while building practical skills. Local expertise in security monitoring and mitigation should be developed to ensure long-term sustainability.

6.3.4 Phase 4: Sustainability Development (18-24 months)

In the final phase, operational responsibilities should transition to local teams, ensuring long-term sustainability of the initiative. Mentoring relationships should be established for ongoing support as local teams take ownership of the systems. Procedures and best practices should be documented to preserve institutional knowledge. Training materials for new staff should ensure continuity as personnel change over time.

Sustainable funding models for continued operation should be developed to maintain the monitoring and response capabilities. Governance structures for regional coordination should be established to ensure continued collaboration. Strategic plans for future capability development should guide ongoing improvement and adaptation. Integration opportunities with global security initiatives should be identified to maximize impact and leverage external resources.

The initial implementation should be evaluated to assess outcomes and impact on regional security posture. Metrics and measurement approaches should be refined based on operational experience and stakeholder feedback. Priorities should be adjusted based on identified trends and emerging threats. Planning for the next phase of development should ensure continuous improvement and adaptation to evolving security challenges.

6.4 Budget and Resources

The proposed budget for this two-year initiative is $400,000, allocated strategically to maximize impact across stakeholder engagement, infrastructure development, technical expertise, and capacity building.

6.5 Expected Outcomes and Benefits

6.5.1 Enhanced Security Posture

The initiative should significantly improve the security posture of Pacific Island networks through measurable reductions in DNS abuse across Pacific ccTLDs. Enhanced monitoring and management should identify and address malicious domains more rapidly, limiting their effectiveness and duration. Higher adoption rates of security protocols like DNSSEC, DMARC, and modern TLS implementations should improve baseline security across the region.

Decreased vulnerability to DDoS attacks should result from remediation of open services that could otherwise be exploited as amplifiers. Improved routing security should reduce the risk of traffic manipulation and hijacking, enhancing the integrity of regional communications. Stronger email security practices should reduce phishing and spam effectiveness, protecting users from common attack vectors. Better certificate management should enhance trust in online services through improved authentication practices.

6.5.2 Improved Regional Coordination

The program should create stronger regional cybersecurity coordination through shared understanding of cybersecurity challenges across Pacific nations. Collaborative approaches to addressing common vulnerabilities should maximize limited resources and expertise. Consistent metrics for measuring progress and comparing performance should enable benchmarking and best practice identification.

Regional knowledge sharing and best practice development should accelerate security improvements through collective learning. Collective representation in global cybersecurity forums should strengthen the Pacific voice in international security discussions and policy development. These collaborative mechanisms should build lasting relationships between national security teams, creating a foundation for continued cooperation beyond the initial project timeline.

6.5.3 Evidence-Based Policy Development

Policymakers should benefit from comprehensive data on cybersecurity status and trends, enabling more informed decision-making about priorities and interventions. Clear metrics for evaluating policy effectiveness should help identify which approaches deliver the best outcomes. Quantifiable measurements of cybersecurity investments should demonstrate return on investment and justify continued resource allocation.

The ability to benchmark against regional and global standards should provide context for evaluating national performance and setting appropriate goals. Tools for prioritizing resources based on actual risk should ensure limited cybersecurity resources are directed to areas with the greatest potential impact. This evidence-based approach should transform cybersecurity policy from intuition-based to data-driven, significantly improving effectiveness and efficiency.

6.5.4 Capacity Development

The region should develop enhanced cybersecurity capabilities through increased local expertise in security monitoring and remediation. Sustainable processes for ongoing security assessment should establish regular practices that continue beyond the project timeline. Enhanced skills in data analysis and interpretation should enable local teams to derive actionable insights from security metrics.

Improved incident response capabilities should reduce the impact of security incidents when they occur, limiting damage and recovery time. Self-sustaining communities of practice should support continued learning and knowledge sharing, creating a foundation for ongoing skill development. These capacity improvements should enhance regional self-sufficiency in cybersecurity, reducing dependence on external expertise over time.

6.5.5 Economic Benefits

Improved cybersecurity will deliver significant economic benefits through protection of digital investments in the region. Submarine cables and telecommunications and data infrastructure should be better protected from security threats, preserving their value and functionality. Reduced costs from security incidents and breaches should improve the return on digital investments and lower operational risks for businesses and governments.

Enhanced reputation of Pacific digital services should make the region more attractive for digital business and investment. Increased trust in e-commerce and online transactions should facilitate greater digital economic activity and inclusion. Greater participation in the global digital economy should create new opportunities for Pacific businesses and citizens. These economic benefits should extend beyond the digital sector to enhance overall economic development and resilience.

7. Project Proposal for Community-Driven Local Internet Connectivity

This proposal outlines a strategic multistakeholder initiative to develop scalable models for expanding local internet connectivity and digital skills across Pacific Island communities. Despite global advances in mobile technology, Pacific Island nations face significant challenges with only 23% of the population regularly connected to 4G+ networks, 18% lacking coverage entirely, and 59% not utilizing available connectivity. This initiative aims to identify practical, culturally-appropriate community-driven solutions to address both the coverage gap and the significant usage gap through sustainable business models that can scale to thousands of villages across the region.

7.1 Background and Context

Digital connectivity in the Pacific Islands faces two distinct challenges that significantly hinder socioeconomic development and integration with the global digital economy. The first challenge is the coverage gap, where local connectivity remains unavailable to 18% of Pacific Islanders. According to data from the GSM Association, addressing this gap would require an estimated $250 million in investment, coupled with regulatory reforms around licensing, import duties, and related costs for telecommunications equipment and consumer devices.

The second and more pervasive challenge is the usage gap, with 59% of Pacific Islanders not utilizing existing mobile connectivity. This underutilization stems from prohibitively expensive services and devices, compounded by limited digital literacy and inadequate understanding of how digital technologies can deliver tangible benefits to local communities. While telecommunications providers could theoretically address the technical infrastructure challenges through increased investment and partnerships with satellite operators, the usage gap requires more innovative approaches centered on community engagement, skill development, and sustainable business models.

Several promising initiatives have emerged across the region, demonstrating potential pathways toward increased connectivity and digital adoption. The Smart Island/Village initiatives in Tonga and Vanuatu have made notable progress in developing sustainable connectivity models. The Tongan Women in ICT group has successfully promoted digital literacy among traditionally underserved populations. Solomon Islands Telecom has pioneered an innovative approach where villages assume management responsibility for mobile towers, effectively navigating complex land ownership and maintenance challenges. Additionally, platforms like TikTok have supported island-specific tourism marketing campaigns in Eastern Indonesia, showcasing how digital tools can create economic opportunities for remote communities.

The experience of Grameen Bank's Village Pay Phone Program in Bangladesh provides a particularly valuable precedent for our approach. This initiative demonstrated that when local entrepreneurs, particularly women, have ownership and economic incentives to provide connectivity services, adoption rates increase dramatically at a significantly lower cost than traditional operator-driven models. The program revealed that the economic return and social incentives necessary to mobilize local agents to offer connectivity, basic training, and marketing services are lower than the return on investment required by traditional telecommunications operators.

7.2 Project Objectives

A critical objective is the identification of sustainable local business models through clearly defined community agent/participation structures with transparent incentives. This could include revenue sharing arrangements with telecommunication providers that ensure both commercial viability and community benefit. Such an

initiative should incorporate local entrepreneurship development programs to build capacity and create additional economic opportunities beyond basic connectivity. Integration of digital payment solutions should further enhance the value proposition and sustainability of these models.

Addressing critical infrastructure challenges is another objective. An important aspect should be the implementation of solar/hybrid power supply solutions suitable for remote island environments with unreliable or non-existent electricity access. Equipment security protocols and transparent land access arrangements should also be established to protect investments and ensure continuity of service. Technical maintenance support networks that balance local responsibility with technical expertise from telecommunications partners should be necessary.

One model to explore could be community internet connectivity hubs that provide reliable broadband access through strategic partnerships with mobile carriers or Low Earth Orbit (LEO) satellite operators. These hubs could serve as centers for comprehensive digital skills training programs tailored specifically to local needs and contexts. They should incorporate small business development support leveraging country code Top-Level Domains, creating pathways for local economic growth through digital channels. Furthermore, these hubs should provide essential cybersecurity awareness and protection education, ensuring that increased connectivity does not lead to increased vulnerability.

7.3 Methodology and Timeline

We propose a comprehensive 12-24 month multistakeholder process structured to ensure thorough engagement and practical outcomes. The initial phase should focus on convening stakeholders from across Pacific Island countries, including telecommunications providers, community representatives, government regulators, and international partners. This inclusive approach should ensure that diverse perspectives and expertise inform the development of solutions. Working groups should be established to focus on specific challenges, ensuring that specialized knowledge is directed toward the most relevant issues.

Following stakeholder engagement, the project should move to a collaborative option development phase lasting approximately eight months. During this period, the project should conduct a comprehensive analysis of socio-economic conditions across different Pacific Island contexts, identifying both common challenges and unique circumstances that may require tailored approaches. We should identify specific regulatory framework adjustments needed to enable innovative connectivity models, particularly regarding licensing requirements for community-based service providers and LEO satellite operators. Technical requirements for different geographical and population density contexts should be defined. Throughout this phase, the project should map potential partnership structures and funding mechanisms to ensure financial viability.

The third phase should focus on creating practical implementation models tailored to different Pacific contexts. The project could develop 3-4 detailed operational models, documented as practical project management templates with clear implementation steps. These should include comprehensive business models showing projected revenue streams, costs, and potential returns for community operators. Capital requirements should be outlined alongside potential funding sources, creating a clear pathway from concept to implementation. Importantly, these models should be practical documents intended for application.

The final phase should involve pilot implementation and monitoring in selected communities. Clear metrics for measuring success should be established, and comprehensive monitoring and evaluation frameworks should track both quantitative outcomes (connectivity rates, usage patterns) and qualitative impacts (community benefits, skill development). Learnings from these pilots should be systematically documented to inform refinement of the models and guide scaling efforts across the broader region.

7.4 Stakeholder Roles and Responsibilities

Participants in local communities should form the foundation of this initiative, taking ownership of hub operations and assuming responsibility for security and maintenance of equipment. They should manage local revenue collection through culturally appropriate methods and lead community engagement and education efforts. Their deep understanding of local contexts, needs, and cultural considerations should ensure that connectivity solutions are relevant and valuable to end users.

Telecommunications providers, including traditional mobile operators and emerging LEO satellite operators, should contribute technical infrastructure deployment expertise and ongoing network maintenance support. They should likely establish service level agreements that balance commercial viability with community accessibility, and provide training and technical capacity building to local operators. Their participation is essential for bridging the technical knowledge gap while ensuring that solutions meet industry standards for reliability and performance.

Government agencies should play a crucial role in regulatory framework development, creating enabling environments for innovative connectivity approaches. They may streamline licensing and permit processes to reduce barriers to entry for community-based providers. Universal service fund allocation mechanisms may be reviewed and potentially redirected to support community connectivity models. Policy coordination across different ministries (telecommunications, economic development, education) should be important to ensure a coherent approach to digital inclusion.

International partners may provide technical assistance, particularly in specialized areas such as satellite communications, renewable energy systems, and digital skills curriculum development. They may also contribute funding support for both pilot implementations and broader scaling efforts. Knowledge sharing from similar initiatives in other regions should accelerate learning and adaptation.

7.5 Budget Requirements

The initiative requires a multiphased funding approach, beginning with approximately $400,000 for the preparation and stakeholder engagement phase. This initial investment should fund comprehensive stakeholder consultations across multiple Pacific Island countries, preliminary technical assessments, and the development of draft operational models. The cost structure acknowledges the geographical challenges of working across dispersed island nations and the importance of face-to-face engagement for building effective partnerships.

Technical assistance requirements should be determined based on the specific models selected for implementation but are anticipated to include expertise in telecommunications infrastructure, renewable energy systems, business model development, and digital skills training. Implementation costs should similarly be determined through the planning process and should vary significantly based on the scale and scope of deployment, technological approaches selected, and existing infrastructure in target communities.

It is important to note that while initial funding is required to develop and test these models, the ultimate goal is to create financially self-sustaining systems that generate sufficient revenue to cover operational costs, maintain and upgrade equipment, and provide meaningful income for community operators. The experience of the Grameen Bank's Village Pay Phone Program demonstrated that with appropriate business models, such initiatives can achieve financial sustainability while delivering significant social benefits.

7.6 Expected Outcomes and Impact

The successful implementation of this initiative should substantially increase connectivity rates across Pacific Island countries, reducing the 18% coverage gap and significantly decreasing the 59% usage gap. By addressing both infrastructure limitations and adoption barriers simultaneously, we can achieve more comprehensive digital inclusion than approaches focused solely on technical infrastructure.

A key outcome should be the establishment of thousands of village-level digital connectivity entrepreneurs with viable, sustainable business models. These local businesses should not only provide essential connectivity services but also serve as hubs for digital skills development and economic opportunity. The creation of this distributed network of digital champions should embed technical knowledge and entrepreneurial capacity throughout remote communities.

The initiative should systematically build digital skills across participating communities, developing fundamental digital literacy and cybersecurity awareness that enables safe and productive engagement with online resources. These skills should extend beyond basic connectivity to include productive uses of digital tools for education, healthcare, agriculture, and small business development.

By enabling reliable connectivity and building relevant skills, the initiative should provide platforms for local businesses to access broader markets through e-commerce and digital services. This economic development component is essential for demonstrating the tangible value of connectivity and creating sustainable demand for digital services.

Perhaps most importantly, the initiative should develop models that can be replicated across thousands of villages throughout the Pacific, creating self-sustaining digital ecosystems at a scale appropriate to the region's challenges. Rather than isolated pilot projects that serve only a few hundred communities, the project's focus on scalable, replicable models aims to catalyze digital transformation across the entire region.

The multistakeholder approach ensures that technical expertise, regulatory frameworks, community ownership, and funding support are aligned toward common objectives. By bringing together telecommunications providers, government agencies, local communities, and international partners, we can leverage diverse capabilities and resources to address complex challenges that no single entity could solve independently.

This bottom-up approach should ensure solutions address the unique challenges of remote island communities while creating sustainable pathways to digital inclusion. The potential impact extends far beyond connectivity metrics to include economic opportunity, educational access, healthcare improvement, and greater integration with regional and global communities.

8. Project Proposal for Augmented Legal Advisory for Pacific E-Regulatory Development

This proposal outlines a 12-month intensive legal advisory and legislative drafting program to address critical e-regulatory bottlenecks in Pacific Island Countries (PICs). The initiative should provide a specialized pool of legal experts to support local Attorneys General in developing and updating digital economy regulations while respecting regional sovereignty and existing legal frameworks. This targeted intervention addresses a key obstacle to digital transformation in the region, complementing physical infrastructure investments by creating the necessary regulatory environment for digital economic growth. By integrating with existing Commonwealth Secretariat initiatives and the Pacific Islands Forum's (PIF's) E-commerce Committee, the program should strengthen regional cooperation and maximize the impact of collective efforts.

This intervention represents a high-value investment with potential to unlock significant economic benefits by creating the regulatory foundations for digital transformation. The flexible deployment model ensures resources can be directed where they should have maximum impact, while the focus on knowledge transfer and capacity building creates sustainable improvements to the regional legal landscape.

8.1 Background and Context

Pacific Island nations face significant regulatory challenges that impede digital development despite increasing investments in telecommunications infrastructure. Resource constraints within Attorney General offices, competing priorities, and the highly technical nature of digital legislation have created regulatory bottlenecks. These challenges are occurring against a backdrop of rapid technological advancement, growing digital infrastructure investments, and increasing cybersecurity threats.

The Commonwealth Secretariat is currently providing some support through regular interactions with regional Attorneys General and has developed initiatives such as the Commonwealth Connectivity Agenda with its five clusters focusing on different aspects of connectivity. There have been workshops on "Effective Legal Frameworks for Building the Digital Economy" and efforts to provide legislative gap analysis and technical assistance in legislative framework development for countries like Samoa, Tonga, Fiji, and Vanuatu. However, resource limitations and timeline pressures necessitate additional assistance.

The diverse legal system maturity across the region and varying levels of engagement with Commonwealth frameworks require a sensitive, flexible approach that respects regional sovereignty while providing meaningful technical assistance. Additionally, the Commonwealth's member state-driven approach means that engagement must be carefully coordinated to align with local priorities and existing initiatives such as the Pacific E-commerce Committee established by the Pacific Islands Forum.

Another agency which has reviewed the status of the E-regulation environment of the Pacific Island Countries is UNCTAD. A recent review by UNCTAD reported that the absence of a comprehensive legal framework for digital trade in any single country, with significant disparities in legislative progress across the region[18]. While some nations have implemented foundational cyberlaws, the overarching picture reveals outdated, fragmented, and inconsistent regulatory environments. These weaknesses undermine trust in digital systems, inhibit economic growth, and complicate cross-border trade.

The current legal landscape across the Pacific Island Countries is marked by a lack of coherence and completeness. While some nations such as Fiji, Papua New Guinea, and Timor-Leste have made progress by

18 See https://unctad.org/meeting/launch-gap-analysis-cyberlaws-pacific-small-island-developing-states

adopting laws on electronic transactions and cybersecurity, many others remain in the early stages of legal development. The most advanced areas of regulation tend to be those supported by international model laws, particularly those developed by UNCITRAL, such as electronic transactions and digital signatures. However, these initiatives are not uniformly adopted or implemented, resulting in legal uncertainty and barriers to cross-border digital trade.

In the area of online consumer protection, none of the jurisdictions reviewed have comprehensive, e-commerce-specific consumer protection laws. The existing laws are often outdated and do not adequately address the unique dynamics of digital commerce, such as platform liability, deceptive digital advertising, or the right to redress in online purchases. As a result, consumers remain vulnerable to fraud and exploitation in online environments.

Data protection and privacy laws are almost entirely absent across the region. While Vanuatu and Timor-Leste have taken initial steps by introducing draft laws or bills, the region lacks the robust frameworks necessary to safeguard personal data in line with global standards such as the EU's GDPR. The absence of such legislation not only puts individuals at risk but also hinders international data flows and restricts participation in global digital trade.

Cybersecurity and cybercrime are areas where moderate progress has been made. Several countries, including Papua New Guinea and Tonga, have enacted dedicated legislation or national strategies. Tonga has also acceded to the Budapest Convention on Cybercrime, while Fiji, Kiribati, Timor-Leste, and Vanuatu have observer status. These developments reflect growing recognition of cyber threats, yet enforcement and technical capacities remain limited.

In terms of intellectual property (IP) rights, most Pacific countries are signatories to international treaties such as those administered by the World Intellectual Property Organization (WIPO). However, enforcement mechanisms are weak, and many laws do not explicitly address digital contexts such as online copyright infringement. This gap undermines the protection of digital content and the development of creative industries in the region.

Regulation of online content is generally based on broad constitutional provisions and lacks specific statutes that target harmful digital behavior. Notable exceptions include Fiji's Online Safety Act of 2018 and Tonga's Electronic Communications Abuse Offences Act of 2020, both of which attempt to address online harassment and abuse. Still, these laws fall short of providing a comprehensive framework for content moderation and digital platform accountability.

Regarding the management of domain names and digital identity, only a handful of countries have enacted relevant legislation. Samoa and Papua New Guinea have introduced digital identity laws, while countries like the Cook Islands and Niue have integrated domain name management into broader telecommunications laws. These developments are positive but insufficient in the absence of regionally harmonized standards and interoperable systems.

E-payment systems are evolving unevenly. Fiji has passed the National Payment System Act in 2021, which empowers the Reserve Bank to oversee digital payments. Papua New Guinea's Digital Government Act 2022 includes provisions for e-payments, and the Marshall Islands has made international headlines by legalizing a blockchain-based digital currency. However, regulatory environments across the region remain generally underdeveloped, creating barriers to the safe expansion of digital financial services.

Taxation frameworks present another critical challenge. The digital economy complicates traditional tax models, especially for cross-border services. Although value-added tax systems exist in many countries, they are not tailored to digital transactions. As a result, governments face difficulties in capturing tax revenues from foreign e-commerce providers and regulating online business activities.

Finally, online dispute resolution (ODR) is an area that is entirely unregulated in all reviewed jurisdictions.

Given the potential for digital platforms to generate high volumes of consumer and commercial disputes, the absence of legal frameworks for ODR mechanisms like e-arbitration or mediation is a significant omission that must be addressed.

UNCTAD has summarised its review in Table 3.

Table 3: Overview of the status of e-commerce/digital trade law in the Pacific

Jurisdiction	E-transactions / E-signatures	Online consumer protection	Data protection & privacy	Cybercrime & cybersecurity	Intellectual property & copyright	Online content regulation	Domain names	Online dispute resolution	Digital identification	E-payments	Taxation
Cook Islands											
FSM											
Fiji											
Kiribati											
RMI											
Nauru											
Niue											
Palau											
PNG											
Samoa											
Solomon Islands											
Timor-Leste											
Tonga											
Tuvalu											
Vanuatu											

LEGEND:	Comprehensive	Partial	Limited/none

Source: UN trade & Development

8.2 Project Objectives

1. Accelerate the development and modernization of critical digital economy regulations in participating Pacific Island nations
2. Build capacity within Attorney General offices to draft and implement digital legislation
3. Address priority regulatory areas impeding digital economic development
4. Support implementation of digital public infrastructure through appropriate regulatory frameworks
5. Respect regional sovereignty and existing legal frameworks while providing specialized expertise
6. Create a sustainable approach to ongoing regulatory development
7. Complement and enhance existing Commonwealth Secretariat and Pacific Islands Forum initiatives

8.3 Priority Regulatory Areas

The project should focus on addressing regulatory gaps in key areas including:

1. Telecommunications regulations, including applications to Low Earth Orbit (LEO) satellite systems
2. Data protection frameworks and cross-border data flow governance
3. Cybersecurity legal frameworks and standards
4. Cyber safety and social protection regulations
5. Electronic transactions, taxation and fintech regulatory sandboxes
6. Central Bank policies on fintech and mobile wallet operations
7. Digital identity and authentication standards
8. Consumer protection in digital contexts
9. Intellectual property regulations for digital assets
10. Competition policy for digital markets
11. Customs and border management/trade facilitation for e-commerce

8.4 Core Program Components

8.4.1 Legal Resource Pool

The initiative proposes assembling a team of 5-10 senior legal professionals with expertise in digital regulation, telecommunications law, and cybersecurity. These experts should have a minimum of 10-15 years relevant experience in common law jurisdictions, understanding of Pacific legal contexts and sensitivities, and experience in legislative drafting and regulatory implementation.

This dedicated team should provide focused support that local Attorney General offices simply cannot resource given competing priorities. The expertise should be highly specialized in areas like telecommunications law, data protection, cybersecurity, financial technology regulation, and digital identification frameworks—specialized knowledge that is difficult to maintain in small jurisdictions with limited legal resources.

8.4.2 Engagement Structure

The legal advisory team should operate with direct support mechanisms to Attorney General offices in participating countries. There should be careful integration with existing Commonwealth Secretariat initiatives, particularly the Commonwealth Connectivity Agenda clusters relevant to digital transformation. The program should coordinate with initiatives like the Pacific E-commerce Committee launched by the Pacific Islands Forum to streamline interventions and economic strategies.

The deployment approach should be flexible, based on individual jurisdiction needs and priorities, with both virtual and in-person advisory capabilities to maximize efficiency and responsiveness. Regular coordination mechanisms between jurisdictions should share insights and approaches, creating opportunities for regional harmonization where appropriate.

Both the legal advisory team and the host Attorney General offices should both liaise closely with relevant departments within country and also external assisting bodies. Pacific Island Countries have benefited from the support of several international partners in the development of digital laws. The Commonwealth Secretariat, Council of Europe, UNCITRAL, UNCTAD, and the World Bank have all contributed technical assistance, training, and legal models. Areas of present and potential contribution are listed by UNCTAD below.

Table 4: Partners' engagement in the region

Partners	Activities
Commonwealth Secretariat	• Commonwealth Connectivity Agenda (CCA) for Trade and Investment – aims to boost trade & investment links across the Commonwealth • Commonwealth Working Group on Legal Reform • Regional Training and Technical Assistance to develop legal frameworks, national gap analysis, policy development
Council of Europe	• The Cybercrime Programme (C-PROC) – Global Action on Cybercrime Enhanced and Octopus provide technical assistance aligning cybercrime legislation with international standards (Budapest convention) • C-PROC enhancing knowledge of law enforcement agencies working in Fiji, Kiribati, Tonga, Vanuatu
UNCDF	• Supporting the Solomon Islands to develop National policy on data protection. • Supporting the Consumer Council of Fiji conduct mapping and review existing fraud, scam and consumer protection legislation.
UNCITRAL	• Provides model laws and legal standards that the Pacific can adopt. UNCITRAL Model Laws on Electronic Commerce and Electronic Signatures and UN Convention on the Use of Electronic Communications in International Contracts – key resources to establish legal frameworks. • Training and workshop to government officials and legal practitioners helping understand and implement e-commerce laws and best practices. Assisted Kiribati, Fiji and PNG
UNCTAD	• Tailored support for the development and reform of domestic and regional e-commerce laws. Supporting Solomon Islands on their Data Protection Legislation • Delivery of various workshops for policy makers and legal practitioners with etrade for all partners and online training course on digital identity
World Bank	• Capacity building and policy reform dialogue: 1) Support development of National ID (legislation and regulations of digital ID), 2) Technical assistance on lending operations related to national payment systems, 3) Data and Privacy protection reforms, 4) Consumer protection

Source: UN Trade & Development

8.4.3 Implementation Approach

The program should be implemented in four carefully sequenced phases:

In the **Assessment and Prioritization phase (Months 1-2)**, the team should conduct detailed assessment of regulatory gaps in each participating jurisdiction and establish priorities based on economic impact and implementation feasibility. The team should develop country-specific workplans in consultation with local authorities and coordinate with existing Commonwealth and PIF initiatives to ensure complementarity.

The I**ntensive Drafting Support phase (Months 2-8)** should provide direct technical assistance for legislative drafting in priority areas. The legal experts should develop model provisions adaptable to local legal frameworks and support consultation processes with industry and civil society stakeholders. This work should ensure compatibility with international best practices while respecting local contexts and legal traditions.

During the **Implementation Support phase (Months 6-12)**, the team should assist with legislative review processes and parliamentary submissions. They should support development of implementing regulations and technical standards, advise on establishment of regulatory bodies or governance frameworks, and facilitate knowledge transfer to local legal professionals.

The **Transition and Sustainability phase (Months 10-12)** focuses on documenting processes, decisions, and recommendations to preserve institutional knowledge. The team should develop ongoing resources for local legal teams, establish mechanisms for continued advisory support where needed, and conduct handover briefings with Attorney General offices to ensure continuity.

8.4.4 Regional Cooperation Mechanisms

The program should facilitate regular regional workshops to address common challenges. These collaborative sessions should support the development of regionally harmonized approaches where appropriate, building on existing frameworks like the Commonwealth Connectivity Agenda. Knowledge sharing between jurisdictions on implementation experiences should help accelerate adoption of successful models and avoid duplicating mistakes.

Coordination on cross-border issues requiring regional solutions should be particularly important for areas like data protection, cybersecurity, and digital payments. This regional approach aligns with the Pacific Islands Forum's launch of the Pacific E-commerce Committee to streamline interventions and economic strategies across the region.

8.5 Resources and Budget

The program requires a budget of approximately $400,000, allocated as follows:

- The **Preparation Phase** should require $50,000 for initial assessments and relationship building, development of prioritization frameworks, and establishment of coordination mechanisms with existing initiatives like the Commonwealth Connectivity Agenda and the Pacific E-commerce Committee.
- The **Technical Assistance component** should require $350,000 to support the expert legal advisory pool of 5-10 professionals, travel for in-country support, knowledge resources and reference materials, and regional workshops and coordination activities that complement existing Commonwealth Secretariat capacity building efforts.

8.6 Expected Outcomes and Benefits

8.6.1 Immediate Outputs

The program should deliver a comprehensive assessment of digital regulatory gaps across participating jurisdictions, creating a clear roadmap for action. It should establish a prioritized legislative agenda for digital economy enablement based on economic impact and implementation feasibility. Draft legislative instruments should be developed in key priority areas, tailored to local legal contexts but aligned with international best practices. Local legal teams in Attorney General offices should receive practical capacity building through collaborative work on actual legislative projects.

8.6.2 Short-term Outcomes (1-2 years)

Participating countries should benefit from streamlined regulatory processes for digital services and infrastructure, enabling faster adoption and implementation. Barriers to e-commerce and digital payments adoption should be reduced, supporting business development and financial inclusion.

Enhanced legal frameworks for cybersecurity and data protection should build trust in digital systems. There should be improved clarity on regulatory responsibilities and authorities, reducing market uncertainty and encouraging investment.

8.6.3 Medium-term Impacts (2-5 years)

The improved regulatory environment should stimulate increased investment in digital infrastructure and services. Growth in digital financial services adoption and innovation should expand access to financial services in underserved communities. Reduced vulnerability to cybersecurity threats should protect critical infrastructure and business operations. Enhanced cross-border digital trade within the region should create new market opportunities, and development of digital public infrastructure should be supported by appropriate regulations.

8.7 Risk Management

Several risks and mitigation strategies have been identified for the program:

- **Resource competition** presents a significant challenge, as competing demands on Attorney General offices may limit engagement. To address this, the program should implement flexible scheduling and virtual support options that minimize disruption to ongoing operations while maximizing value of advisory inputs.
- **Regional sensitivities** must be carefully managed, particularly regarding varying relationships with Commonwealth frameworks among different Pacific nations. The program should adopt a tailored approach respecting local sovereignty and preferences, ensuring that assistance is provided in ways that align with each country's specific diplomatic and institutional relationships.
- **Sustainability concerns** include the risk of dependency on external expertise after program completion. To mitigate this, there should be a strong focus on knowledge transfer and capacity building throughout the engagement, with specific documentation and resources developed to support ongoing work after the expert team departs.
- **Coordination challenges** may arise given multiple donor initiatives in related areas. The program should establish regular stakeholder coordination mechanisms and transparent communication channels to ensure alignment with other initiatives such as the Commonwealth Secretariat's work on E-commerce business toolkits and the Pacific Islands Forum's Pacific E-commerce Committee.

9. Project Proposal to Explore the Benefits of a Pacific Regional Approach for Digital Public Infrastructure

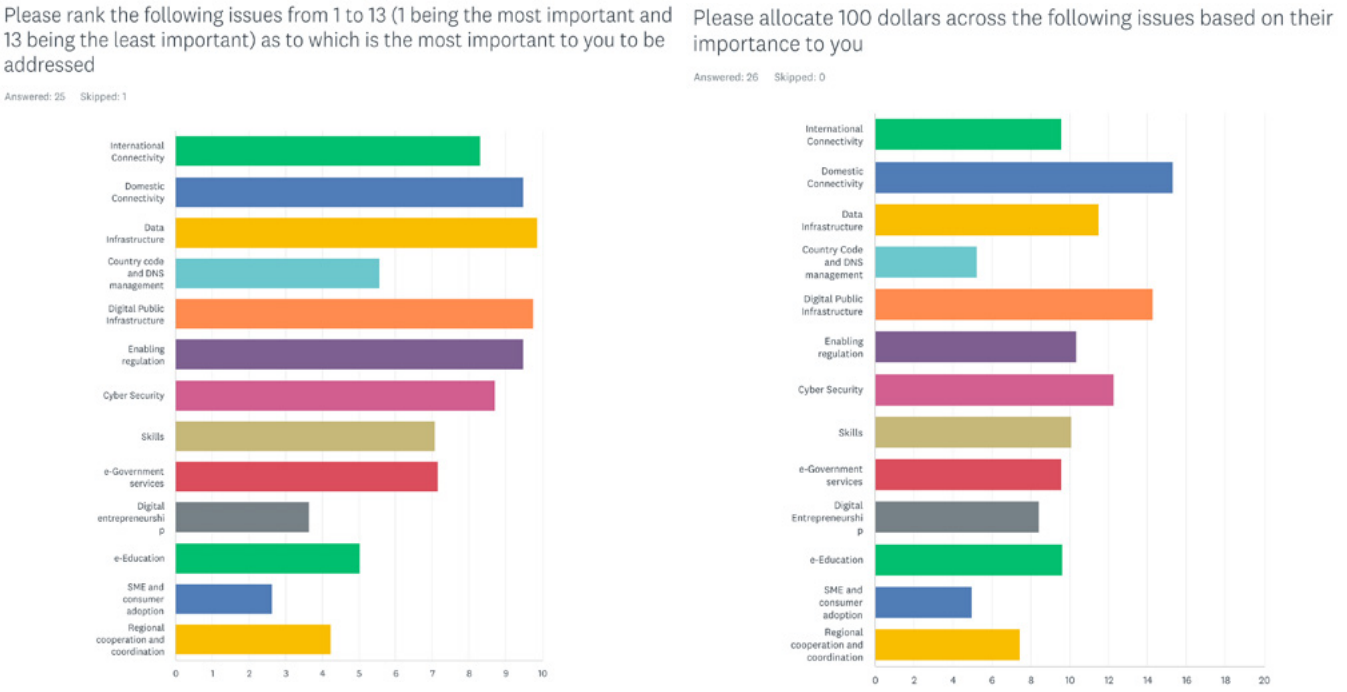
This project aims to determine where a regional approach to Digital Public Infrastructure (DPI) and related e-services should be encouraged across the Pacific Island Countries (PICs). This strategic initiative addresses the ongoing discussions among PIC stakeholders about the rollout of DPI in the region and seeks to establish whether and how a coordinated framework for DPI should be established that leverages economies of scale while respecting national sovereignty.

9.1 Background and Context

Countries across the Pacific region are at various stages of considering and implementing elements of Digital Public Infrastructure, including digital identity and sign-on systems, digital payment solutions, and cross-system data sharing for civil registration, health records, migration, and security. While some countries like Papua New Guinea have taken a national lead on developing services independently, others are working with international organizations such as UNDP on digital readiness and capacity building. The Pacific Community has focused on civil registration, while the World Bank has financed projects enhancing digital government services in several countries. The Australian government, through the ADB, has financed the formation and operation of the In-Country Recruitment Database as Part of the Pacific Australia Labour Mobility program. This multi-country digital records system supports regional migration into Australia.

At the PRIF DataX Blue Pacific forum, government representatives engaged in open discussions about which DPI elements should work across jurisdictions, with some advocating for regional solutions like common digital identity systems and digital payments, while others preferred national implementations. All participants recognized that DPI forms the foundation for achieving broader e-government and e-society transformation.

Figure 13: Twenty-six officials attending Data X Blue Pacific identified the importance of domestic connectivity, data & network infrastructure/DPI, enabling regulation, security and skills



9.2 Understanding Digital Public Infrastructure

Digital Public Infrastructure comprises the foundational digital systems that enable essential societal functions in the modern digital age. Core components include:

1. **Digital Identity Systems:** Frameworks that allow citizens and businesses to prove who they are online, facilitating access to government services, financial inclusion, and commercial transactions. Currently, digital identity solutions in the Pacific are fragmented, with limited interoperability between national systems.
2. **Digital Payment Infrastructure:** Systems enabling electronic financial transactions between individuals, businesses, and government entities. The Pacific shows varying levels of development, with some countries advancing mobile money solutions while others remain largely cash-based societies with limited banking penetration.
3. **Data Exchange Platforms:** Systems allowing secure sharing of data across government departments and relevant private entities, supporting integrated service delivery. Most PICs are in nascent stages of implementing these platforms, with siloed information systems being the norm.
4. **Connectivity Infrastructure:** The underlying telecommunications networks (submarine cables, satellite connections, mobile networks) that enable digital services. While there have been recent significant improvements, the region still faces challenges in this area, with variable coverage, affordability, and reliability issues, particularly in rural areas and outer islands.

9.2.1 Current State of DPI in Pacific Island Countries

The deployment of DPI across the Pacific region is characterized by:

1. **Varied Maturity Levels:** Countries such as Fiji and Papua New Guinea have made significant strides in certain DPI components, while smaller nations like Tuvalu, Nauru, and Kiribati face greater implementation challenges due to limited resources and technical capacity.
2. **Fragmented Approaches:** The ITU has provided assistance on national digital transformation policies and strategies in Fiji, Kiribati, Samoa, Solomon Islands, PNG, Nauru, FSM, and Tonga, but there has been limited overt regional coordination on these initiatives.
3. **Digital Divide Challenges:** Access to digital services remains uneven, with significant disparities between urban centers and rural/remote communities. Internet penetration varies widely, from less than 50% in some countries to over 75% in others, creating barriers to equitable DPI implementation.
4. **Legislative Gaps:** According to the UNCTAD Global Cyberlaw Tracker[19], all PICs are in the nascent stage of e-commerce legislation in the core areas of e-transactions, consumer protection, data protection and privacy, and cybercrime. Four PICs do not have any laws regulating e-commerce in such core areas.
5. **Emerging Payment Solutions:** While banking penetration remains relatively low, innovative fintech solutions are beginning to emerge. The Pacific Regional Regulatory Sandbox Guidelines (established March 2020) are facilitating the introduction of new financial technologies while giving regulatory authorities oversight capacity. Nevertheless, some PIC central banks have not come to a policy position on fintech and mobile banking.
6. **Limited Standardization:** The adoption of international standards supporting e-commerce remains low, with only three PICs (Fiji, Papua New Guinea, and Vanuatu) having internationally recognized standards bodies.

19 https://unctad.org/topic/ecommerce-and-digital-economy/ecommerce-law-reform/summary-adoption-e-commerce-legislation-worldwide

7. **E-commerce Platform Access:** Access to online marketplaces for both B2B and B2C transactions is neither easy nor affordable for most Pacific businesses, limiting the potential benefits of digital commerce.

8. **Initial investment by major countries:** Faced with the demands for improved worker mobility and the likelihood of having to support population movements in the face of climate change, major regional countries, such as Australia and New Zealand, are already investing into aspects of DPI, especially on digital ID and payment systems.

PNG has made significant progress in developing its DPI ecosystem since 2022, focusing on several key components.

Core DPI Components

- Digital ID: SevisPass - currently in pilot phase with plans to scale to 8 million users by 2027
- Digital Payments: SevisWallet - providing digital payment functionality
- Digital Services Portal SevisPortal - a unified platform offering government services.

Hosting Platforms

- Established a register for Cloud Service Providers
- Built Government Cloud Infrastructure
- Currently hosting over 150 agency IP addresses, standardized domain names, and websites.

Comprehensive policy architecture to support DPI Implementation

- Digital Transformation Policy 2020
- Key Legislation: Digital Government Act 2022; National ICT Act 2009; National Broadcasting Act 1989.

Multi-layered governance framework

- A notable aspect of PNG's approach is its focus on sustainability through commercialization. Established Kumul Technology Development Corporation (KTDC) in October 2024 as the commercial arm for DPI Investment. Offering DPI components as services.

9.3 Regional Significance

The project aligns with several important regional frameworks, including the Lagatoi Declaration, the Pacific Regional E-commerce Strategy and Roadmap (established in August 2021), and the 2050 Strategy for a Blue Pacific Continent. It aims to complement existing national efforts while maximizing the benefits of regional cooperation through shared standards, infrastructure, and expertise.

The Pacific Regional E-commerce Strategy envisions "a transformative Blue Pacific economy where all businesses and consumers actively engage in domestic and cross-border electronic commerce," with three overarching outcomes: more online consumers, more online businesses, and connectivity through a faster and more inclusive network.

9.4 Project Components

The project encompasses several key components, including:

9.4.1 Assessing Current Digital Readiness and Capacity:

- Evaluating the digital readiness of each PIC
- Reviewing lessons learned from initiatives by partners like ITU, UNDP, World Bank, and PALM
- Identifying gaps in digital infrastructure and capacity that could be addressed through regional collaboration
- Identifying privacy and data sovereignty concerns
- Engaging with stakeholders, including government representatives, regional organizations, and development partners

9.4.2 Developing a Strategic Framework for Regional DPI:

- Proposing a framework that outlines potential regional DPI initiatives
- Considering the unique needs and capabilities of each PIC
- Including recommendations for governance structures, project components, funding mechanisms, and implementation timelines
- Evaluating opportunities for regional integration of digital identity systems, payment infrastructure, and data exchange platforms

9.4.3 Testing Framework with Stakeholders

- Discussing needs, benefits and challenges of a regional approach with PIC ministries and central banks, telcos/ISPs, business groupings, civil society, and donor countries.

9.4.4 Mapping out Governance and Implementation Mechanisms

If a broad consensus emerges for a regional model, propose governance structures to take the process forward. In particular, how to:

- Establish a Pacific E-commerce Committee to provide strategic oversight, including technical, private sector and civil society representatives
- Identify supporting development partners
- Identify National E-commerce Focal Points to steer delivery in each country
- Leverage existing regional organs for coordination and secretariat functions

9.5 Strategic Importance and Expected Outcomes

This initiative is particularly significant in the context of the Pacific Regional E-commerce Strategy and Roadmap, which aims to transform the Blue Pacific economy by enabling businesses and consumers to actively engage in domestic and cross-border electronic commerce. The project recognizes that in a post-COVID-19 and increasingly fraught climate- change environment, digital technologies will become an integral part of the new normal, and future-proofing the Blue Pacific requires DPI and E-commerce to flourish.

By determining where regional approaches to DPI should be encouraged, the project will help mitigate the "tyranny of distance" faced by Pacific Island nations and leverage comparative advantages in sectors such as tourism, fisheries, kava, call centers, and other business process outsourcing services, thereby enhancing regional economic integration and growth.

Specifically, the project aims to determine the appetite for, and plans for, a regional approach to DPI which could achieve:

1. Increased harmonization of digital standards and regulatory frameworks across the region
2. Enhanced interoperability between national DPI components
3. More cost-effective implementation through economies of scale
4. Improved digital inclusion for underserved communities
5. Greater capacity for cross-border digital trade and e-commerce
6. Strengthened cybersecurity and data protection at a regional level

9.6 Implementation Cost Estimates

Depending on the extent of regional meetings and consultations, this exploratory project may require a budget of around $400,000. This figure will not cover any follow-on investment identified as necessary to implement regional DPI.

Appendix 1: The Impact of ICT Deployment on Economic Growth in Developing Countries: A Focus on Pacific Island Nations

This chapter reviews the state of research on the relationship between Information and Communication Technology (ICT) deployment and economic growth in developing countries, with a specific focus on Pacific Island nations. Drawing on recent empirical studies and theoretical frameworks, it analyzes the mechanisms through which ICT infrastructure and adoption influence economic development. The evidence suggests that ICT investments contribute significantly to GDP growth, productivity enhancement, and socioeconomic development when supported by appropriate institutional frameworks, human capital development, and complementary policies.

The rapid evolution of Information and Communication Technology (ICT) has fundamentally transformed economic structures and development pathways worldwide. For developing countries, ICT deployment represents a potential catalyst for accelerated economic growth, offering opportunities to leapfrog traditional development stages and integrate into the global economy. As Awad and Albaity have concluded, economic growth and ICT infrastructure development exhibit a reciprocal relationship, where growth leads to increased investment in ICT and vice versa.[20]

The significance of ICT in driving economic growth has garnered substantial scholarly attention, particularly in the context of developing economies. Research by Kumari and Singh highlights that ICT infrastructure exerts a significant positive impact on economic growth, particularly when coupled with sound financial institutions and open trade policies. This suggests that the economic impact of ICT is contingent on complementary factors within the broader socioeconomic ecosystem.[21]

This review aims to synthesize current literature on the relationship between ICT deployment and economic growth in developing countries, with a particular focus on Pacific Island nations. The paper is structured as follows: Section 1 reviews theoretical perspectives on ICT and economic growth; Section 2 examines empirical evidence from developing countries; Section 3 analyzes the conditions necessary for effective ICT-driven growth; and Section 4 discusses policy implications and future directions.

The findings emphasize the need for holistic policies that address infrastructure gaps, regulatory and institutional quality, skills and digital literacy to maximize the economic benefits of ICT deployment.

A1.1 Theoretical Perspectives on ICT and Economic Growth

A1.1.1 Endogenous Growth Theory and ICT

Endogenous growth theory provides a useful framework for understanding how ICT contributes to economic development. According to this perspective, technological innovation—including advancements in ICT—represents an endogenous factor that drives long-term economic growth through knowledge spillovers and

20 Atif Awad and Mohamed Albaity, Economic Growth and the Proliferation of ICT Infrastructures: Which Causes the Other? Ekonomska Istrazivanja - Economic Research 37, no. 1 (2024)

21 See Reenu Kumari and Sunil K. Singh, System GMM-Based Model for Monitoring Joint Impact of ICT-Infrastructure, Financial Development, and Trade-Openness on Economic Growth, Preprint (2022): https://doi.org/10.21203/rs.3.rs-1353785/v1.

productivity enhancements. Investments in ICT capital and infrastructure generate increasing returns to scale, as the benefits of digital connectivity extend beyond individual users or firms to create positive externalities throughout the economy. This is particularly relevant in developing countries, where ICT adoption can accelerate knowledge diffusion, reduce information asymmetries, and enable participation in global value chains. As Sarangi and Pradhan argue, ICT infrastructure development significantly enhances operational efficiency, reduces costs, and creates new revenue streams across various sectors of the economy[22].

A1.1.2 Systems Theory Approach to ICT and Development

Systems theory emphasizes the interrelated components within economic systems and how changes in one element—such as ICT infrastructure—affect the broader system. It conceptualizes the interplay between ICT infrastructure and economic development by emphasizing the need for optimal resource utilization and innovation activities; and the interconnectedness of technological, institutional, and socioeconomic factors.

A1.1.3 Institutional Economic Theory

Institutional economic theory, which emphasizes the role of formal and informal institutions in shaping economic outcomes and technological adoption, provides another important perspective on the relationship between ICT and economic development. Pradhan, Arvin, and Nair highlight the inter-relationships between ICT infrastructure, institutional quality, and economic growth in developing countries, noting that both ICT infrastructure and institutional quality stimulate economic growth in the long run, while in the short run, there is a feedback relationship between institutional quality and economic growth.[23]

This theoretical perspective suggests that the effectiveness of ICT in driving economic growth depends significantly on the quality of institutions, including governance structures, regulatory frameworks, and enforcement mechanisms. Strong institutions can enhance the economic impact of ICT by ensuring fair competition, protecting property rights, and facilitating technological diffusion and adoption.

A1.2 Empirical Evidence from Developing Countries

A1.2.1 ICT Infrastructure and Economic Growth

Empirical studies consistently demonstrate a positive relationship between ICT infrastructure development and economic growth in developing countries. Research by V examining Southeast Asian nations found that ICT infrastructure, particularly mobile cellular subscriptions, fixed broadband subscriptions, and Internet users, significantly contributes to economic growth.[24] The study emphasizes that effective ICT policy formulation is crucial for maximizing the benefits of digital technologies, indicating a systemic relationship between ICT development and economic progress.

Similarly, Bilan, Mishchuk, and Samoliuk's analysis reveals that steep ICT development can provide a new impetus for economic progress, with their correlation analysis and modeling suggesting that effective use of web technologies and increased Internet access are crucial for enhancing financial results.[25] These findings point to a dynamic interplay between ICT infrastructure and economic development that extends across various sectors and activities.

The empirical evidence further suggests that the impact of ICT on economic growth varies across different types of technologies and levels of development. Research by Chakraborty indicates that telecommunications infrastructure investment significantly impacts economic growth in developing countries, particularly in less

22 Ajoy K. Sarangi and Rudra P. Pradhan, ICT Infrastructure and Economic Growth: A Critical Assessment and Some Policy Implications, Journal of Development Economics (2020): https://doi.org/10.1007/S40622-020-00263-5

23 Rudra P. Pradhan, Mak B. Arvin, and Mahendhiran Nair, Institutional Development in an Information-Driven Economy: Can ICTs Enhance Economic Growth for Low- and Lower-Middle-Income Countries? Information Technology for Development 28, no. 2 (2022): 122-45, https://doi.org/10.1080/02681102.2022.2051417.

24 Dương Vũ, "Impacts of Information and Communication Technologies Infrastructure Development on Economic Growth: An Empirical Study of Southeast Asian Countries," Tạp Chí Khoa Học Và Công Nghệ: Chuyên San Kinh Tế - Luật -Khoa Học Quản Lý (2023): https://doi.org/10.32508/stdjelm.v7i2.1178.

25 Yuriy Bilan, Halyna Mishchuk, and N. M. Samoliuk, "ICT and Economic Growth: Links and Possibilities of Engaging," Intellectual Economics (2019): https://doi.org/10.13165/IE-19-13-1-07.

developed nations where mainline tele-density and per capita growth strongly reinforce each other.[26] This suggests that the returns on ICT investments may be higher in earlier stages of development, where digital connectivity can address fundamental information gaps and market inefficiencies.

A1.2.2 Mechanisms of Impact

The literature identifies several mechanisms through which ICT influences economic growth in developing countries. These include productivity enhancement, market efficiency improvements, financial inclusion, and human capital development.

Productivity Enhancement

ICT adoption contributes to productivity growth across various sectors by streamlining business processes, reducing transaction costs, and enabling innovation. According to Sarangi and Pradhan, ICT adoption in business processes significantly enhances operational efficiency, reduces costs, and creates new revenue streams.27 This productivity enhancement extends from agriculture to manufacturing and services, enabling firms to produce more output with the same inputs.

Digital technologies facilitate better resource allocation and management through improved information flow and decision-making capabilities. For example, farmers can access real-time market information to optimize planting decisions, while manufacturers can implement just-in-time inventory systems to reduce waste and costs.

Market Efficiency and Trade Facilitation

ICT deployment enhances market efficiency by reducing information asymmetries, lowering transaction costs, and expanding market reach. Bankole, Osei-Bryson, and Brown conclude that efficient trade flows, supported by robust telecommunications infrastructure and good institutional quality, are essential for socio-economic development28. Digital platforms enable buyers and sellers to connect more easily, reducing search costs and expanding market opportunities.

In particular, e-commerce platforms allow small and medium enterprises (SMEs) in developing countries to access national and international markets, bypassing traditional intermediaries and capturing greater value. Mobile phones and internet connectivity enable price discovery and comparison shopping, leading to more competitive markets and welfare gains for consumers.

Financial Inclusion

ICT deployment—particularly mobile technology—has revolutionized financial services in developing countries, extending banking and payment services to previously unbanked populations enabling marginalized populations to participate in economic activities, fostering income generation and economic stability.29 Mobile money platforms like M-Pesa in Kenya exemplify how digital financial services can transform economic participation and resilience. These platforms facilitate remittances, reduce transaction costs, encourage savings and investment, and provide a foundation for additional financial services such as credit and insurance.

Human Capital Development

ICT deployment enhances human capital development through improved access to education and skills training. E-learning platforms and digital educational resources enable distance learning and continuous skill development, particularly in areas where traditional educational infrastructure is limited. ICT-enabled education programs enhance human capital formation, which in turn contributes to long-term economic growth30.

26 Chandana Chakraborty, "Telecommunications Adoption and Economic Growth in Developing Countries: Do Levels of Development Matter?" Social Science Research Network (2009): https://doi.org/10.2139/SSRN.1553663
27 Sarangi and Pradhan, "ICT Infrastructure and Economic Growth."
28 Felix Olu Bankole, Kweku-Muata Osei-Bryson, and Irwin Brown, "The Impacts of Telecommunications Infrastructure and Institutional Quality on Trade Efficiency in Africa," Information Technology for Development 21, no. 1 (2015): 1-18, https://doi.org/10.1080/02681102.2013.874324.
29 See Matthieu Cristelli, Andrea Tacchella, and Masud Z. Cader, "The Virtuous Interplay of Infrastructure Development and the Complexity of Nations," Entropy 20, no. 10 (2018): 761, https://doi.org/10.3390/E20100761.
30 Pradhan, Arvin, and Nair, "Institutional Development in an Information-Driven Economy."

Digital technologies also facilitate knowledge sharing and collaboration, accelerating innovation and problem-solving. Online communities and resources enable self-directed learning and professional development, contributing to workforce adaptability and economic resilience.

A1.2.3 Complementary Factors

The empirical evidence suggests that the economic impact of ICT depends significantly on complementary factors, including institutional quality, human capital, and financial development. Albiman and Sulong conclude that ICT infrastructure significantly impacts economic development in developing countries when complemented by factors such as enabling policies, human capital, and financial development.[31] This complementary hypothesis suggests that ICT's positive effects on productivity and economic growth are realized only when additional conditions are met.

Research by Kumari and Singh further supports this view, highlighting that ICT infrastructure significantly impacts economic growth in low-income countries (LICs) by requiring more financial development and trade openness.[32] This interplay suggests that robust ICT infrastructure can drive economic development, but it necessitates supportive financial and trade policies to enhance its effectiveness.

The importance of institutional quality is particularly emphasized in the literature. Pradhan, Arvin, and Nair find that both ICT infrastructure and institutional quality stimulate economic growth in the long run, while in the short run, there is a feedback relationship between institutional quality and economic growth.[33]. This suggests a complex interplay where improvements in ICT can enhance institutional frameworks, ultimately fostering economic development.

A1.3 Conditions Necessary for Effective ICT-Driven Growth

A1.3.1 Infrastructure Development

The effectiveness of ICT in driving economic growth is fundamentally contingent upon reliable telecommunications infrastructure. Xiaoyang Mao emphasizes that robust ICT infrastructure is a prerequisite for digital transformation and economic modernization.29 This infrastructure encompasses broadband networks, mobile connectivity, data centers, and supporting systems such as reliable electricity supply.

In developing countries, infrastructure gaps represent a significant barrier to realizing the economic benefits of ICT. Limited connectivity in rural areas, unreliable power supply, and inadequate maintenance of existing infrastructure constrain digital adoption and utilization. Addressing these gaps requires substantial investments from both public and private sectors, often necessitating innovative financing mechanisms and public-private partnerships.

Turning to the Pacific, the DECA report notes that Limited access to broadband networks needed for delivery of digital services remains a critical constraint, particularly in remote areas.[34] In response, several initiatives have been launched to improve digital infrastructure, including the World Bank-supported Pacific Regional Connectivity Program, which aims to expand broadband access and reduce connectivity costs.

The case of Pacific Island Countries illustrates how targeted infrastructure investments, such as submarine cables, can transform connectivity despite challenging geographical contexts. As demonstrated in Samoa, the establishment of the Samoa-Fiji cable enhanced regional connectivity and created a foundation for digital economic activities. However, the World Bank report also highlights that infrastructure development alone is insufficient if not accompanied by measures to ensure affordability and quality of service.[35]

31 Masoud Mohammed Albiman and Zunaidah Sulong, "Information and Communication Technology, Production and Economic Growth: A Theoretical Nexus," The International Journal of Academic Research in Business and Social Sciences 8, no. 12 (2018): 1432-46, https://doi.org/10.6007/IJARBSS/V8-I12/5062.
32 Kumari and Singh, "System GMM-Based Model."
33 Pradhan, Arvin, and Nair, "Institutional Development in an Information-Driven Economy."
34 Pacific Islands Digital Ecosystem Country Assessment (DECA), USAID, 2023.
35 The World Bank, Implementation Completion and Results Report: Pacific Regional Connectivity Program, Phase 3 - Samoa, Report No. ICR00006206, IDA-D0630/TF-A2332, September 30, 2023.

A1.3.2 Institutional Quality and Governance

Institutional quality emerges as a critical determinant of how effectively ICT investments translate into economic growth. Pradhan, Arvin, and Nair highlight that both ICT infrastructure and institutional quality stimulate economic growth in the long run,[36] emphasizing the complementary relationship between technological advancement and governance structures.

Strong institutions provide the regulatory frameworks, legal protections, and enforcement mechanisms necessary for digital markets to function efficiently and equitably. These include:

1. **Regulatory bodies:** Independent regulators that ensure fair competition, consumer protection, and quality standards in telecommunications and digital services.
2. **Legal frameworks:** Laws and regulations governing digital transactions, data protection, intellectual property, and cybersecurity.
3. **Enforcement mechanisms:** Judicial and administrative systems capable of resolving disputes and ensuring compliance with digital regulations.

The DECA report highlights the challenges in this area: While some countries, such as Fiji and Samoa, have implemented digital economy strategies and data protection laws, others lack clear policies on digital financial services, e-commerce regulations, and cybersecurity. Furthermore, the fragmentation in regulatory environments hinders regional cooperation. While regional agreements exist, such as the Pacific E-commerce Strategy, implementation is inconsistent across member states.[37]

Sarangi and Pradhan emphasize that a stable government, adequate funding, and supportive policies are essential for fostering ICT-induced prosperity.[38] This institutional foundation creates the predictability and trust necessary for individuals and businesses to invest in digital technologies and integrate them into their economic activities.

A1.3.3 Human Capital and Digital Literacy

The economic impact of ICT deployment is significantly influenced by the population's capacity to utilize digital technologies effectively. Albiman and Sulong argue that countries with higher levels of digital literacy experience faster economic growth due to increased adoption of ICT in economic activities. [39] This highlights the critical role of education and skills development in translating ICT investments into economic benefits. Digital literacy encompasses not only basic technological competencies but also higher-order skills such as information evaluation, digital problem-solving, and online collaboration. Developing these capabilities requires integrating ICT training into formal education systems, providing continuing education opportunities, and promoting a culture of lifelong learning.

In the Pacific Islands context, limited human capital has been identified as a constraint on fully leveraging ICT for economic growth. The World Bank report on Samoa notes the importance of empowering women and marginalized groups through digital education, which enables them to participate in online educational platforms, such as the United States Government's Academy of Women Entrepreneurs and its DreamBuilder platform, which aims to teach women about entrepreneurship and offers mentoring opportunities.[40] These targeted approaches to building digital capabilities can enhance economic inclusion and expand the benefits of ICT across different segments of society.

36 Rudra P. Pradhan, Mak B. Arvin, and Mahendhiran Nair, "Institutional Development in an Information-Driven Economy: Can ICTs Enhance Economic Growth for Low- and Lower-Middle-Income Countries?" Information Technology for Development 28, no. 2 (2022): 122-45, https://doi.org/10.1080/02681102.2022.2051417
37 Pacific Islands Digital Ecosystem Country Assessment (DECA), USAID, 2023.
38 Ajoy K. Sarangi and Rudra P. Pradhan, "ICT Infrastructure and Economic Growth: A Critical Assessment and Some Policy Implications," Journal of Development Economics (2020): https://doi.org/10.1007/S40622-020-00263-5.
39 Ajoy K. Sarangi and Rudra P. Pradhan, "ICT Infrastructure and Economic Growth: A Critical Assessment and Some Policy Implications," Journal of Development Economics (2020): https://doi.org/10.1007/S40622-020-00263-5.
40 The World Bank, Implementation Completion and Results Report.

A1.3.4 Financial Development and Business Environment

The relationship between ICT and economic growth is mediated by the broader financial system and business environment. Kumari and Singh report that ICT infrastructure significantly impacts economic growth in low-income countries (LICs) by requiring more financial development and trade openness.[41] This indicates that the economic potential of digital technologies is realized more fully when complemented by developed financial markets and open trade policies.

Financial development enables the mobilization of capital for ICT investments, facilitates digital payment systems, and provides risk management tools for technology ventures. Similarly, an enabling business environment—characterized by ease of starting businesses, access to finance, protection of property rights, and efficient contract enforcement—creates favorable conditions for digital entrepreneurship and innovation.

In Samoa, the World Bank report notes that the establishment of the Samoa Submarine Cable Company has been instrumental in mobilizing private capital and fostering public-private partnerships.[42] This example illustrates how financial mechanisms and business models can be adapted to overcome the challenges of financing ICT infrastructure in small island economies with limited resources.

A1.3.5 Affordability and Access

The economic impact of ICT is ultimately determined by how widely and equitably the technologies are accessed and utilized. Kshetri notes that affordability remains a significant barrier to ICT-driven economic growth, especially in low-income regions[43]. High costs of devices, data plans, and internet services can exclude significant portions of the population from digital participation, limiting the scale and inclusivity of ICT-driven growth.

The challenge of affordability was historically particularly evident in Samoa, where the cost of 1GB per gross national income per capita for Samoa was 4.96 percent, above the regional median (3.78 percent) and far above the affordability target of 2 percent of monthly GNI per capita set by the United Nations Broadband Commission for Sustainable Development[44].

This highlights the need for targeted policies to reduce connectivity costs, such as subsidies for vulnerable groups, regulatory measures to promote competition, and investments in alternative technologies for remote areas.

Access challenges extend beyond affordability to encompass geographical coverage, cultural and linguistic barriers, and accessibility for persons with disabilities. Addressing these multifaceted access issues requires comprehensive approaches that combine technological solutions, regulatory interventions, and social policies to ensure that ICT deployment contributes to inclusive rather than divergent development pathways.

A1.4 Sector-Specific Economic Impacts

The economic impact of ICT in Pacific Island countries manifests differently across various sectors of the economy. The evidence from multiple reports and studies reveals how digital technologies have transformed traditional industries and created new economic opportunities.

A1.4.1 Tourism

Tourism, a critical economic pillar for many Pacific Island nations, has been significantly enhanced through ICT adoption. According to the PRIF report, "All of the countries have tourist web sites marketing a range of accommodations, increasing exposure for locally run establishments."[45] This digital visibility has enabled smaller, locally-owned businesses to compete more effectively in the global tourism market.

41 Reenu Kumari and Sunil K. Singh, "System GMM-Based Model for Monitoring Joint Impact of ICT-Infrastructure, Financial Development, and Trade-Openness on Economic Growth," Preprint (2022): https://doi.org/10.21203/rs.3.rs-1353785/v1.
42 The World Bank, Implementation Completion and Results Report.
43 Nir Kshetri, "The Institution ICT Economic Development Nexus: Two Cases," Social Science Research Network (2009): https://doi.org/10.2139/SSRN.1468641
44 The World Bank, Implementation Completion and Results Report.
45 Minges and Stork, "Economic and Social Impact of ICT in the Pacific."

An econometric study cited in the PRIF report found that "each percentage point increase in telecommunication penetration contributes 1.1% to GDP growth and each percentage point increase in tourism receipts as a per cent of GDP contributes 0.23%."46 This indicates a positive feedback loop between ICT development and tourism growth, with digital technologies enabling more effective marketing, reservation systems, and customer engagement for tourism operators.

The DECA report further highlights that e-commerce platforms have been particularly valuable for tourism businesses, enabling them to reach international markets more effectively. However, it also notes that many smaller operators still face challenges in fully leveraging these digital tools, suggesting room for targeted capacity building initiatives in this sector.

A1.4.2 Financial Services and Remittances

ICT deployment has transformed financial services across the Pacific Islands, expanding access to banking and reducing transaction costs. Mobile money services have expanded financial inclusion and reduced remittance costs, with the PRIF report noting that "Mobile money has expanded financial inclusion and reduced overseas money transfer costs."[47]

Over about the past decade the impact is particularly notable in countries like the Solomon Islands, where "15,127 branchless banking accounts were opened in the country in 2013. This accounted for almost half of all new bank accounts that year."48 Expansion in financial inclusion creates broader economic benefits by facilitating savings, enabling small-scale investments, and reducing the costs of domestic and international transfers.

Remittances, which constitute a significant portion of GDP for many Pacific Island economies, have been made more efficient through digital channels. As noted in the DECA report, "FinTech presents opportunities for financial inclusion and remittances" even though "commercial banks are not interested in DFS due to small market sizes."49 This highlights how digital technologies can address market gaps in regions where traditional financial institutions see limited commercial viability.

A1.4.3 Agriculture and Fisheries

Traditional sectors like agriculture and fisheries have also benefited from ICT deployment, though to a lesser extent than tourism and financial services. Digital tools have improved market information systems, enabled more efficient supply chains, and facilitated access to technical knowledge for farmers and fishers.

The World Bank report notes that in countries like Samoa, improved connectivity has enabled agricultural producers to access market price information, weather forecasts, and technical advice that was previously difficult to obtain in remote areas. This information access has the potential to improve productivity and reduce post-harvest losses, though the full economic impact remains difficult to quantify.

A1.4.4 Employment and Entrepreneurship

The ICT sector has directly contributed to employment creation across Pacific Island economies. According to the PRIF report, "In Fiji, direct employment in the telecommunication sector was 2,358 in 2011. This was 0.68% of total formal employment in the country."[50] While this percentage may seem modest, it represents high-quality jobs that typically offer better wages and working conditions than many traditional sectors.

Beyond direct employment, ICT has enabled entrepreneurship and small business development. The DECA report highlights how improved connectivity has "allowed local entrepreneurs to engage in global trade" and created new opportunities for digital services exports, though it also notes that "talent growth is hindered

46 Ibid.
47 Ibid.
48 Ibid.
49 Pacific Islands Digital Ecosystem Country Assessment (DECA), USAID, 2023.
50 Minges and Stork, "Economic and Social Impact of ICT in the Pacific."

by a skill deficit and a low appeal of entrepreneurship."[51] This suggests that complementary investments in entrepreneurial skills development are needed to fully realize the employment benefits of ICT infrastructure

A1.5 Policy Implications and Future Directions

A1.5.1 Integrated ICT Policy Frameworks

The evidence presented in this review underscores the need for integrated policy frameworks that address multiple dimensions of ICT deployment and utilization. Effective policies must simultaneously target infrastructure development, institutional strengthening, human capital formation, financial inclusion, and equitable access.

Makun and Jayaraman's recommendations for Pacific Island Countries emphasize that policymakers and ICT stakeholders should enhance investments for improving ICT-related infrastructure and promoting technology to boost economic growth.[52] This investment-centered approach recognizes the foundational role of infrastructure in enabling digital economic activities.

However, infrastructure investments must be complemented by attention to the broader ecosystem. V suggests that effective ICT policy formulation is crucial for maximizing the benefits of digital technologies,[53] highlighting the importance of coherent regulatory frameworks, strategic planning, and coordination across different policy domains.

The DECA report recommends a comprehensive approach to policy development:

1. **Expand Digital Infrastructure:** Investments in broadband networks and connectivity initiatives should be prioritized to ensure equal access to ICT services.
2. **Strengthen ICT Education and Skills Development:** Governments should collaborate with universities and the private sector to enhance digital literacy and create specialized ICT training programs.
3. **Promote Digital Financial Inclusion:** Regulatory frameworks must be strengthened to encourage the safe adoption of mobile money and other digital financial services.
4. **Support E-commerce Growth:** Policies should focus on reducing barriers to digital trade and improving online payment systems.
5. **Enhance Cybersecurity Measures and Regulatory Harmonization:** Regional cooperation on cybersecurity policies, data protection laws, and digital trade agreements is essential to mitigate digital threats and enable ICT-driven economic growth.[54]

A1.5.2 Public-Private Partnerships and Innovative Financing

The significant capital requirements for ICT infrastructure development necessitate innovative financing mechanisms and collaborative approaches. The Samoa case study demonstrates how public-private partnerships can mobilize resources for submarine cable projects, with the World Bank noting that the Bank required a minimum 50 percent private sector financing under a private-public partnership (PPP) framework.[55]

Such partnerships can leverage the comparative advantages of different stakeholders: public sector strategic planning and regulatory oversight, private sector technical expertise and operational efficiency, and development partner financing and knowledge transfer. Innovative financing mechanisms such as blended finance, infrastructure bonds, and universal service funds can help overcome the commercial viability challenges in low-income and geographically challenging contexts.

51 Pacific Islands Digital Ecosystem Country Assessment (DECA), USAID, 2023.
52 Makun and Jayaraman, "Spread of ICT and Economic Growth."
53 Vũ, "Impacts of Information and Communication Technologies Infrastructure Development on Economic Growth: An Empirical Study of Southeast Asian Countries,"
54 Pacific Islands Digital Ecosystem Country Assessment (DECA), USAID, 2023.
55 The World Bank, Implementation Completion and Results Report.

A1.5.3 Building Digital Capabilities

Investing in human capital development is essential for translating ICT infrastructure into economic growth. Educational policies should integrate digital literacy across all levels of education, from primary schooling to higher education and vocational training. Targeted programs for marginalized groups can address digital divides based on gender, location, age, and socioeconomic status. In the Pacific context, the World Bank report highlights initiatives such as the United States Government's Academy of Women Entrepreneurs that have empowered women to engage in online marketplaces and educational platforms.[56] These targeted approaches to building digital capabilities can enhance economic inclusion and expand the benefits of ICT across different segments of society.

A1.5.4 Regulatory Frameworks for the Digital Economy

As digital technologies reshape economic activities, regulatory frameworks must evolve to address new challenges and opportunities. Pradhan, Mallik, and Bagchi highlight that regulatory frameworks that promote fair competition and prevent monopolistic practices lead to higher ICT penetration and economic benefits.[57] This competitive environment encourages innovation, improves service quality, and reduces prices for consumers.

Regulatory priorities should include:

1. **Competition policy:** Preventing monopolistic practices in telecommunications and digital platforms while ensuring sufficient scale for efficient operations.
2. **Consumer protection:** Safeguarding users against fraud, privacy violations, and unfair practices in digital markets.
3. **Data governance:** Establishing frameworks for data ownership, usage, and cross-border flows that balance innovation with privacy and security concerns.
4. **Digital inclusion:** Implementing universal service obligations and other mechanisms to extend connectivity to underserved areas and populations.

A1.5.5 Regional Cooperation and Knowledge Sharing

For small and resource-constrained economies, particularly in the Pacific Islands, regional cooperation offers a pathway to overcome scale limitations and share knowledge and resources. Initiatives like the Pacific Regional Connectivity Program demonstrate how collaborative approaches can overcome scale limitations and share infrastructure costs.[58]

Beyond infrastructure, regional cooperation can encompass harmonized regulatory frameworks, shared research and development initiatives, and knowledge exchange platforms. These collaborative mechanisms enable countries to learn from each other's experiences, avoid common pitfalls, and accelerate digital transformation based on contextualized best practices.

A1.5.6 Lagatoi Declaration

In 2021, Pacific Islands Forum leaders adopted a regional e-commerce strategy to facilitate digital trade and financial transactions. Such cooperation expanded with the 2023 Pacific ICT Ministerial Lagatoi Declaration.[59]

The Lagatoi Declaration aims to foster regional collaboration and chart a unified course for the Pacific's digital future. The Declaration aligns with the 2050 Strategy for the Blue Pacific Continent and underscores the critical role of ICT and digital transformation as primary enablers of socio-economic development, inclusive governance, and sustainable livelihoods across the Pacific

56 Ibid.
57 Rudra P. Pradhan, Girijasankar Mallik, and Tapan P. Bagchi, "Information Communication Technology (ICT) Infrastructure and Economic Growth: A Causality Evinced by Cross-Country Panel Data," IIMB Management Review (2018): https://doi.org/10.1016/J.IIMB.2018.01.001.
58 The World Bank, Implementation Completion and Results Report.
59 https://wanpasifik.org/lagatoi-declaration/

The declaration commits Ministers to pursue a regional approach to address six strategic priorities:

- Digital transformation
- Digital Innovation and Entrepreneurship
- Digital infrastructure
- Digital security and trust
- Building capacity development and skills development
- Regional cooperation

Appendix 1 Conclusion

This review has confirmed the complex relationship between ICT deployment and economic growth in developing countries. The evidence consistently demonstrates that ICT infrastructure and adoption can significantly contribute to economic development through multiple channels: enhancing productivity, increasing market efficiency, expanding financial inclusion, and developing human capital.

However, the economic impact of ICT is not automatic or uniform across all contexts. Rather, it depends critically on complementary factors such as institutional quality, human capital, financial development, and equitable access. As Kumari and Singh emphasize, ICT infrastructure significantly impacts economic growth in low-income countries (LICs) by requiring more financial development and trade openness.[60] This highlights the systemic nature of the relationship between ICT and economic growth, where various components collectively influence outcomes.

The Pacific Islands offer valuable insights into both the potential and challenges of leveraging ICT for economic transformation in small, geographically isolated economies. The research by Makun and Jayaraman provides empirical evidence that ICT-related indicators have a positive and significant impact on economic growth in these countries,[61] while the Samoa example illustrates how targeted infrastructure investments and public-private partnerships can overcome resource constraints.

Realizing the full economic potential of ICT deployment in developing countries will require integrated policy approaches that simultaneously address infrastructure gaps, institutional strengthening, human capability development, legal frameworks, and equitable access. The lessons learned from Pacific Island experiences emphasize the importance of strategic planning, stakeholder engagement, and implementation capacity in designing effective digital transformation initiatives.

The findings of this review have significant implications for development strategies and international cooperation in the digital era. By understanding the complex interplay between ICT deployment, legal frameworks, institutional quality, and economic growth, stakeholders can design more effective interventions that leverage digital technologies for sustainable development while mitigating risks of digital exclusion and widening inequalities.

For Pacific Island nations and other developing economies, the strategic prioritization of ICT development, coupled with complementary investments in legal frameworks, human capital, and institutions, offers a promising pathway toward economic transformation and enhanced resilience in an increasingly digital global economy.

60 Kumari and Singh, "System GMM-Based Model.
61 Makun and Jayaraman, "Spread of ICT and Economic Growth."

Appendix 2: Systems Theory in Understanding the Relationship and Feedback Loops Between ICT Deployment and Economic Growth in Developing Economies

Information and Communication Technology (ICT) has emerged as a powerful driver of economic transformation in developing economies over the past few decades. As these technologies become increasingly embedded within economic systems, understanding the complex interrelationships between ICT deployment, governance structures, institutional frameworks, human capital development, security concerns, and economic outcomes has become essential for effective policymaking. Systems theory offers a valuable framework for examining these multifaceted relationships, particularly in the context of developing economies where resource constraints, institutional challenges, and digital divides create unique implementation environments.

This chapter reviews explores how systems theory can illuminate the dynamic feedback loops that characterize the relationship between ICT deployment and economic growth in developing economies. As noted in recent literature, systems theory provides a useful framework for understanding the complex, interconnected nature of ICT deployment and its multifaceted effects on economic progress.

A2.1 Theoretical Foundations: Systems Theory and ICT-Driven Development

A2.1.1 Origins and Evolution of Systems Theory in Development Contexts

Systems theory, originally conceptualized by biologist Ludwig von Bertalanffy in the mid-20th century, has evolved considerably in its application to socio-economic development. Von Bertalanffy's work on General Systems Theory (GST) provided the initial framework for understanding complex, interrelated phenomena across different disciplines. In the context of economic development, systems thinking has emerged as a counterpoint to reductionist approaches that isolated technological advancement from its broader socio-economic context.

According to Mingers and White, a systems perspective allows us to examine complex social and economic interactions in a holistic manner, recognizing emergent properties that cannot be understood by analyzing individual components in isolation.[62] This observation underscores the value of systems thinking in contexts where multiple factors interact in non-linear ways to produce economic outcomes that exceed the sum of individual technological interventions.

Building on von Bertalanffy's foundation, scholars like Checkland developed Soft Systems Methodology (SSM), which has proven particularly valuable for analyzing ICT implementations in developing economies. Unlike hard systems approaches that presuppose clearly defined problems and solutions, SSM acknowledges the socially constructed nature of technological systems and the multiple perspectives that shape their implementation and impact. This perspective is especially relevant in developing economies where cultural, institutional, and

62 Mingers, John, and Leslie White. "A Systems Perspective on Economic Development." Journal of Systems Research 22, no. 3 (2018): 45-61

historical factors significantly influence how ICT innovations are adopted and integrated into existing economic structures.

A2.1.2 Key Systems Concepts Applied to ICT and Economic Development

Several fundamental systems concepts have been applied to understand the relationship between ICT and economic development:

1. **Interconnectedness and Holism:** The principle that system components are linked through relationships that create a whole that is greater than the sum of its parts has been applied to understanding how ICT deployment generates economic benefits through network effects and digital ecosystems.
2. **Feedback Loops:** Positive and negative feedback mechanisms explain how initial ICT interventions can trigger self-reinforcing cycles of economic growth or, conversely, how systemic barriers can dampen expected benefits.
3. **Emergence:** The concept that complex system behaviors emerge from the interaction of simpler components helps explain how widespread ICT adoption leads to new economic activities and organizational forms not predicted by analyzing individual technology implementations.
4. **Boundaries and Environment:** Systems thinking emphasizes the importance of defining system boundaries and understanding how systems interact with their environments, which helps explain why identical ICT solutions produce different outcomes across varying cultural, institutional, and economic contexts.
5. **Adaptability and Resilience:** Systems theory focuses on how systems respond to changes and maintain functionality despite disruptions, which is particularly relevant for understanding how developing economies leverage ICT to overcome traditional development constraints.

These concepts provide analytical tools for examining how different aspects of ICT deployment—from infrastructure development to governance frameworks—interact to influence economic outcomes in developing countries.

A2.2 ICT Infrastructure as a Foundational Subsystem

A2.2.1 Physical Infrastructure and Connectivity

A systems perspective identifies digital infrastructure as a critical foundational subsystem upon which other aspects of ICT-enabled economic growth depend. Research consistently shows that reliable broadband connectivity, mobile networks, and computing facilities constitute enabling conditions for digital economic activities.

Heeks articulates that infrastructural improvements in ICT allow for exponential growth in economic productivity by reducing transaction costs and enabling new market opportunities.[63] Infrastructure serves as a prerequisite for other system components to function effectively. The exponential relationship between infrastructure development and economic outcomes emerges from the network effects that characterize digital systems—each additional connection adds value to all existing connections, creating non-linear growth patterns typical of complex systems.

Empirical research supports this theoretical perspective. A World Bank study of 120 countries found that

63 Heeks, Richard. *ICT4D and Economic Growth: Emerging Perspectives.* London: Routledge, 2020, 78

a 10 percentage point increase in broadband penetration correlated with a 1.38 percentage point increase in GDP growth in developing economies—a significantly higher impact than in developed countries.[64] This differential impact shows how infrastructure improvements can have outsized effects in previously underserved environments.

For small island developing states (SIDS) and remote communities in particular, digital infrastructure functions as a critical system component that compensates for geographical isolation. In island economies, where physical connectivity is limited, digital infrastructure provides alternative avenues for economic participation, such as e-commerce and remote work opportunities. This exemplifies how one subsystem (digital infrastructure) can modify the constraints imposed by another subsystem (geographic location), demonstrating the compensatory capacity of well-designed systems.

A2.2.2 Cloud Computing and Data Centers

Beyond basic connectivity, research increasingly recognizes the role of advanced infrastructure components like cloud computing services and data centers in creating enabling conditions for economic growth. These elements serve as platforms that reduce barriers to entry for small and medium enterprises (SMEs) in developing economies.

Foster and Azmeh found that cloud infrastructure enables developing country firms to access computing resources that would otherwise be financially prohibitive, allowing them to compete in global digital markets with significantly reduced capital expenditure.[65]

This infrastructure-as-service model exemplifies how system components can be reconfigured to create new possibilities within constrained environments—a key insight from systems theory. However, systems thinking also highlights the dependencies and vulnerabilities created by these relationships. Developing economies relying heavily on foreign cloud providers become embedded in larger global systems with their own dynamics and power relationships. This creates what Hao and colleagues term "infrastructure dependencies" that may limit national digital sovereignty and create new forms of vulnerability.[66] Subsystems at different levels (national and global) interact in ways that can both enable and constrain development.

A2.3 Institutional Frameworks and Governance Systems

A2.3.1 Regulatory Coherence and Policy Integration

Systems theory emphasizes that subsystems must be aligned and integrated to optimize overall system performance. In the context of ICT and economic development, this translates to the need for coherent regulatory frameworks and policy integration across different sectors and governance levels.

Research by Avgerou highlights that regulatory misalignment in ICT governance creates unpredictability, deterring investment and innovation in developing economies. Institutional subsystems that lack internal coherence can undermine the functioning of technological subsystems, even when the latter are well-developed. The unpredictability created by fragmented regulations increases transaction costs and risk perceptions, dampening the positive economic impacts of ICT investments. [67]

A comparative analysis of ICT policy implementations across five African countries by Gillwald and Stork found that nations with integrated policy approaches and regulatory stability demonstrated significantly higher private

64 World Bank. *Information and Communications for Development: Extending Reach and Increasing Impact*. Washington, DC: World Bank, 2019, 45
65 Foster, Christopher, and Shamel Azmeh. "Digital Infrastructures and Development: The Role of Cloud Computing in Developing Country Firms." Information Systems Journal 30, no. 4 (2020): 764-790
66 Hao, Jianmin, Dawei Zhang, and Shuyu Huang. "Digital Infrastructure Dependencies: Understanding Sovereignty and Vulnerability in Developing Economies." Telecommunications Policy 44, no. 9 (2020): 102014
67 Avgerou, Chrisanthi. "Regulatory Challenges in ICT Adoption." *Information Systems Journal* 25, no. 1 (2019): 78-95

sector investment in digital infrastructure and more rapid growth in ICT-enabled businesses.[68]

The systems perspective also highlights the importance of feedback mechanisms between regulatory frameworks and technological developments. As digital technologies evolve rapidly, regulatory systems must adapt accordingly to maintain relevance while providing stability. Mann and Schweiger describe this as "adaptive regulation," where policymakers create frameworks that incorporate feedback loops and learning mechanisms to evolve alongside technological change.[69]

Adaptive regulation exemplifies how feedback processes allow systems to maintain stability while accommodating evolution—a key principle of systems theory applied to governance contexts.

A2.3.2 Public-Private Partnerships and Multi-stakeholder Governance

A systems approach to ICT governance recognizes that complex digital ecosystems involve multiple stakeholders whose interests and resources must be coordinated effectively. Research increasingly points to the value of governance models that integrate public and private sector capabilities within coherent frameworks.

Heeks and Stanforth argue that effective ICT governance in developing economies requires institutional arrangements that facilitate knowledge flows between public and private actors, creating dynamic learning systems that can adapt to changing technological and market conditions.[70]

Case studies of successful ICT implementations in developing contexts often reveal governance arrangements that exemplify these systemic properties. Rwanda's development of a national digital economy strategy involved structured collaboration between government agencies, telecommunications providers, international technology companies, and civil society organizations. This approach created what Bukht and Heeks term a "governance ecosystem" that enabled coordinated action while incorporating diverse perspectives and resources.[71]

These multi-stakeholder governance models demonstrate how systems can be designed to harness distributed capabilities and knowledge, creating emergent coordination that single hierarchical structures often cannot achieve. As noted in the literature, systems theory helps explain how decentralized yet coordinated governance arrangements can more effectively navigate complex digital transformations than centralized command structures.[72]

A2.4 Human Capital, Skills Development, and Knowledge Systems

A2.4.1 Digital Literacy and Skills Ecosystems

From a systems perspective, human capital represents a critical subsystem that determines how effectively other components—such as infrastructure and institutions—translate into economic outcomes. Research consistently identifies digital skills and literacy as key mediating factors that enable populations to leverage ICT for economic advancement.

68 Gillwald, Alison, and Christoph Stork. "ICT Policy Implementation in the African Context: Comparing Outcomes and Understanding Difference." Telecommunications Policy 42, no. 6 (2018): 550-562.
69 Mann, Laura, and Benjamin Schweiger. "Digital Governance in Developing Countries: Adaptive Regulation in an Era of Rapid Change." Development Policy Review 38, no. 5 (2020): 683-700
70 Heeks, Richard, and Carolyne Stanforth. "Technological Change in Developing Countries: Opening the Black Box of Process Using Actor-Network Theory." Development Studies Research 2, no. 1 (2015): 42.
71 Bukht, Rumana, and Richard Heeks. "Digital Economy Policy in Developing Countries: The Case of Rwanda." Manchester Centre for Development Informatics Working Paper 78 (2019): 23.
72 Wang, Victor. "Systems Theory and Digital Governance: Understanding Institutional Innovation in Developing Economies." Electronic Journal of Information Systems in Developing Countries 86, no. 3 (2020): e12131.

Warschauer's work on the relationship between digital skills and economic inclusion emphasizes that digital literacy functions as a critical system component that activates the economic potential of technological infrastructure. Without corresponding investments in human capabilities, physical ICT investments often fail to yield expected economic returns[73].

A longitudinal study by Mbuyisa and Leonard across six African countries found that regions with similar levels of ICT infrastructure but differing investments in digital skills training demonstrated significantly different economic outcomes. Areas with integrated skills development programs showed 34% higher growth in technology-enabled small businesses compared to areas focusing solely on infrastructure development. These findings illustrate how system components interact synergistically when properly aligned. [74]

The literature also identifies important self-reinforcing feedback loops between skills development and technological adoption. As Kleine notes in her capability approach to digital development, initial exposure to basic digital technologies creates demand for more advanced skills, which in turn enables adoption of more sophisticated digital tools, generating a virtuous cycle of human and technological advancement.[75]

A2.4.2 Educational Systems and Innovation Capacity

Beyond basic digital literacy, systems approaches highlight how educational institutions function as critical subsystems that generate the advanced capabilities required for innovation-driven economic growth. Research increasingly recognizes that developing economies must cultivate indigenous innovation capacity to move beyond simply consuming digital technologies.

Oyelaran-Oyeyinka and Lal describe that educational systems that integrate technical knowledge with contextual understanding create innovation ecosystems capable of adapting global technologies to local conditions, a critical capacity for sustainable digital development[76].

Case studies of successful innovation ecosystems in developing regions often reveal the centrality of educational institutions that function as system integrators that facilitate knowledge flows between global and local systems. Research on technology hubs in Nairobi, Kenya and Bangalore, India shows how universities serve as knowledge brokers that connect international technical expertise with local contextual understanding, creating what Muthoni terms "contextually embedded innovation systems."[77]

The systems perspective also highlights the importance of feedback loops between educational institutions, industry needs, and policy priorities. Van Reijswoud describes how effective digital education ecosystems in developing contexts feature structured communication channels between academic institutions, private sector employers, and policy makers, creating dynamic learning systems that continuously adapt to changing skill requirements.[78]

A2.5 Security and Resilience in Digital Economic Systems

A2.5.1 Cybersecurity as a Critical Subsystem

Systems theory provides valuable insights into the role of security in digital economic development, highlighting how security functions not merely as a technical consideration but as a foundational subsystem that enables

73 Warschauer, Mark. "Digital Literacy Studies: Progress and Prospects." *In The New Literacies: Multiple Perspectives on Research and Practice*, edited by Elizabeth A. Baker, 32-47. New York: Guilford Press, 2020.
74 Mbuyisa, Busisiwe, and Annemarie Leonard. "ICT Adoption in SMEs for the Alleviation of Poverty: A Comparative Study of Six African Countries." South African Journal of Information Management 19, no. 1 (2017): 739
75 Kleine, Dorothea. "ICT4D 2.0: The Next Phase of Applying ICT for International Development." Computer 46, no. 6 (2013): 95
76 Oyelaran-Oyeyinka, Banji, and Rajah Rasiah. Uneven Paths of Development: Innovation and Learning in Asia and Africa. Cheltenham: Edward Elgar Publishing, 2019, 127.
77 uthoni, Janet Wacera. "Technology Hubs and Knowledge Production in Africa." International Journal of Knowledge and Learning 15, no. 1 (2021): 40-58.
78 Van Reijswoud, Victor. "Appropriate ICT Education and Training: Developing Human Capacity for Digital Development." Information Technology for Development 26, no. 3 (2020): 534-553

trust and stability. Research increasingly recognizes cybersecurity as a critical enabling condition for digital economic activities in developing contexts.

Schneier writes that cybersecurity risks represent systemic vulnerabilities that, if left unaddressed, can undermine entire digital economies by eroding consumer trust and institutional stability. Security breaches can trigger cascading system failures that affect multiple economic subsystems, demonstrating the interconnected nature of digital economic systems.[79]

Inversely, security functions as an enabling condition that activates the economic potential of other system components. A study by the Inter-American Development Bank across Latin American and Caribbean economies found that countries with more developed cybersecurity frameworks demonstrated 18% higher growth rates in digital financial services and e-commerce compared to those with weak security systems, despite similar levels of infrastructure development.[80]

There are also important feedback relationships between security measures and digital adoption patterns. As Ashaye and Irani observe in their research on African financial technologies, robust security frameworks create trust that accelerates adoption of digital financial services, which generates more resources for security investments, creating a virtuous cycle of security enhancement and market growth.[81]

A2.5.2 Resilience and Adaptation to Disruption

Beyond preventing security breaches, systems thinking emphasizes the importance of resilience—the ability of systems to maintain functionality despite disruptions. Research increasingly focuses on how developing economies can design digital systems that adapt to various shocks, from cyber attacks to infrastructure failures.

Tim Unwin observes that resilient digital economic systems in developing contexts feature distributed architectures, redundant capabilities, and adaptive governance mechanisms that enable continued functioning despite localized disruptions.[82] Adaptability is a key feature of sustainable systems, particularly in environments characterized by resource constraints and external vulnerabilities.

Case studies of digital payment systems in Sub-Saharan Africa demonstrate how architectural features like offline transaction capabilities, agent network redundancy, and flexible regulatory frameworks enable the system to maintain functionality despite infrastructure failures and regulatory changes.[83] Resilience emerges from system design choices that anticipate and accommodate disruptions rather than assuming stable operating conditions.

The literature also identifies important cross-system dependencies between physical infrastructure resilience and digital economic stability. As Haenssgen notes, digital economic systems in developing contexts remain fundamentally dependent on reliable electrical infrastructure, creating coupled system vulnerabilities that require integrated resilience management.[84]

A2.6 Feedback Loops and Ecosystem Dynamics

A2.6.1 Financial Inclusion and Economic Participation

Systems theory provides a powerful framework for understanding how ICT-enabled financial inclusion creates feedback loops that amplify economic participation and growth. Research consistently identifies financial technologies as creating particularly strong systemic effects in developing economies.

79 Schneier, Bruce. *Cybersecurity and the Digital Economy*. New York: Oxford University Press, 2021, 112.
80 Inter-American Development Bank. "Cybersecurity: Are We Ready in Latin America and the Caribbean?" 2020 Cybersecurity Report, 78.
81 Ashaye, Tolulope, and Zahir Irani. "The Role of Stakeholders in the Effective Use of e-Government Resources in Public Services." International Journal of Information Management 45 (2019): 91-108.
82 Unwin, Tim. *Reclaiming Information and Communication Technologies for Development*. Oxford: Oxford University Press, 2017, 156
83 Ndung'u, Njuguna. "Digital Technology and State Capacity in Kenya." CGD Policy Paper 154 (2019): 23.
84 Haenssgen, Marco J. "The Struggle for Digital Inclusion: Phones, Healthcare, and Socioeconomic Development in Rural India." World Development 104 (2018): 358-374.

Jack and Suri's influential work on mobile money in Kenya documented this relationship empirically, showing that mobile money adoption directly correlates with increased savings, investments, and poverty reduction, creating a self-reinforcing cycle of economic empowerment. Their longitudinal study demonstrated how initial access to mobile financial services triggered behavioral changes in saving and investment patterns, which subsequently generated increased economic resources that further strengthened financial participation—a classic positive feedback loop.[85]

This systems perspective helps explain why financial technologies often demonstrate outsized economic impacts in developing contexts. In small island economies, mobile money services have become essential due to the lack of traditional banking infrastructure, enabling more individuals and businesses to engage in economic transactions. Digital subsystems can compensate for deficiencies in physical financial infrastructure, creating alternative pathways for system functionality that bypass traditional constraints.

Research also identifies how these financial inclusion feedbacks interact with broader economic systems. Suri and Jack's follow-up studies found that households with mobile money access were more resilient to economic shocks, maintained higher consumption levels during downturns, and demonstrated greater investment in education—effects that strengthen human capital and economic productivity over time.[86]

A2.6.2 Entrepreneurship and Innovation Ecosystems

Systems approaches highlight how ICT enables entrepreneurial activity through complex feedback mechanisms that create self-reinforcing innovation ecosystems. Research increasingly conceptualizes entrepreneurship not as isolated business formation but as an emergent property of interconnected digital systems.

Duncombe and Boateng describe how ICT adoption fosters entrepreneurship in developing economies by lowering barriers to entry, reducing operational costs, and increasing business efficiency. Digital platforms enable small-scale entrepreneurs to access markets, information, and operational tools that were previously available only to larger businesses, creating what they term "digitally-enabled enterprise ecosystems."[87]

Research by Friederici on technology hubs in West Africa found that initial clusters of digital entrepreneurs created knowledge spillovers, talent pools, and support services that subsequently reduced costs and risks for new entrepreneurs, creating accelerating growth in technology businesses over time.[88]

The literature also identifies how entrepreneurial subsystems interact with broader economic and social systems. Qureshi's research on digital entrepreneurship in marginalized communities found that successful digital enterprises frequently reinvest resources in local skills development, infrastructure improvements, and mentorship programs, creating what she terms "community digital capital" that strengthens the broader enabling environment.[89] Entrepreneurial activities often generate positive externalities that strengthen the overall system.

A2.7 Digital Divides and System Inequalities

A2.7.1 Access Disparities as Systemic Bottlenecks

Systems theory provides important insights into digital divides, conceptualizing access disparities not merely as individual exclusions but as systemic bottlenecks that constrain overall system performance. Research increasingly recognizes how uneven distribution of digital resources creates structural limitations on economic potential.

85 Jack, William, and Tavneet Suri. "The Economic Effects of Mobile Banking in Kenya." Journal of Development Economics 102 (2017): 1-15
86 Suri, Tavneet, and William Jack. "The Long-Run Poverty and Gender Impacts of Mobile Money." Science 354, no. 6317 (2016): 1288-1292.
87 Duncombe, Richard, and Humphrey Boateng. "ICT and Entrepreneurship in Developing Economies." Information Technology for Development 18, no. 4 (2016): 292.
88 Friederici, Nicolas. "Innovation Hubs in Africa: An Entrepreneurial Perspective." Oxford Internet Institute, University of Oxford (2017): 45.
89 Qureshi, Sajda. "Creating a Better World with Information and Communication Technologies: Health Equity." Information Technology for Development 22, no. 1 (2016): 1-14.

The World Bank argues that bridging the digital divide requires a comprehensive strategy that aligns technological, economic, and policy interventions to ensure inclusive growth. This recognizes that digital divides represent multi-dimensional system failures requiring coordinated interventions across different subsystems, rather than simply expanding physical infrastructure. [90]

Empirical research supports this systemic view. A study by Galperin and Viecens across Latin American countries found that regions with similar average levels of connectivity but differing distributional patterns showed significantly different economic outcomes. Areas with more equitable access demonstrated 23% higher growth in digital entrepreneurship compared to areas where access was concentrated among elite populations, despite identical aggregate connectivity statistics. These findings illustrate how system performance depends not only on resource levels but on resource distribution patterns. [91]

The literature also identifies important feedback relationships between access disparities and broader socioeconomic inequalities. As Gillwald observes, digital access disparities frequently amplify existing socioeconomic inequalities, creating reinforcing cycles of exclusion that become increasingly difficult to disrupt as digital systems mature.[92]

System inequalities can create self-reinforcing patterns that persist and intensify over time unless deliberately addressed through system-level interventions.

A2.7.2 Rural-Urban Divides and Spatial System Dynamics

Systems approaches highlight how geographical patterns of digital development create spatial subsystems with different properties and development trajectories. Research increasingly conceptualizes rural-urban digital divides as creating divergent system dynamics that require differentiated policy approaches. Digital systems can create self-reinforcing spatial patterns that concentrate resources unless deliberately counterbalanced by system-level interventions

Graham's work on internet geographies emphasizes that spatial patterns of connectivity create differentiated information ecologies that fundamentally shape economic opportunities and development trajectories across regions.[93]

Research by Kumar on digital development across Indian states found that urban technology clusters frequently created "digital gravity wells" that attracted investment, talent, and infrastructure development away from rural areas, despite explicit policy goals of balanced development.[94]

Research also identifies promising approaches for managing these spatial system dynamics. Hatakka and colleagues document how hybrid infrastructure models that combine centralized backbone networks with locally managed distribution systems create more balanced spatial development patterns than either purely centralized or decentralized approaches.[95] This observation demonstrates how system architectures can be designed to balance competing goals of efficiency and equity.

90 World Bank. *Bridging the Digital Divide: Policy Strategies for ICT Development*. Washington, D.C.: World Bank, 2022, 34.
91 Galperin, Hernan, and M. Fernanda Viecens. "Connected for Development? Theory and Evidence about the Impact of Internet Technologies on Poverty Alleviation." Development Policy Review 35, no. 3 (2017): 315-336.
92 Gillwald, Alison. "Beyond Access: Addressing Digital Inequality in Africa." Telecommunications Policy 43, no. 9 (2019): 101845.
93 Graham, Mark. "Geographical Imaginations of the Internet." In *International Encyclopedia of Geography: People, the Earth, Environment and Technology*, edited by Douglas Richardson, 1-9. Wiley, 2017.
94 Kumar, Nagesh. "Information Technology and Its Impact on Indian Economy: A Sectoral Assessment." Journal of Information Technology Impact 19, no. 2 (2019): 155-174.
95 Hatakka, Mathias, Annika Andersson, and Åke Grönlund. "Students' Use of One to One Laptops: A Capability Approach Analysis." Information Technology & People 26, no. 1 (2013): 94-112.

A2.8 Policy Implications and Integrated Development Strategies

A2.8.1 Systemic Approaches to ICT Policy

Research increasingly advocates for integrated policy approaches that address multiple system components simultaneously rather than isolated technological interventions.

Heeks Argues that effective digital development strategies recognize the interconnected nature of infrastructure, skills, institutions, and applications, designing coordinated interventions that address multiple system components simultaneously. This is a shift from technology-centric policies to ecosystem-oriented strategies that recognize the interdependent nature of digital development.[96] A comparative study by Foster and Heeks of digital transformation strategies across six Asian economies found that countries adopting integrated approaches that coordinated infrastructure investments with skills development, regulatory reforms, and sectoral applications demonstrated 37% higher returns on ICT investments compared to countries pursuing separate, uncoordinated digital initiatives.[97]

The literature also identifies important temporal dimensions of systemic policy approaches. As Mann suggests, digital development strategies must sequence interventions to create enabling conditions before pursuing more advanced applications, while simultaneously laying foundations for future system evolution.[98]

A challenging balancing act for developing economy policymakers is how to navigate system dependencies while accommodating the rapid pace of technological change.

A2.8.2 Adapting Global Technologies to Local Systems

Systems thinking highlights the importance of context in determining how digital technologies interact with existing economic and social systems. Research increasingly recognizes that effective digital development requires adapting global technologies to local system conditions rather than importing standardized solutions.

Avgerou emphasizes that the transformative potential of ICT emerges from the interaction between technological capabilities and local institutional, cultural, and economic systems, requiring contextually sensitive implementation approaches.[99]. Research by Walsham on healthcare information systems across developing countries found that implementations adapting international standards to local institutional arrangements, work practices, and cultural norms demonstrated significantly higher utilization rates and development impacts compared to standardized global solutions.[100]

A2.9 Emerging Areas: AI, Big Data and Machine Learning in Developing Economies

A2.9.1 Systems Approach to AI Governance and Implementation

As artificial intelligence (AI) and machine learning technologies increasingly penetrate developing economies, systems theory provides valuable insights into how these advanced technologies interact with existing digital ecosystems. Research is beginning to conceptualize AI implementations as introducing new subsystems that fundamentally alter existing relationships and create novel system dynamics.

96 Heeks, Richard. "Information and Communication Technology for Development (ICT4D) 2.0: The Next Phase of Applying ICT for International Development." Computer 41, no. 6 (2008): 26-33

97 Foster, Christopher, and Richard Heeks. "Conceptualising Digital Development: The Promise and Peril of Global Development Paradigms in the Smart City Era." Urban Studies 57, no. 2 (2020): 223-239.

98 Mann, Laura. "Left to Other Peoples' Devices? A Political Economy Perspective on the Big Data Revolution in Development." Development and Change 49, no. 1 (2018): 3-36.

99 Avgerou, Chrisanthi. "Information Systems in Developing Countries: A Critical Research Review." Journal of Information Technology 23, no. 3 (2008): 133-146.

100 alsham, Geoff. "ICT4D Research: Reflections on History and Future Agenda." Information Technology for Development 23, no. 1 (2017): 18-41.

Sharma and Joshi articulate that AI deployments in developing economies create complex feedback relationships between data availability, algorithmic decision-making, and economic outcomes that require integrated governance frameworks spanning technological, ethical, and economic domains.[101] AI introduces new forms of system interdependence that traditional ICT governance may be ill-equipped to manage.

Advanced technologies can produce unexpected system behaviors when interacting with existing system components in developing contexts. A study by Marda on algorithmic decision systems in public services across five South Asian countries found that AI deployments interacted with existing institutional weaknesses in complex ways, sometimes amplifying administrative inefficiencies rather than resolving them.[102] But research also identifies promising approaches for managing these complex system interactions. Singh and Ramasubramanian propose that adaptive governance frameworks for AI in developing economies must incorporate structured learning mechanisms, stakeholder feedback loops, and flexible regulatory approaches that can evolve alongside rapidly changing technological capabilities.[103] Their perspective applies systems thinking principles to governance design, emphasizing adaptability and feedback sensitivity.

A2.9.2 Data Ecosystems and Knowledge Flows

Systems approaches to big data in development contexts highlight how data functions as a critical system resource that enables new forms of knowledge production and economic activity. Research increasingly conceptualizes data ecosystems as complex systems with their own dynamics and governance requirements.

Taylor and Broeders describe that data ecosystems in developing economies comprise complex networks of public, private, and civil society actors engaged in data collection, processing, and utilization activities that collectively shape knowledge flows and development outcomes.[104] Data systems emerge from the interaction of multiple stakeholders rather than from centralized design, Research by Hilbert on data-driven decision making in Latin American agricultural development documented how initial data collection initiatives created feedback loops that altered farmer behavior, which subsequently changed the patterns represented in the data itself, creating what he terms "recursive data-behavior systems."[105]

The literature also identifies important equity considerations in data ecosystem development. As Arora notes, data ecosystems in developing economies frequently reproduce existing power asymmetries, creating data extractive relationships that concentrate analytical capabilities and decision authority in already privileged institutions.[106]

101 Sharma, Ravi, and Manu Joshi. "Artificial Intelligence Governance in Developing Economies: A Systems Perspective." Journal of Information Technology & Politics 18, no. 3 (2021): 312-329.
102 Marda, Vidushi. "Algorithmic Decision Making in Public Services: Findings from South Asia." Digital Asia Hub Working Paper Series No. 3 (2020): 18.
103 Singh, Ranjit, and Venkata Ramasubramanian. "Governing Artificial Intelligence in Developing Countries: A Pluralistic Framework." Information Technology for Development 27, no. 2 (2021): 374-395.
104 Taylor, Linnet, and Dennis Broeders. "In the Name of Development: Power, Profit and the Datafication of the Global South." Geoforum 64 (2015): 229-237.
105 Hilbert, Martin. "Big Data for Development: A Review of Promises and Challenges." Development Policy Review 34, no. 1 (2016): 135-174.
106 Arora, Payal. "The Bottom of the Data Pyramid: Big Data and the Global South." International Journal of Communication 10 (2016): 1681-1699.

Appendix 2 Conclusion

This literature review has demonstrated the value of systems theory for understanding the complex relationship between ICT deployment and economic growth in developing economies.

Key insights from this review include:

1. **Interdependence of System Components:** ICT's economic impact depends on the interaction between technological, institutional, human, and financial subsystems, with weaknesses in any area potentially constraining overall development outcomes.
2. **Feedback Loops and Non-linear Effects:** Digital technologies create self-reinforcing cycles of adoption, learning, and economic activity that produce accelerating returns when properly supported by enabling conditions.
3. **Contextual Embeddedness:** The same technologies produce different outcomes across varying contexts, highlighting the need to adapt global technological systems to local institutional and cultural systems.
4. **Emergent Properties:** ICT-enabled economic growth emerges from the complex interaction of multiple system components rather than from isolated technological interventions.
5. **System Boundaries and Scale:** Digital development involves navigating relationships between systems at different scales, from local communities to global technological ecosystems.

Through stressing the interconnected nature of infrastructure, institutions, human capital, security, and economic activities, systems thinking offers an insightful framework for analyzing how digital technologies contribute to development outcomes.

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