Pacific Infrastructure Maintenance Benchmarking Report

2021 BASELINE ASSESSMENT

PRIF
Pacific Region
Infrastructure Facility

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All tables and figures were provided by the authors, unless otherwise specified.

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EXECUTIVE SUMMARY

ABBREVIATIONS

ADB	Asian Development Bank
AMVU	Asset Management Valuation Unit
AUD	Australian Dollar
CAPEX	Capital Expenditure
CEO	Chief Executive Officer
CIG	Cook Islands Government
CIIC	Cook Islands Investment Corporation
CIR	Capital Intensity Ration
DFAT	Department of Foreign Affairs and Trade (Australia)
DoFT	Department of Finance and Treasury
EU	European Union
FAR	Fixed Assets Register
FIJ	Republic of the Fiji Islands
FJD	Fiji Dollar
FSM	Federated States of Micronesia
GDP	Gross Domestic Product
GRC	Gross Replacement Cost
IAS	International Accounting Standards
IASB	International Accounting Standards Board
IATA	International Air Transport Authority
IBNET	International Benchmarking Network Database
IDA	International Development Association
IFAC	International Federation of Accountants
IFRS	International Financial Reporting Standards
IFC	International Finance Corporation (of World Bank Group)
IIA	Institute of Internal Auditors
IIMM	International Infrastructure Management Manual
IPSAS	International Public Sector Accounting Standards
IPCC	Intergovernmental Panel on Climate Change
IPWEA	Institute of Public Works Engineers of Australasia
JICA	Japan International Cooperation Agency
KIR	Kiribati
kWh	Kilowatt hour
LCR	Lifecycle Cost ration
LG	Local Government
MFAI	Ministry of Foreign Affairs and Immigration
MFAT	Ministry of Foreign Affairs and Trade (NZ)
MFEM	Ministry of Finance and Economic Management
MOE	Ministry of Education
MoF	Ministry of Finance
MTEB	Medium Term Expenditure Budget
MTEF	Medium Term Expenditure Framework
MW	Megawatt
MWh	Megawatt hours
NIIP	National Infrastructure Investment Plan
NIU	Niue
NTF	National Transport Fund (SOL)
NTP	National Transport Plan (SOL)
NZD	New Zealand Dollar
ODA	Official Development Assistance
O&M	Operations and Maintenance
OPEX	Operating Expenditure
OPM	Office of the Prime Minister
PACC	Pacific Adaptation to Climate Change
PASAP	Pacific Adaptation Strategy Assistance Program
PCCSP	Pacific Climate Change Science Program
PCRAFI	Pacific Catastrophe Risk and Financing Initiative
PFM	Public Financial Management
PFTAC	Pacific Technical Assistance Center
PIC	Pacific Island Countries
PIMP	Preventative Infrastructure Master Plan
PGK	Papua New Guinea Kina
PMC	Project Management Committee
PO	Planning Office
PPA	Pacific Power Association
PPP	Public Private Partnership
PRC	Peoples' Republic of China
PRIF	Pacific Region Infrastructure Facility
PWWA	Pacific Water and Wastewater Association
PV	Photovoltaic
PUB	Public Utilities
RAV	Replacement Asset Value
RE	Renewable Energy
ROBOC	Revenue on Behalf of the Crown
RMI	Republic of the Marshall Islands
SBD	Solomon Islands Dollar
SIDS	Small Island Developing States
SOE	State-Owned Enterprise
SOL	Solomon Islands
SPC	The Pacific Community
SPCZ	South Pacific Convergence Zone
SPREP	Secretariat of the Pacific Regional Environment Program
SPEA	South Pacific Engineers Association
SRES	Special Report: Emission Scenarios
SRIC	Strengthening Resilience in Island Communities
TA	Technical Assistance
TA TAU	Te Aponga Uira (Power company)
TEU	Twenty Foot equivalent unit (of cargo)
TMV	Te Mato Vai
TON	Tonga
TOP	Tongan Pa'anga
TUV	Tuvalu
UNDP	United Nations Development Program
UNITAR	United Nations Institute for Training and Research
USD	United States Dollar
USP	University of the South Pacific
VAN	Vanuatu
VT	Vanuatu Vatu
WATSAN	Water and Sanitation Program
WB	World Bank Group
WG	Working Group
WSM	Samoa
WST	Samoan Tala

PREFACE

It is with much pleasure that we release the **2021 Baseline Assessment Report** for infrastructure maintenance across Pacific Island Countries. This presents the results of the inaugural assessment of the infrastructure maintenance environment, financial performance and levels of maturity assessed against the requirements of good infrastructure maintenance management.

The Pacific Region Infrastructure Facility's aim is for this baseline assessment report and the methodologies outlined within to be used by its member countries to formulate performance improvement programs that would benefit their respective organizations.

PRIF has recognized the important role that this kind of baseline report plays in providing infrastructure entities (government departments, trading bodies, state owned enterprises and private sector providers) with a baseline of performance across the region from which they can compare practices and monitor improvements against. It has given its support to this important initiative.

PRIF wishes to thank the infrastructure entities across the Pacific that participated in the assessment process and contributed to this report. It would particularly like to thank the lead agencies in each country and the points-of-contact within these agencies who coordinated the responses across sectors. Without these individuals we would not have been able to deliver this very important document.

PRIF also wishes to acknowledge the technical expertise of its consultants, Glenn Fawcett and Kerry McGovern. It would also like to thank contributions from members of PRIF's Sustainable Infrastructure Management Working Group, all of whom worked to make this report a success.

EXECUTIVE SUMMARY

E.1 Built Infrastructure Serves the People

E.1.1 Introduction

Well-maintained infrastructure is crucial to ensuring the peoples of the Pacific Island Countries (PICs) have access to reliable services and that each nation prospers. It means that children can access safe drinking water, they can study at night with access to good light, and they can swim in clean waterways and oceans. When they travel to school or home for Christmas with their families, they have access to a transport system that gets them to their destination safely and on time.

The responsibility to maintain this infrastructure is shared across many government departments, state-owned enterprises (SOEs), and the private sector. The maintenance work must be planned, funded, and resourced with skilled staff, materials, and equipment.

Governments and donors work together to provide nations with the infrastructure that will serve the population including the children. However, it is largely the PICs who are responsible for operating and maintaining this infrastructure, natural resources, buildings, and equipment. We now know that the capital cost of building infrastructure is around one-fifth of the total cost of operating and maintaining the infrastructure over its lifetime.

This report provides a snapshot of measures and the maturity of maintenance practices across Pacific Island governments and SOEs. It establishes a baseline from which to recognize improvements in the maintenance of the built infrastructure of PICs over time.

E.1.2 Sectors for Inclusion

For this inaugural Baseline Assessment Report, we are focused on the sustainable maintenance and preservation of **built infrastructure** across sectors that have a high proportion of long-life, high-value fixed assets such as transmission lines, bridges, wharves, pipelines, landfill sites, buildings, and roads. This report aims to improve awareness of the burden of infrastructure maintenance across six core sectors of 14 countries:

	**ROADS**	*Earthworks; sealed roads; unsealed roads; footpaths; streetlight lights; traffic signals; guardrails; curbing; roadside drains; bridges; fords; culverts; retaining walls.*
	**AIRPORTS**	*Runways; taxiways; aprons; navigation aids; runway lighting; weather stations; control systems; fueling systems.*
	**PORTS**	*Wharfs; jetties; navigation aids; tugboats; container yards; cranes; dredges.*
	**WATER/SANITATION**	*Pipelines; laterals; valves; actuators; hydrants; boreholes; dams; storage tanks; pumps; motors; generators; control panels; telemetry; meters; compressors; dosing equipment.*
	**ENERGY**	*Diesel engines; hydro turbines; generators; transformers; solar panels; fuel stations; telemetry equipment; switching equipment; transmission/distribution lines.*
	**SOLID WASTE**	*Leachate collection/liner; weigh bridges; medical waste incinerators; collection trucks; hazardous waste facilities; refuse collection centers.*

Melanesia
- Fiji
- Papua New Guinea
- Solomon Islands
- Republic of Vanuatu

Micronesia
- Kiribati
- Federated States of Micronesia
- Republic of the Marshall Islands
- Republic of Nauru
- Republic of Palau

Polynesia
- Cook Islands
- Niue
- Samoa
- Kingdom of Tonga
- Tuvalu

E.2 Why Is It Important to Maintain Infrastructure?

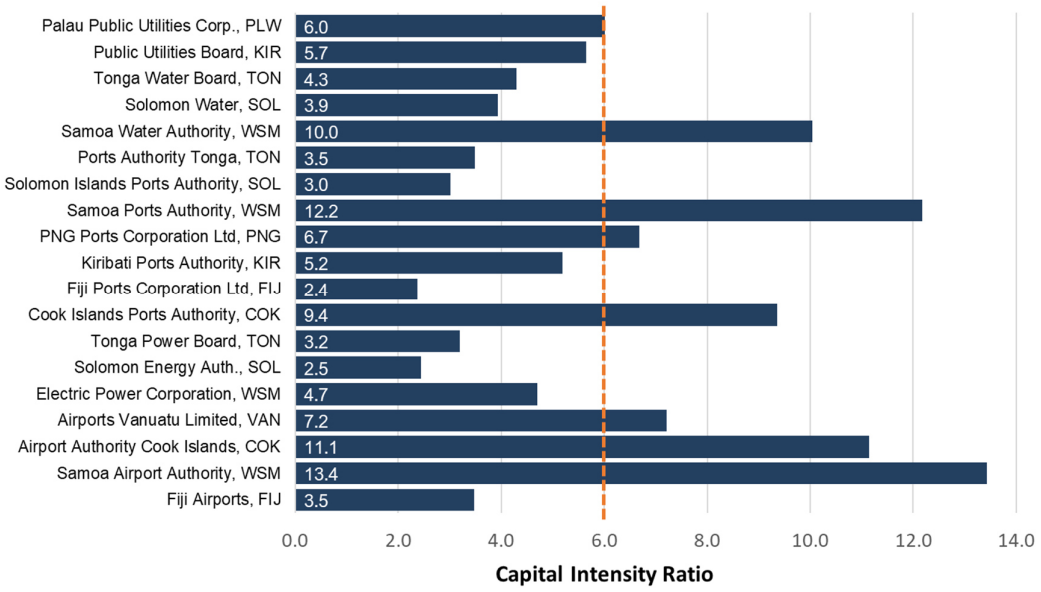
E.2.1 Built Infrastructure Service Providers are Capital-Intensive

The term "capital-intensive" refers to industries that require large amounts of capital investment in fixed assets. Companies in capital-intensive industries are often marked by high levels of depreciation and have correspondingly high levels of operating leverage (the ratio of fixed costs to variable costs). As a result, capital-intensive industries need a high volume of production to provide an adequate return on investment. This also means that small changes in revenue can lead to big changes in profits and return on invested capital.

Most public sector infrastructure service providers are capital-intensive. They have high fixed costs, and high sunk costs in the form of the depreciation expense on high value mechanical and electrical equipment. The Capital Intensity Ratio (CIR) is expressed as:

Capital Intensity Ratio (CIR) = Replacement Cost (Fixed Assets) / Revenue per annum.

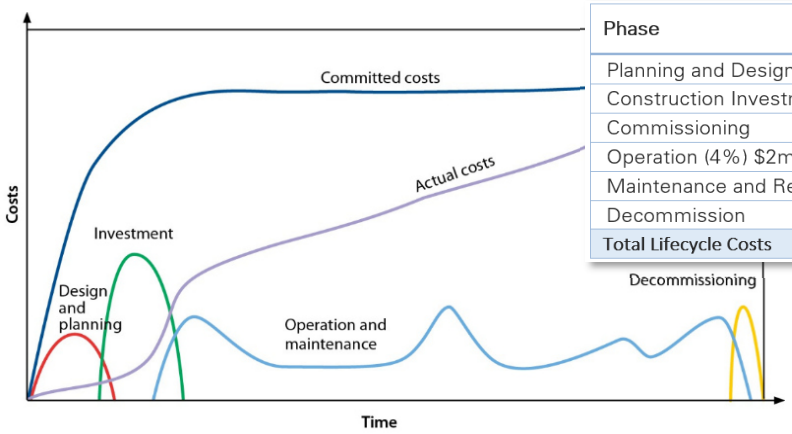
The higher the ratio, the more difficult it is for the entity to replace its assets. This ratio illustrates the number of years it would take for each of the following entities to replace its infrastructure if it were to apply all its revenues from fees and charges and government subsidies to doing so, without paying any salaries or operating or maintenance or interest and redemption payments.



When we exclude the exceptions/outliers discussed in Section 4.10, we get an average CIR of 6.2. In other words, the average capital value of fixed infrastructure across all sectors is 6.2 times greater than the annual revenue generated by the service providers in these sectors. As a comparison, Coca-Cola Company, which has a large asset base to produce beverage for consumers, has a CIR of 1.7. British Petroleum, which also has a significant investment in oil refinery assets, has a CIR of 0.46. The very high CIR of infrastructure entities in comparison, shows why these businesses remain public assets and why disciplined maintenance practices are so important to preserve this considerable capital investment in good working order.

E.2.2 The Capital Cost of Infrastructure Is Only 20% of the Total Lifecycle Cost

It is reasonably well accepted by facility/plant infrastructure teams that the planning and construction cost of new assets can be as little as 20%–25% of the total lifecycle cost of operating and maintaining this infrastructure. The design and construction cost is therefore a poor indicator of the cost of owning the infrastructure. Tariffs not only need to recover the capital cost of construction but also the significant ongoing daily operational expenses (for example, power, chemicals) and the expenses incurred to maintain, repair, and refurbish assets over the life of the facility/network. During the planning and design phase, the subsequent costs of operations and maintenance are predetermined. A facility/network can be designed to minimize construction costs, while shifting them to more frequent or specialized operating and maintenance over the life of the asset. Once the design is approved, there is very little PICs can do to change the cost of operating and maintaining the infrastructure. These uncontrollable costs are four to five times the capital construction cost.



Phase	Phase Cost	% of Total
Planning and Design	$6m	3%
Construction Investment	$48m	20%
Commissioning	$2m	1%
Operation (4%) $2m/yr x 50yrs	$100m	43%
Maintenance and Refurbishments (3%)	$75m	32%
Decommission	$2m	1%
Total Lifecycle Costs	$233m	100%

The lifecycle operations and management (O&M) ratio is expressed as:

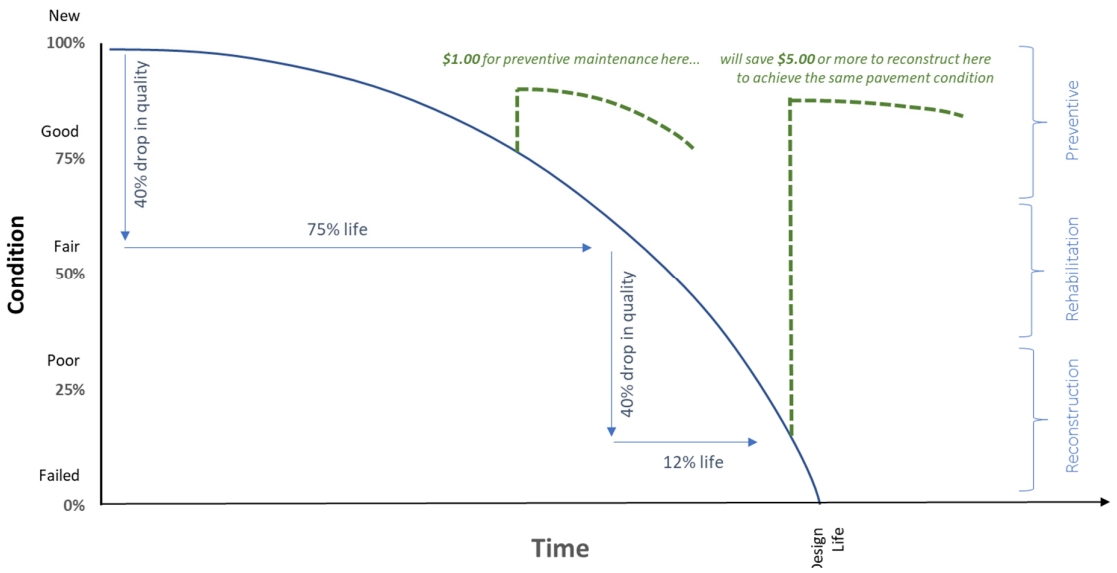
Lifecycle O&M Ratio = (Annual O&M Expenditure x Average Useful Life) / Gross Replacement Cost

This ratio helps governments and infrastructure entities with understanding the ongoing commitment that infrastructure construction is likely to have on the future annual budgets. As reported in Section 4.11, where we have good PIC data, we get an average lifecycle O&M ratio of 4.3. In other words, the ongoing commitment of PICs to funding O&M infrastructure assets across these entities is **4.3 times** (430%) the capital cost of constructing that infrastructure. Or expressed another way, the capital cost of infrastructure is around **19%** of the total cost of ownership.

At the completion of the planning and design phase, we have only incurred around 3% of the total cost of ownership yet decisions made in this phase, such as the capacity and conceptual design of the treatment plant or, in fact, whether a new treatment plant is even required, have predetermined (committed) 75% of the total lifecycle cost of ownership. If infrastructure entities are to reduce the ongoing costs of ownership (O&M), then they must be considering the optimization of these **during the planning phase** of a project.

E.2.3 Why We Need to Maintain Infrastructure in Good Condition

While new infrastructure appears not to require maintenance, it is now known that it is cheaper to fund and do routine maintenance to keep new infrastructure in good working order than allowing it to deteriorate to a level where a rebuild is the only option. Assets in poor condition attract the most complaints from users and operators leading to political priority being assigned to rehabilitating the neglected assets. This is called a "fix-worst-first" philosophy. This approach ranks assets in descending order of condition, putting the worst at the top thus spending money where it appears to address the most complaints. Because funding is then applied to the "worst" more costly rebuild or rehabilitation projects, the rest of the assets miss out on routine and more cost-effective maintenance. They continue to deteriorate, often beyond the threshold where preventive maintenance treatments remain viable. The result is an ever-growing list of assets needing to be rebuilt, with the result that the overall network deteriorates and services become unreliable.



It is cheaper to maintain an asset in good working order than to bring a poorly functioning asset back into good order.

E.2.4 Why We Need to Separate the "M" from "O&M"

One way to understand infrastructure maintenance is to compare how much it costs to make repairs, perform routine maintenance, and replace parts on an asset to how much it costs to replace the entire asset. The Replacement Asset Value (RAV) is expressed as:

Replacement Asset Value = Annual Maintenance Expenditure / Gross Replacement Cost

For active assets such as pumps, motors, generators, etc., the gold standard is RAV=2%–5%. The difficulty in reporting this ratio across public sector infrastructure entities is the general inconsistency in how maintenance expenditure is reported in financial statements. Most often it is bundled in with operating costs (hence the O&M ratio reported above), but some maintenance activities are also capitalized. The **two entities**, both in the water sector, who did report reasonable maintenance expenditure in their financial statements had an average **RAV=3.8%** (Section 4.6.1).

To get information on the cost of maintaining capital-intensive infrastructure, entities should be coding their maintenance expenditure against the type of maintenance. This will enable them to better manage the effectiveness of their investment strategies. As a minimum this would include accounting for:

▪ **Corrective maintenance**	*Replace damaged barrier, road slip.*
▪ **Routine maintenance**	*Pothole repairs, air filter clean, flushing, oil change.*
▪ **Preventive maintenance**	*Road resurfacing, unsealed grading, protective painting, road marking.*
▪ **Rehabilitate or refurbish**	*Rip and remake pavement, re-gravel road, reline pipe, refurbish motor.*
▪ **Replace or reconstruct**	*Bridge replacement, renew fencing, replace generator.*

There are several challenges in managing capital-intensive entities in PICs to keep infrastructure in good working order. PIC sector entities are already building their capacity to future maintain their infrastructure.

E.3 What Are the Biggest Challenges and Achievements?

E.3.1 Assessing Maturity of Maintenance Practices (Self-Assessment)

A primary objective of this baseline report is to help raise the profile of infrastructure maintenance within PIC governments and among donors and stakeholders. The maturity assessment is a useful tool in that it defines the broad domain of maintenance, provides a common vocabulary, and allows organizations to monitor progress against defined requirements. This benchmark report builds on existing asset management frameworks and industry research reports to deliver a maintenance-specific maturity assessment framework. It defines **12 core competency areas** across five domains of effective infrastructure maintenance: Regulatory, Funding, Asset Knowledge, Maintenance Planning, and Program Delivery. The assessment is carried out against **37 business requirements** (for example, having a central register of all assets) across these core competency areas.

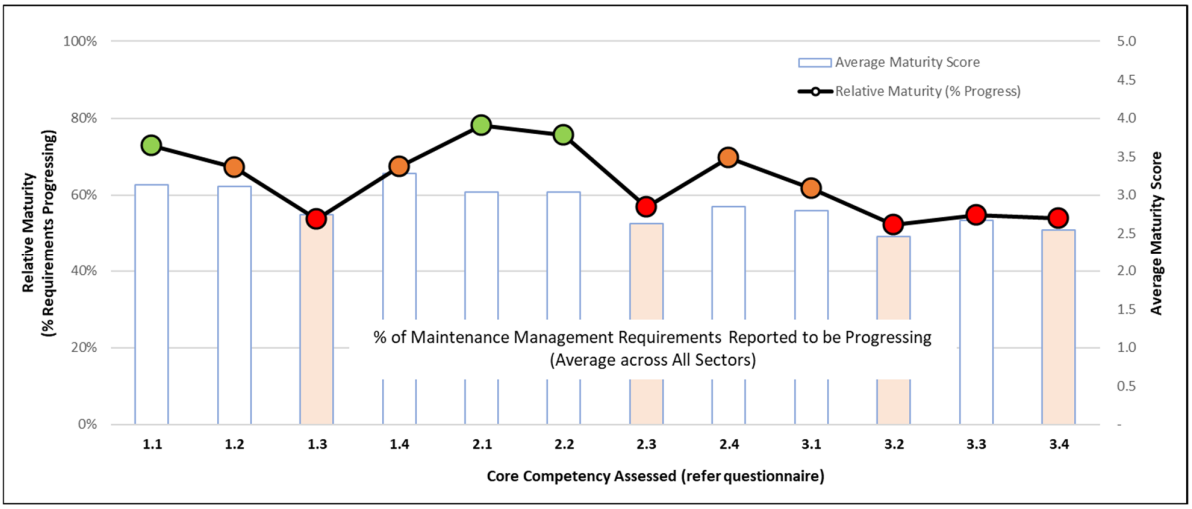
Of the 49 infrastructure entities to whom a copy of the assessment framework was sent for self-assessing their progress (maturity level) against each of the business requirements, 26 responded.

This first step in the assessment process is primarily about setting a baseline against which infrastructure entities can monitor change/improvement. A very similar initiative has been in place for the past 8 years to track asset management maturity across Australian local governments through the "National State of the Assets" (IPWEA, 2021) assessment. The most value comes from comparing the year-on-year trend at an entity level. Aggregating results from a single year and attempting to glean defensible insights would require a peer review of the scores, which this report recommends.

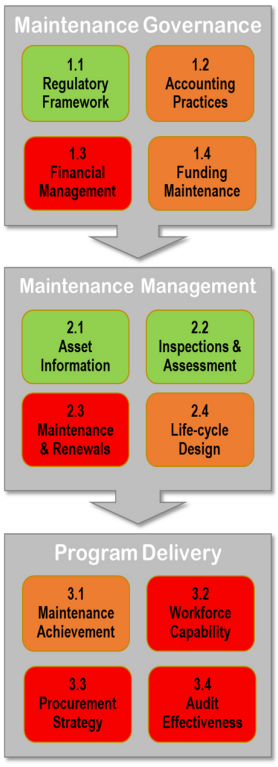
However, while not statistically defensible we can make some general observations on the aggregated self-assessment scores to demonstrate how the framework data may form a basis for future interpretation. For example,

a) The most mature infrastructure maintenance "Accounting Practices" were reported in the Aviation and Port sectors which could be attributed to the international as well as national regulatory oversight of these sectors. (For example, airports require certification to operate). Both these sectors scored highly in the Maintenance Funding competency area.
b) There was a significant variation in assessed maturity across the Regulatory Accountability competency area. Possibly unsurprisingly, the roads sector reported the least maturity in this area, as there is typically little independent regulatory oversight on the effectiveness of the maintenance of the road network by government public works entities.

Furthermore, in addition to viewing the Average Maturity Score, which can smooth the outlier data, we can also look at the "percentage of requirements being progressed". This is expressed as the number of requirements that were assigned a score of "3-Developing" or "4-Competent" or "5-Advanced" and dividing that number by the total number of requirements assessed. The figure below shows the aggregated results **for all sectors**.



As stated above, the primary purpose of the assessment is to provide a baseline for year-on-year comparison; however, we can make some general observations on this initial assessment from which future infrastructure maintenance trends will build upon:



Entities report that they have made **most progress** to date against:
- **2.1 Asset Information** (78% of requirements were progressing),
- **2.2 Inspections** (74%), and
- **1.1 Regulatory Accountability** (73%).

Most entities are familiar with the concepts of a good asset management system, having been exposed to regional influences and guidance material from the United States, Australia, and New Zealand. The need for a good asset register and inspection program generally features heavily as the first steps in setting up a robust asset management system. The oversight by regional and national bodies in the aviation, maritime, and energy sectors aided the higher levels of regulatory accountability in these sectors.

The **next wave** of competency areas for development partners and governments to target for improvement (in orange above) are:
- **1.2 Accounting Practices** (67% of requirements were progressing),
- **1.4 Maintenance Funding** (67%),
- **2.4 Whole-of-Life Design** (70%), and
- **3.1 Maintenance Achievement** (62%).

The least-developed area across all sectors was **Workforce Capability**, where only 51% of requirements were met. It is also noteworthy that **three of the top four** challenges identified by survey participants (E.3.3) related to the capacity and capability of in-country resources. The shortage of specialist expertise extends well beyond maintenance and is a significant ongoing socio-economic challenge for small PICs. This report does not attempt to address this complex issue but rather focuses on the nearer-term improvements in maintenance practices, which may be less well documented.

E.3.2 Greatest Achievements Identified by Participants

During the self-assessment, the entities were also asked to list their top three **greatest accomplishments**. The top 10 most common areas of success reported were:

1. Implementation of policy and a regulatory framework to better support maintenance
2. Improved planning of infrastructure projects, including obtaining insurance
3. Obtaining donor support for important initiatives
4. Better trained maintenance personnel
5. Ability to monitor infrastructure and respond to problems encountered
6. Obtained funding for important maintain projects
7. Self-sufficient routine maintenance program
8. Increase in level of funding
9. Procurement of new equipment
10. Completed some critical rehabilitation projects

E.3.3 Greatest Challenges Identified by Participants

In the Infrastructure Maintenance Maturity Assessment Framework, we asked entities what their three **greatest challenges** were in delivering a robust maintenance program. The top 10 most common themed responses were:

1. Insufficient revenue/tariff options (maintenance funding constraints)
2. Capability/expertise and retention of inhouse staff (general resource constraints)
3. Capability of the private sector (expertise of contractors/consultants)
4. Lack of specialist inhouse skills (defined)
5. Natural disaster/environmental impacts
6. Renewal of aging assets
7. Culture to adopt change
8. Access to equipment and materials (constrained natural resources)
9. Struggle to move from reactive to planned maintenance
10. Governance and legislative arrangements do not promote maintenance

E.4 What Are Our Key Development Opportunities?

E.4.1 Enhancing the Maturity Assessment Process

A key deliverable under this study was the creation of an Infrastructure Maintenance Maturity Assessment Framework. To maximize the return on that investment, we need to assign responsibilities for its ongoing use. Sharing skills across the sectors and among PICs can be effectively facilitated by regional bodies, such as the Pacific Water and Wastewater Association (PWWA), the Pacific Power Association (PPA), the Pacific Community (SPC), the Secretariat of the Pacific Regional Environment Program (SPREP), the Pacific Aviation Safety Office (PASO), and regional professional bodies such as CPA PNG, Institute of Internal Auditors (IIA), and the embryonic South Pacific Engineers Association (SPEA).

While our study has relied solely on a self-assessment of maintenance maturity (pulse check), there would be merit in instituting the next steps of a robust maturity assessment framework, namely reviewing the self-assessment scores, assign a baseline score and setting a target (based on a 3–5 year horizon). They would also propose improvement initiatives that will help move the entity from their baseline position to the set target.

We recommend that PRIF:

1. Conduct follow-up one-on-one calls with survey participants to solicit feedback on the assessment process and willingness to participate in a peer review session.
2. Facilitate peer review sector level meeting with those who volunteer. This meeting will walk through each requirement and discuss the participants assigned scores and consolidate results. Participants would benefit from hearing what others are doing and PRIF would end up with a validated set of scores. The relevant regional body (for example, PPA for Energy Sector) would also participate.
3. Engage an expert to complete a deeper exploratory, set target scores and a 3-year improvement plan with 2–3 entities using the Infrastructure Maintenance Maturity Assessment Framework core competencies and recommendations in this report as the basis.

E.4.2 Enhancing the Tracking of Key Financial Measures

There are seven key financial measures identified in this report. All seven measures are considered worthy of ongoing reporting if we are to improve the way we track and fund maintenance.

- Unit replacement cost
- Average Useful Life
- Capital Intensity
- Lifecycle O&M
- Use Cost Recovery Ratio
- Replacement Asset Value
- Maintenance Provision Value

In part, different accounting standards and maturity of accounting practices means that not all data are available to report these measures on an equitable or complete basis. An analysis in areas where we do have data shows fluctuation over time, so it is important we continue to track both the measures and their trends.

We recommend that PRIF work with stakeholders to:

1. Improve the quality of the data provided by each infrastructure entity (refer to actions in Section 5);
2. Promote the reporting of these measures in one place, usually the entities financial statements; and
3. Collate the financial measures of SOEs, etc., in a centralized database.[1]

[1] *The Pacific Private Sector Development Initiative (PSDI) initiated a regional database to improve the online accessibility of information on SOEs and their performance and requested ADB and PSDI support. It established several webpages to provide a platform to allow for the integration of information on the PSDI SOE reform program with the existing Ministry of Finance webpages for PICs. This platform could be built on to collect and collate financial statement information of SOEs and the above measures, within each Ministry of Finance website.*

E.4.3 Potential Actions for Development Partners and PICs

The table below summarizes some near-term actions that could be taken to build on the current maintenance competencies of the sectors in PICs.

Development Opportunity	Potential Actions for Development Partners	Potential Actions for PICs
Theme 1: ACCOUNTING FOR MAINTENANCE		
a) Improve the account codes for maintenance expenditure across sectors. b) Fully report maintenance expenditure in the notes to the financial statements. c) Account for the accumulated and annual depreciation of all infrastructure in financial statements.	▪ Conduct a study to identify how maintenance expenditure is being coded and present a best-practice guideline that meets the needs of PIC SOEs and Ministries of Finance. ▪ Conduct a study to identify how affordable asset valuations can be completed and present a best-practice guideline for PICs. ▪ Promote TAs that assist entities to survey their assets, develop robust valuation methodologies (rates, useful life, etc.), and report these in their physical asset registers and in asset registers in the accounting systems and hence in the financial statements.	▪ Improve the general ledger coding to enable entities to separately identify recurrent and capital maintenance, and operational expenses in multi-year and annual budgets. ▪ Assist Ministries of Finance to cooperate in developing affordable and reliable asset valuation methodologies. ▪ Consider the impact on the MTEB of funding depreciation of the infrastructure of SOE/Departments. ▪ Build the financial management capacity of SOEs to have clear audit opinions on financial statements.
Theme 2: PLANNING AND BUDGETING MAINTENANCE		
a) Develop a Maintenance Strategy appropriate to the infrastructure assets. b) Budgets for maintenance per category. c) Incorporate the required lifetime maintenance and operating expenses into the economic evaluation of capital projects.	▪ Ensure all **new** infrastructure funded under IDA is supported by a full lifecycle economic analysis of ongoing operation and maintenance costs. Require donors and governments to identify revenue streams to support the ongoing O&M. ▪ Promote TAs that assist entities develop 10-year systematic maintenance strategies: methods, forecast expenditure, and revenue streams.	▪ Ensure medium-term expenditure frameworks set budgets for routine/corrective maintenance, preventive maintenance, rehabilitation, and renewal of infrastructure. ▪ Ensure maintenance crews are an integral part of developing forward budgets. ▪ Require entities to provide a maintenance plan in their budget proposals.
Theme 3: FUNDING CAPITAL MAINTENANCE		
a) Develop a 3-year rolling budget for funding capital maintenance. b) Look to development partner assistance and government grants to fund capital maintenance. c) Create a separate fund for maintenance. d) Establish term-maintenance contracts.	▪ Conduct a pilot study across 5–6 entities that manage a robust capital maintenance program and disseminate best practices. ▪ Promote TAs that assist entities to survey their assets and develop forward plan of capital maintenance requirements. ▪ Support a TA to assess the savings from funding capital maintenance. ▪ Increase the volume of funding assistance allocated to preventive maintenance and rehabilitation of existing infrastructure. ▪ Identify skill requirements and support apprenticeships and other ways for the skills of maintaining infrastructure to be developed and shared in and among PICs.	▪ Ensure medium-term expenditure frameworks are in place and that annual budget requests include 3+ year projection of capital maintenance requirements. ▪ Improve the budget process to separate recurrent and capital maintenance from operational budgets. ▪ Investigate packaging maintenance into longer-term contracts for the private sector and civil society to promote greater cost certainty and investment in equipment and staff development.

Section 1

INTRODUCTION AND CONCEPTS

1.1 Purpose Statement

1.1.1 Aim of the Infrastructure Maintenance Baseline Report

The primary aim of this initiative is to improve maintenance of infrastructure across Pacific Island Countries (PICs) through the publication of an inaugural baseline report that provides metrics and assesses progress (maturity) against the key requirements of good maintenance management practices. The intent of the report, which will be periodically updated, will be to *raise the profile of infrastructure maintenance* within governments and among donors and stakeholders.

1.1.2 Objectives for this Baseline Assessment

The Pacific Region Infrastructure Facility (PRIF) studies have validated the need to improve the management and maintenance of infrastructure to enhance the quality of services, and to reduce life-cycle cost to PIC governments and donors. From a review of PRIF's foundational work, *Infrastructure Maintenance in the Pacific: Challenging the Build-Neglect-Rebuild Paradigm, 2013*, PRIF identified six broad objectives for improving the management and maintenance of infrastructure:

1) Increased budgets for maintenance, including improved budget execution and cost-recovery mechanisms.
2) Improved management and processes, including asset registers, public financial management, and government procurement.
3) Expanded capacity of the supply sector, including capable contractors, and enhanced private-sector management and technical skills.
4) Improved governance and political economy, including improving information and establishing maintenance as a government priority.
5) Effective donor / government relationships, including coordination.
6) Reduced maintenance burden resulting from climate change and disasters.

1.2 Infrastructure in Pacific Island Countries

It has now been almost 50 years since some of the urban infrastructure in PICs was first built. A PRIF study in 2013 found a pattern of "Build-Neglect-Rebuild", one common in developing countries. While in the initial planning for new infrastructure assets or asset replacement, governments and donors would be expected to consider the condition of current stock, service level standards, environmental factors, customer/community needs and expectations, and how these can be met using available resources, reliable records of all infrastructure controlled by the public sector have taken time to gather. The many factors that could be considered at the planning stage, including future demand for infrastructure, possible revenue sources, delivery modalities, and expected impacts of climate change.

The early stage of development has focused on building infrastructure. Since then, the focus has shifted to managing the services delivered using this infrastructure. The role infrastructure and maintenance plays in delivering a service (for example, clean drinking water and reliable electricity) and the associated processes that

work in harmony (for example, managing demand, education, urban planning) are now all seen as a part of a wider asset management system.

> *Vanuatu's current infrastructure stock exceeds the level of assets that the government can operate and maintain sustainably. Many infrastructure assets are being unduly dissipated because of poor maintenance. Vanuatu needs to focus its infrastructure investments to strategically key sectors (under government policy) and limit infrastructure stock levels which it can afford to maintain - (Government of the Republic of Vanuatu, 2015)*

Now that some of this built economic infrastructure is about 50 years old, it is becoming obvious that the operation and maintenance (O&M) of that infrastructure bears a cost that PICs and development partners had not calculated with any reliability. Further, the overall operations and maintenance costs are not yet being estimated and funded in the initial planning stages of new infrastructure projects.

> *A key recommendation of the VISIP 2015 is that operational and asset management considerations should not be side issues to be considered after the infrastructure investment decisions have been made, but rather become of core importance to the investment decisions themselves. Maintaining and efficiently operating the current stock of assets should have much higher priority than expanding the stock - (Government of the Republic of Vanuatu, 2015)*

While new infrastructure appears not to require maintenance, it is now accepted that funds invested in regular planned maintenance produce a better return than neglecting it and allowing it to run down to the extent necessary to build new infrastructure. Project sustainability is determined by the ability of the institution and its staff and contractors to maintain and operate the asset, by the appropriateness of the technology applied and by the ability of the entity delivering services to communicate the benefits being provided. Bringing the community along enables them to see the value they obtain from paying fees and charges, which generate income to support the ongoing costs of operating and maintaining the asset.

> *Research indicates that it is important that infrastructure activities are supported by practical, effective, enforceable, and culturally-sensitive legislation and policies - (PASAI, 2011).*

Maintenance is provided within a changing context. Governments' role *(UN Habitat Booklet, 1993)* includes:

a) Legislative and policy issues
b) Institution strengthening
c) Human-resources development
d) Planning and management
e) Community participation
f) Technical issues
g) Finance and cost recovery

1.3 Countries for Inclusion in Study

To ensure the usefulness of the baseline report, data will be included for the 14 PRIF member countries located in three sub-regions:

Melanesia
- Fiji
- Papua New Guinea
- Solomon Islands
- Republic of Vanuatu

Micronesia
- Kiribati
- Federated States of Micronesia (FSM)
- Republic of the Marshall Islands (RMI)
- Republic of Nauru
- Republic of Palau

Polynesia
- Cook Islands
- Niue
- Samoa
- Kingdom of Tonga
- Tuvalu

Figure 1. Map of Pacific Island Countries

Source: https://www.theprif.org/where-we-work.

1.4 Responsibility for Maintaining Infrastructure

While the context differs among PICs and sectors, the types of entities responsible for maintaining infrastructure include:

1. Central Government – through Ministry of Finance and relevant Infrastructure Ministries.
2. Local Government – funded by local fees and charges and allocations from central government.
3. State Owned Enterprises – with their own sources of income and operating according to general SOE legislation.
4. Corporations – with or without government ownership, operating under the Corporations Law.
5. Donor projects – designed to meet a specific need using a predetermined funding arrangement.
6. Community groups – that take on responsibility for maintaining local infrastructure such as village roads, local water systems, and household waste collection.

In addition to these entities, the following types of regional and/or international bodies provide guidance in the form of standards applied in the monitoring of infrastructure performance.

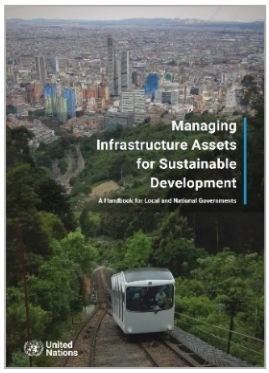
- Regional bodies who set standards and expectations for the services, for example, Pacific Aviation Safety Office and Pacific Maritime Safety Program.
- International bodies who set standards
  a. United Nations Statistics Division (System of National Accounts),
  b. International Monetary Fund (Government Finance Statistics Manual 2014),
  c. Basel Convention,
  d. International Civil Aviation Organization,
  e. International Maritime Organization,
  f. Nautical Port Information Standards, etc.
- International Organization for Standardization (ISO 55000 and related standards)
- Professional bodies publish standards for use by professionals across governments as follows:
  a. International Public Sector Accounting Standards (IPSAS),

b. International Financial Reporting Standards (IFRS)
c. International Infrastructure Maintenance Manual (IIMM) etc.

- Suppliers that determine warranty restrictions for use of their equipment.

The entities responsible for the maintenance of infrastructure assets across sectors and PICs vary. Some government entities maintain infrastructure in more than one sector, for example, roads and airfields. Others are private companies with no or limited government ownership and control, while some are SOEs established with a legislative mandate to maintain the infrastructure. The maintenance of infrastructure is further complicated by a federated structure that coordinates between national and state governments, and between the national government and local or municipal councils. Where regulatory frameworks and good coordination are in place and monitored, with entities held accountable, maintenance is generally given priority. The main examples are airports, which are carefully maintained to ensure ongoing International Air Transport Association (IATA) accreditation, and large marine vessels, which must adhere to maritime safety regulations and international insurer requirements.

1.5 Infrastructure Definition and Sectors for Inclusion



The United Nations handbook for managing infrastructure assets groups public assets into four categories: Buildings, Equipment, Natural resources, and Infrastructure. For our assessment, we are focused on the sustainable maintenance and preservation of infrastructure and have focused on the **six capital-intensive sectors** identified in **Table 1**. These sectors have a high proportion of long-life, high-value fixed assets such as transmission lines, bridges, wharves, pipelines, buildings, and roads. The full cost of operating and maintaining these assets is rarely taken into consideration when preparing business cases for the construction of new infrastructure or when acquiring/transferring infrastructure ownership to a new entity. As infrastructure assets age, maintenance costs increase along with a corresponding decrease in their reliability and performance. This report aims to improve awareness of the burden of infrastructure maintenance across the core sectors.

Figure 2. Public Infrastructure Assets

Public assets are all the physical assets that are essential to the delivery of basic public services and are owned or managed by local or central governments.

Source: United Nations. (2021). Managing Infrastructure Assets for Sustainable Development: A Handbook for Local and National Governments. New York: United Nations.
Retrieved from https://www.un.org/development/desa/financing/document/un-handbook-infrastructure-asset-management

Infrastructure is a network of assets that serve the community at large. Infrastructure is long-lived, and is continually maintained, replaced, and refurbished. The infrastructure systems considered in this report are in **Table 1** below.

For financial reporting purposes, infrastructure is described by IPSAS as part of "Plant and Equipment". While there is no universally accepted definition of infrastructure assets, they usually display some or all of the following characteristics:

a) they are part of a system or network;
b) they are specialized in nature and do not have alternative uses;
c) they are immovable; and
d) they may be subject to constraints on disposal.

The vast majority of infrastructure assets are found in the public sector; however, maintenance responsibilities are not confined to public sector organizations. Infrastructure assets meet the definition of property, plant, and equipment, and should be accounted for in accordance with this standard. Examples of infrastructure assets include road networks, sewer systems, water and power systems, and communication networks (International Public Sector Acounting Standards, 2018).

Table 1. Infrastructure Sectors for Inclusion

Sector	Example of Infrastructure Assets in Sector
ROADS	Earthworks; sealed roads; unsealed roads; footpaths; streetlight lights; traffic signals; guardrails; curbing; roadside drains; bridges; fords; culverts; retaining walls.
AIRPORTS	Runways; taxiways; aprons; navigation aids; runway lighting; weather stations; control systems; fueling systems.
PORTS	Wharfs; jetties; navigation aids; tugs; container yards; cranes; dredges.
WATER and SANITATION	Pipelines; laterals; valves; actuators; hydrants; boreholes; dams; storage tanks; pumps; motors; generators; control panels; telemetry; meters; compressors; dosing equipment.
ENERGY	Diesel engines; hydro turbines; generators; transformers; solar panels; fuel stations; telemetry equipment; switching equipment; transmission/distribution lines.
SOLID WASTE	Leachate collection/liner; weigh bridges; medical waste incinerators; hazardous waste facilities; refuse collection centers.

Source: Authors.

The stock of infrastructure assets is the network or combination of systems of assets that continue to serve a defined purpose. For example, water and sanitation services in urban areas rely on reliable energy. Further, the maintenance of water and sanitation relies on a functioning road network and, in most PICs, ports and airfields. All rely on a functioning waste management system. Disruptions like climate change and a pandemic affect the ability of PICs to operate and maintain infrastructure. The useful life or "service life" of infrastructure assets is extended as long as they continue to serve a purpose. It is the effective maintenance of infrastructure that enables PICs to extend the "service life" of their aging infrastructure.

1.6 Categorizing Maintenance

Maintenance involves activities designed to prolong the useful life or "service life" of an asset. The categorization of maintenance often varies across organizations as described in the PRIF report "Infrastructure Maintenance in the Pacific: Challenging the Build-Neglect-Rebuild Paradigm" (PRIF, 2013) and the "Study of Infrastructure Maintenance Budgets in the Cook Islands" (PRIF, 2021). For this study, we present a consolidated definition of maintenance in the table below which provides a consistent definition for use throughout the report.

Table 2. Infrastructure Maintenance Categories

Maintenance Category	Description	Example Work Types	Budget Category
Corrective Maintenance	Typically triggered by breakdown or observed wear-and-tear that requires imminent repair. Remedial action to return asset to service. Smaller repairs covered under an allowance in the operating budget. Some larger repairs may be a capital expense.	Replace damaged barrier, heating and ventilation (HVAC) repair, road slip.	Operating or Capital
Routine Maintenance	Conducted on a regular basis, designed to minimize wear-and-tear and maintain assets in operational condition. Budgets typically set on historic levels and volumes.	Pothole repairs, air filter clean, flushing, oil change.	Operating

Maintenance Category	Description	Example Work Types	Budget Category
Periodic or Preventive Maintenance	Typically, time- or condition-based, scheduled maintenance designed to ensure the continuing operation of the asset to achieve its desired design life. Tends to occur less frequently than routine maintenance and on a larger scale. Budgets typically set on planned work volumes rather than site-specific.	Road resurfacing, unsealed grading, protective painting, road marking	Operating or capital (based on type of treatment)
Rehabilitate or Refurbish	Often considered as a project expense rather than maintenance. Involves major planned work on an asset to prolong its service life. It is usually a large expense and needs to be added into the capital budget for a 1–3 year planned horizon.	Rip and remake pavement, regravel road, reline pipe, refurbish pump motor, replace roof iron.	Capital
Replace or Reconstruct	Significant work that replaces an existing asset like-for-like. Results in an update to the Fixed Asset Register (FAR) and fully restores the service life of an asset. Not considered as maintenance and always a capital expense.	Bridge replacement, renew fencing, replace generator.	Capital (Update FAR)
New or Improve	A new asset, works to create a new asset, or to upgrade/improve an existing asset beyond its original capacity or performance, in response to changes in usage, customer expectations, or anticipated future needs.	Replace water main with larger capacity. New airport.	Capital (Update FAR)

Source: Adapted from IPWEA. (2020). International Infrastructure Management Manual (6th Edition). Institute of Public Works Engineering Australasia.

Periodic maintenance is often referred to as preventive (or planned) maintenance as these activities are designed to prevent additional and more costly repairs or rehabilitation in the future (refer to example in **Section 1.8**). Corrective maintenance is sometimes undertaken as a stopgap measure while waiting for a more extensive rehabilitation. A well-planned preventive maintenance program will keep assets in good working order and ultimately provide a better financial return over the full life of the asset. (IRCWASH, 1988).

Corrective repairs, and routine and periodic maintenance are necessary for a utility to continue operating in its current state and achieve the desired service life of assets. Significant corrective maintenance work, and rehabilitation and refurbishment of assets is sometimes referred to as "**capital maintenance**" as these treatments are seen as a cost-effective method of extending the service life of an asset often beyond its original design life thus reducing the need for more significant capital replacement costs. Capital maintenance tends to increase when preventive maintenance is neglected.

As the study of the maintenance budgets in the Cook Islands found, "many of the figures used were budget estimates. In some cases, it was not possible to identify all maintenance costs, and in other cases it was not possible to accurately split maintenance from capital costs, particularly for expenditure on the road and water networks in Rarotonga." (PRIF, 2021) Because accounting policies and practices differ, with government agencies often coding the direct costs of maintenance, while SOEs may allocate maintenance staff time to the maintenance they report in their financial statements, it is not currently possible to consistently report maintenance expenditure between entities. Being able to track these budgets and their interdependencies is an essential part of any asset management system.

1.7 Role of Maintenance in Achieving Asset Design Life

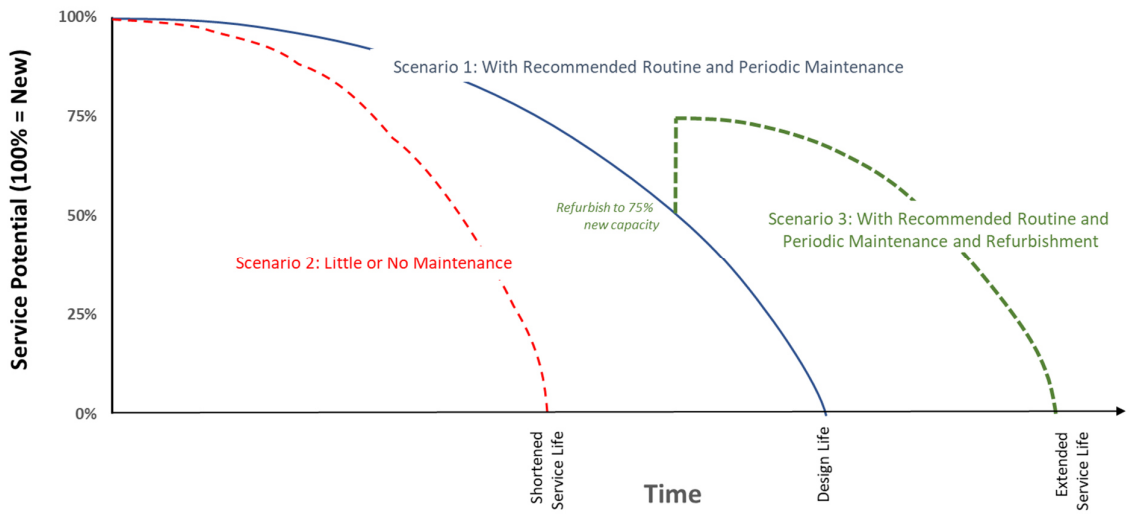
When new infrastructure is built it will typically have a "design life" assigned upon which its economic viability will have been assessed. To achieve this, asset managers need to adhere to the manufacturers' recommended maintenance regime or accepted best practice (Scenario 1 in **Figure 3**).

When maintenance regimes are not followed, assets will fail to meet service standards (for example, pumping capacity, in-service hours) and thus need replacement before their design life has been realized. In this situation the "service life" of the asset will be less than its design life (Scenario 2 in **Figure 3**).

Capital maintenance in the form of a rehabilitation or refurbishment can restore the service potential of an asset and extend its service life beyond its original design life (Scenario 3 in **Figure 3**)

The pattern of "Build-Neglect-Rebuild" (PRIF, 2013) discussed throughout this report is related to Scenario 2 in **Figure 3** presented below. This report also promotes a move toward Scenario 3 whereby a greater volume of planned capital maintenance will extend the service life of infrastructure assets beyond their intended design life and result in overall lower whole-of-life costs to infrastructure entities.

Figure 3. The Impact of Maintenance on the Service Life of Assets



Source: Adapted from Asset Management Insights Ltd. (2013). Effective Age. Retrieved from Asset Insights.net: https://www.assetinsights.net/Glossary/G_Effective_Age.html.

1.8 Whole-of-Life Costs of Infrastructure

It is accepted by facility/plant-based infrastructure teams that the planning and construction cost of new assets **can be as low as 20% of the total life cycle cost of this infrastructure**. In the example below, from a South Australian water utility, the planning and acquisition cost of a new water treatment plant amounts to approximately 23% of the total cost to the SOE over the life of the facility.

Table 3. Example of Lifecycle Costs (Water Treatment Plant)

Phase	Phase Cost	% of Total
Planning and Design	$6m	3%
Construction Investment	$48m	20%
Commissioning	$2m	1%
Operation (4%) $2m/yr. x 50yrs	$100m	43%
Maintenance and Refurbishments (3%) $1.5m/yr. x 50yrs	$75m	32%
Decommission	$2m	1%
Total Lifecycle Costs	**$233m**	100%

Source: Dr. P. Burns, K McGovern & Associates.

The design and construction capital cost is therefore a poor indicator of the cost of owning the infrastructure. Tariffs not only need to recover the capital cost of construction, but also the significant ongoing daily operational expenses (power, chemicals, etc.) and maintenance, repairs, and refurbishment of assets over the life of the plant.

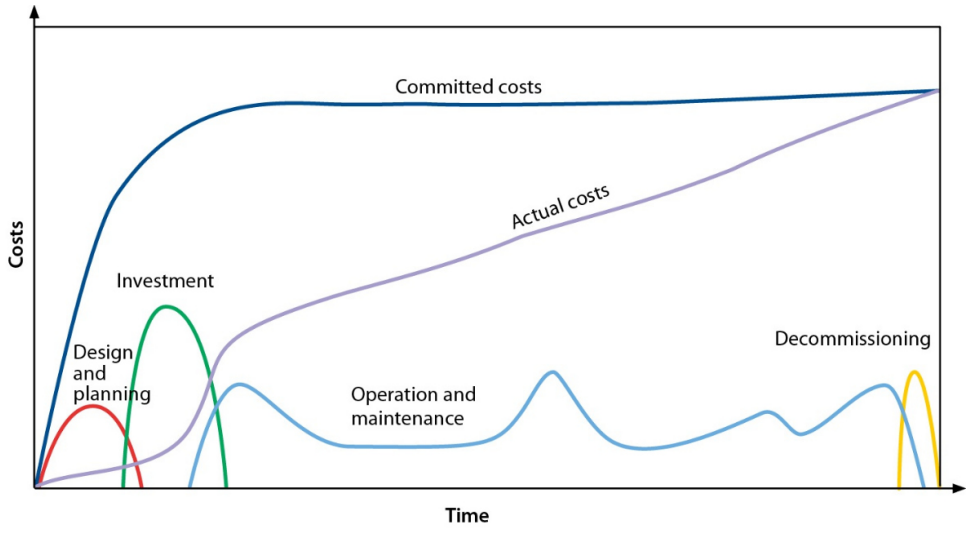
When we are first considering the need for a new asset, we do not spend a great deal of money. In the example, the planning costs amount to $4m. The actual design and construction costs represent 12 times this amount, and this is the upfront cost that is most noticeable and that features in the media, despite O&M being the greatest cost. Although only $3.5m per year, over the 50 years of its intended life, this represents $175m or **75% of the total cost of ownership** in the above example. Finally, unlike a vehicle, there is no residual value in a treatment plant that has reached the end of its life and thus its disposal comes at an additional, albeit comparatively small, cost.

This is just an example for demonstration purposes for, as we know, the service life of an infrastructure asset is heavily dependent on its maintenance regime. If no maintenance is carried out (that is, the build-neglect-rebuild paradigm) then the life of the infrastructure will be shorter, and the ratio of capital construction costs to total maintenance costs will be higher.

1.8.1 Opportunity to Reduce Operation and Maintenance Costs

In the above example, we showed how O&M activities can equate to 75% of the total lifecycle cost of ownership. The figure below shows how quickly the opportunity to reduce these significant costs diminishes.

Figure 4. An Indicative Graph of the Life Cycle Costs for a Water Treatment Plant



Source: Elomatic. (2018, April). Life Cycle Costing – predicting life cycle costs as part of maintenance management and investment planning. Retrieved from Elomatic Consulting Engineers: https://blog.elomatic.com/en/life-cycle-costing-predicting-life-cycle-costs-as-part-of-maintenance-management-and-investment-planning/.

At the completion of the planning and design phase, we have only incurred around 3% of the total cost of ownership yet decisions made in this phase, such as the capacity and conceptual design of the treatment plant or, in fact, whether a new treatment plant is even required, have predetermined 75% of the total cost of ownership. By the end of the planning phase, there are already limited opportunities to optimize the ongoing operation and maintenance costs. By the time the facility is designed and built, 85% of the lifecycle costs of ownership have already been determined.

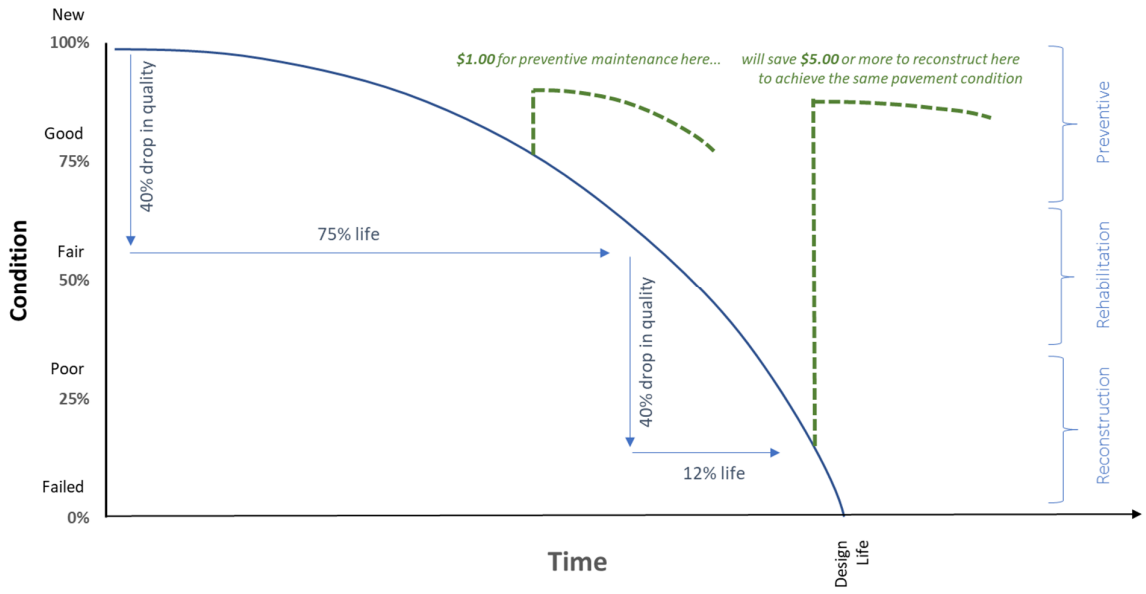
If infrastructure entities are to reduce the ongoing O&M costs, then they must be considering these during the planning phase of a project.

1.8.2 Earlier Intervention with Periodic Preventive Maintenance

Assets in poor condition attract the most attention from users and operators, leading to a temptation to invest in rehabilitating the backlog of these assets in poor condition as a priority, a "fix-worst-first" philosophy. This approach ranks assets in descending order of condition, putting the worst at the top, thus spending money where it appears to do the "most good" and is most easily justified. However, while the more costly "worst" interventions are attended to first, the rest of the assets continue to deteriorate, often beyond the threshold where preventive maintenance treatments remain viable. The result is an ever-growing list of assets requiring expensive rehabilitation and reconstruction treatments and a worsening overall condition of the network (Moodley, 2019).

There is a great deal of research in the road pavement space that supports the economics of early intervention, quoting how **$1 spent on preventive maintenance will save $5 or more on reconstruction**. The best way to increase the overall condition of pavements in the long run is to first protect the pavements in fair or average condition.

Figure 5. Impact of Early Preventive Pavement Maintenance Intervention



Source: Adapted from Bryce, Rada, and Hicks (2019). Effect of preservation treatments on pavement performance. Proceedings of the World Conference on Pavement and Asset Management (WCPAM 2017). CRC Press.

The South African National Road Agency (SANRAL) estimates that the cost of repairing roads increases to six times the cost of preventative maintenance after 3 years of neglect, and to 18 times after 5 years of neglect (Burningham & Stankevich, 2005).

Table 4. Main Infrastructure Entities Identified for Participation (Sorted by Country Code)

Country	Code	Roads	Airports	Ports	Water / Sanitation	Energy	Solid Waste
Fiji	FIJ	Fiji Roads Authority	Airports Fiji Limited	Fiji Ports Corporation Ltd	Water Authority of Fiji	Fiji Electric Authority	Dept of Environment, Waste Management and Pollution Control Unit
Papua New Guinea	PNG	Department of Transport & Infrastructure	National Airports Corporation Limited PNG	PNG Ports Corp.	Water PNG and Eda Ranu	PNG Power Ltd	Department of Environment and Conservation
Solomon Islands	SOL	Ministry of Infrastructure Development	Civil Aviation Authority of Solomon Islands	Solomon Island Port Authority	Solomon Island Water Authority	Solomon Island Power	Ministry of Infrastructure Development
Vanuatu	VAN	Public Works Department, MIPU	Airports Vanuatu	Department of Ports and Marine, MIPU	UNELCO and Department of Water	UNELCO Vanuatu Ltd	Public Works Department, MIPU
Kiribati	KIR	Ministry of Public Works and Utilities	Ministry of Communications Transport and Tourism Dev.	Kiribati Port Authority	Public Utilities Board	Public Utilities Board	Local Councils
FSM – Pohnpei	FSM	Pohnpei Transport Authority	Micronesia Pohnpei International Airport	Pohnpei Port Authority	Pohnpei Utilities Corp.	Pohnpei Utilities Corp.	Dept of Environment, Climate Change and Emergency Mgt.
FSM – Chuuk	FSM	Chuuk State Government	Micronesia Chuuk International Airport	Transportation and Public Works Dept	Chuuk Public Utility Corp.	Chuuk Public Utility Corp.	Chuuk State Government, Transportation and Public Works
FSM – Kosrae	FSM	Kosrae State Department of Transportation	Micronesia Kosrae International Airport	Kosrae Ports Authority	Kosrae Utilities Authority	Kosrae Utilities Authority	Kosrae Island Resource Management
FSM - Yap	FSM	Yap State Public Works Department	Micronesia Yap International Airport	Yap State Public Works Department	Yap State Public Service Corp.	Yap State Public Service Corp.	Authority (KIRMA)
Marshall Islands	RMI	Ministry of Works, Infrastructure and Utilities	Marshall Islands Airport Authority	Marshall Islands Port Authority	Majuro Water & Sewer Co.	Kwajalein Atoll Joint Utility and Marshall Energy Co.	Ministry of Works, Infrastructure and Utility
Nauru	NRU	Department of Transport	Department of Civil Aviation	Marine Department	Nauru Utilities Corp.	Nauru Utilities Corp.	Dept of Environment
Palau	PLW	MPIIC, Bureau of Public Works	MPIIC, Bureau of Aviation	Port of Malakal	Palau Water & Sewerage	Palau Public Utilities Corp.	MPIIC, BPW, Solid Waste Management Division
Cook Islands	COK	Infrastructure Cook Islands	Airport Authority Cook Islands	Cook Islands Ports Authority	To Tatou Vai Ltd	Te Aponga Uira and Aitutaki Power Supply	Infrastructure Cook Islands
Niue	NIU		Department of Transport, Ministry of Infrastructure	Ministry of Infrastructure	DOE - Waste & Sanitation	Niue Power Corporation	Niue Recycling Facility
Samoa	WSM	Land Transport Authority	Samoa Airport Authority	Samoa Ports Authority	Samoa Water Authority	Electric Power Corporation	Ministry of Natural Resources and Environment
Tonga	TON	Ministry of Works	Tonga Airports Ltd	Ports Authority of Tonga	Tonga Water Board	Tonga Power Ltd	Tonga Waste Authority Ltd
Tuvalu	TUV	Public Works Department	Department of Civil Aviation	Department of Marine and Port Services	Ministry of Utilities and Industries	Tuvalu Electricity Corp	Ministry of Foreign Affairs, Trade, Tourism, Environment and Labor

Source: Authors.

Section 2

MAINTENANCE ENVIRONMENT

The sections herein provide the context within which infrastructure entities operate, and some of the key challenges these entities face in providing maintenance services. It is intended to provide the reader with an understanding of the wider maintenance environment before exploring the assessed maturity of these entities and their financial performance.

2.1 Regulatory and Governance

Good governance means that those with responsibility for infrastructure have the legal powers and the funding to fulfil their responsibilities, are open and accountable for their decisions and use of resources, and report annually to the legislature and through it to the public on their plans, operations, and the performance of the entity they manage. They develop budgets which reflect the true cost of infrastructure ownership and ensure revenue streams are equitable and provide the required levels of funding.

Good governance provides the users who fund infrastructure services with confidence in the services provided. PICs have created SOEs to operate ports, and to deliver water and sanitation and energy. Land and air transport infrastructure services are generally provided by the government, and waste management by a partnership between a government department, local government (LG), and voluntary and business groups.

Without arms-length regulated services, including transparent approval of pricing, the build-neglect-rebuild paradigm, in these circumstances, is rational. It is the least-cost method of obtaining high-cost infrastructure.

Energy Sector Observations

In the energy sector, early failures of off-grid renewable energy projects in Pacific Small Island Developing States (SIDS) were due mainly to technical problems with untested equipment. Failures in the last 2 decades, however, have been more the result of inadequate institutional arrangements for operation and maintenance, which have also afflicted projects that use conventional (non-renewable) technologies.

Low electricity tariffs resulting from political imperatives adversely affect the performance of state-owned utilities, which are unable to invest in maintenance, generation capacity, or extension of electricity grids. One way to address this issue is to establish a regulatory body to set prices independently of government. Evidence from Pacific SIDS suggests that utilities operating under independent price regulation are more likely to generate a profit, and perform better, than utilities operating where prices are set by government (whether directly, or through government influence over utility management/boards). The benchmarking survey of Pacific power utilities found that this was the case whether the utility was state-owned or a private company.

The O&M of off-grid systems has historically been problematic, both in Pacific SIDS and other developing countries. There are many examples of off-grid rural electrification projects that have not proven sustainable. In Thailand, the government sponsored solar-charging program failed due to poor operation and maintenance of equipment at the village level.
(Dornan, Access to Electricity in Small Island Developing States of the Pacific: Issues and Challenges, 2014).

There are limits to the ability of all users to pay fees for infrastructure services. For example, access to safe drinking water is an expectation. Where some people cannot afford the fees, governments subsidize the delivery of the services through community service obligations, which are funded through the government's annual budget and refund the SOE. In this context, infrastructure services can be enjoyed by everyone to the level of service which can be funded.

Keeping infrastructure services being delivered within the acceptable limits, requires reliable processes for not only the cost of services, but also the capture and response to breakdowns by maintenance teams.

2.2 Funding for Maintenance

Governments are finding it challenging to fund the added operating and maintenance costs of an ever-growing stock of existing and new infrastructure. User fees and charges may not yet cover the costs of delivering services in urban and rural areas of PICs.

> With a 3.2% decrease in tax revenue collection in 2018, the Palau government continues to struggle to balance its budget mainly due to increasing maintenance costs. Additionally, the government has completed some major infrastructure projects that we now have to maintain. The government continues to seek other revenue sources to meet these anticipated costs. New measures have been introduced to try and raise additional revenue, i.e., tax reforms, eliminating import duty exemptions, moving to cost, insurance, and freight valuation, and adopting a value-added tax; however, the proposals have yet to be enacted (Deloitte, 2018)

2.2.1 Gross Domestic Product

Gross domestic product (GDP) records the currency value of economic production exchanged in the formal sector of each PIC and influences the revenue that governments can raise to, among other things, maintain its infrastructure. For most PICs it has continued to rise over time, though there was some contraction in 2019 because of the novel coronavirus (COVID-19) disease pandemic. It is expected that GDP will further contract in 2020 and 2021.

Table 5. Gross Domestic Product, 2012–2019 (million USD)

Country	2012	2013	2014	2015	2016	2017	2018	2019
Melanesia	**26.62**	**26.84**	**30.22**	**28.47**	**27.87**	**30.45**	**32.09**	**32.98**
Fiji	3.35	3.49	4.86	4.68	4.93	5.35	5.54	5.48
Papua New Guinea	21.29	21.26	23.21	21.72	20.76	22.74	24.03	24.96
Solomon Islands	1.19	1.28	1.34	1.31	1.38	1.48	1.59	1.60
Vanuatu	0.78	0.80	0.81	0.76	0.80	0.87	0.94	0.94
Micronesia	**1.02**	**1.03**	**1.02**	**1.05**	**1.11**	-	-	-
Kiribati	0.19	0.19	0.18	0.17	0.18	-	-	-
Fed. States of Micronesia	0.33	0.32	0.32	0.32	0.33	0.37	0.40	-
Marshall Islands	0.19	0.19	0.18	0.18	0.19	0.22	0.22	0.24
Nauru	0.10	0.11	0.09	0.10	0.11	0.13	0.13	-
Palau	0.22	0.23	0.24	0.28	0.30	0.28	0.28	0.28
Polynesia	**1.58**	**1.56**	**1.60**	**1.55**	**1.61**	**1.70**	**1.75**	**-**
Cook Islands	0.30	0.29	0.32	0.30	0.31	0.35	0.36	0.38
Niue	0.02	0.03	0.03	0.02	0.02	0.03	0.03	-
Samoa	0.76	0.76	0.78	0.79	0.82	0.83	0.83	0.85
Kingdom of Tonga	0.46	0.44	0.43	0.40	0.42	0.46	0.48	0.51
Tuvalu	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.04

Source: SPC Pacific Data Hub. Data received 4 November 2020.
Note: Conversions from local currency to USD use the IMF exchange rate for that year. Reported in million USD.

2.2.2 Tax Revenue of Each Government

Tax revenue, as a percentage of GDP, indicates the total funds, excluding donor contributions, available to governments to fund all services. These include the operations and maintenance of government funded infrastructure services which support growing economic activity and a growing, mainly urban, population. The following table records tax revenues as a percentage of GDP for PIC governments.

Table 6. Tax Revenue, as a Percentage of Gross Domestic Product

Country	2012	2013	2014	2015	2016	2017	2018	2019	2020
Fiji	25.07	25.39	24.83	25.66	25.7	27.23	26.24	24.87	25.07
Papua New Guinea			19.27	16.93	13.92	13.91	15.43	14.15	19.27
Solomon Islands	28.9	30.05	29.23	30.93	27.59	28.71	29.95	26.64	28.9
Vanuatu	19.65	20.34	20.42	20.93	23.18	24.16	30.27	31.45	19.65
Kiribati	67.85	76.97	96.96	120.5	92.55	99.57	113.3	114.8	67.85
Fed. States of Micronesia	14.5	17.79	28.69	28.37	27.14	31.39	44.69	38.73	14.5
Marshall Islands	19.72	22.06	23.95	27.1	31.41	37.63	32.18	32.75	19.72
Nauru			80.80	84.21	91.45	92.21	108.5	80.80	
Palau	22.06	22.65	24.62	25.38	25.57	26.98	27.58	28.39	22.06
Average	**28.25**	**30.75**	**38.75**	**42.22**	**39.83**	**42.42**	**47.57**	**43.62**	**27.13**

Source: https://data.worldbank.org/indicator/GC.TAX.TOTL.GD.ZS (13 Aug 2021)

Tax revenue refers to compulsory transfers to the central government for public purposes. Certain compulsory transfers such as fines, penalties, and most social security contributions are excluded. Refunds and corrections of erroneously collected tax revenue are treated as negative revenue (World Bank, 2021). Given the size of most PICs, it is a central government's access to funds that determine its ability to maintain, for example, road infrastructure. Drops in PIC tax revenue began in 2018 and has been further exacerbated by the global pandemic.

In addition, many infrastructure services are delivered by SOEs with the legislative power to raise fees and charges/tariffs directly from delivering the infrastructure services to users, for example, households and businesses. The ability of mainly urban users to pay for these services is roughly indicated by GDP per capita.

2.2.3 Impact of the COVID-19 Pandemic

The global pandemic has led to the closure of borders. This has held back imports of capital goods and the arrival of foreign experts, delaying infrastructure and reconstruction efforts for many PICs such as Marshall Islands, Micronesia, Solomon Islands, Tonga, and Vanuatu (International Monetary Fund, 2021). The IMF has reported that, "for most of the islands, the contraction in 2020 has turned out to be less severe than previously expected, as governments have taken measures to support the populations and sectors most affected by the pandemic. The economic contraction in some of PIC's main trading partners (such as Australia and New Zealand) also turned out to be less severe than expected; and remittances have held up relatively well" (International Monetary Fund, 2021).

It will be some time before the financial impact of the pandemic on all PIC governments can be reliably understood.

Table 7. Gross Domestic Product per capita (USD)

Country	2012	2013	2014	2015	2016	2017	2018	2019	2020
Fiji	4,591	4,840	5,605	5,390	5,651	6,101	6,317	6,175	4,881
Papua New Guinea	2,790	2,729	2,920	2,679	2,509	2,695	2,801	2,829	2,636
Solomon Islands	2,142	2,249	2,275	2,167	2,225	2,333	2,412	2,344	2,258
Vanuatu	2,997	2,955	2,927	2,696	2,806	3,082	3,125	3,102	2,783
Kiribati	1,789	1,716	1,643	1,543	1,585	1,641	1,698	1,655	1,671
Federated States of Micronesia	3,131	2,995	2,972	2,907	3,015	3,290	3,568	3,585	
Marshall Islands	3,182	3,247	3,185	3,200	3,491	3,673	3,794	4,073	
Nauru	9,563	9,648	10,171	8,365	9,556	10,361	11,615	10,983	
Palau	12,044	12,561	3,712	15,876	16,653	16,065	15,657	14,908	
Samoa	4,022	4,038	3,938	4,074	4,109	4,260	4,189	4,324	4,067
Kingdom of Tonga	4,582	4,428	4,354	4,336	4,158	4,513	4,741	4,903	
Tuvalu	3,506	3,457	3,398	3,198	3,254	3,574	3,702	4,056	4,143
Average	**4,528**	**4,572**	**4,758**	**4,703**	**4,918**	**5,132**	**5,302**	**5,245**	(n/a)

Source: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=S2. (13 Aug 2021)

The per capita GDP has increased steadily between 2010 and 2018. In Palau, it began to decline in 2017, with declines in 2019 also for the Solomon Islands, Vanuatu, Fiji, Nauru, and Kiribati. Further declines are expected for 2020 and 2021 because of the impact of the pandemic, although, as Pacific Technical Assistance Center (PFTAC) reports, the decline has not been as bad as feared.

The decline in tax revenue shown in Table 6 occurred in all PICs in the table except for Kiribati. Again, these data are from before the pandemic, indicating an overall reduction in the ability of PIC governments to fund the annual operation and maintenance costs of current and any new infrastructure that will come into operation.

2.2.4 The Impact of Climate Change

Climate change is affecting where infrastructure can be built in the long term. Of the 20 countries with the highest average annual disaster losses scaled by GDP, eight are PICs: Vanuatu, Niue, Tonga, the Federated States of Micronesia, the Solomon Islands, Fiji, the Marshall Islands and the Cook Islands.

One attempt to identify the action that PIC governments could take was made in a recent article in "Sustainability" (Nakatani, 2021) "Fiscal rules for natural disaster and climate change-prone small states". Because detailed macroeconomic data are not available for the above countries, the author used Papua New Guinea as an example. The fiscal framework proposed is yet to be tested in small states around the world. If implemented, it may affect the fiscal rules currently being applied by PIC governments and could affect SOEs' ability to fund infrastructure after natural disasters and in mitigating risks arising from climate change.

A 2013 report found that, "The total value of infrastructure, buildings, and cash crops considered at some level of risk in the Pacific is estimated at over US$112 billion" (see Figure 6 below). Inaction could therefore prove extremely costly and will only grow more expensive in the future (see table below for asset replacement costs and economic losses due to extreme events).

Figure 6. Estimated Cost of Natural Disasters in PICs

Country	Assets replacement cost US$ million	Annual average economic losses		Losses from 100-Year event	
		US$ million	% GDP	US$ million	% GDP
Cook Islands	1,422	4.9	2.0	103.0	42.2
Fiji	22,175	79.1	2.6	844.8	28.1
Micronesia, Fed. Sts.	2,048	8.3	2.9	150.7	52.4
Kiribati	1,182	0.3	0.2	4.0	2.6
Marshall Islands	1,696	3.1	2.0	67.4	43.3
Nauru	453	0.00	0.00	0.00	0.00
Niue	249	0.9	5.8	22.7	143.4
Palau	1,501	2.7	1.6	46.7	27.5
Papua New Guinea	49,209	85.0	0.9	794.9	8.4
Samoa	2,611	9.9	1.7	152.9	27.0
Solomon Islands	3,491	20.5	3.0	280.6	41.4
Timor-Leste	20,145	5.9	0.8	143.7	20.5
Tonga	2,817	15.5	4.3	225.3	63.0
Tuvalu	270	0.2	0.8	4.8	15.1
Vanuatu	3,334	47.9	6.6	370.1	50.8
TOTAL	**112,602**	**284.2**		**3211.6**	

Source: World Bank, Pacific Catastrophe Risk Assessment and Financing Initiative, Country Risk Profiles (Washington, DC: World Bank, 2011).

The resilience of infrastructure, reinforced by a regular maintenance program, is needed if PICs are to mitigate the predictable impacts of climate change.

Experience tells us that the capital cost of infrastructure can be approximately 20% of its total cost. With an ever-increasing frequency and ferocity of natural disasters, donors and governments are addressing how best to manage the risk and the role maintenance plays in building resilience. In this rapidly changing environment, it is not yet clear what sources of income that PICs can access to fund current and expected future annual costs.

2.3 Maintenance Program Delivery

Preventive maintenance is undertaken by a dedicated workforce that develops and passes on the skills of maintaining the assets. These people have access to spare parts, to specialists in maintaining the equipment / asset, and to manuals and mentors. In a maintenance culture, apprentices learn from their elders and are available when required to keep the asset functioning. They also are available to do unscheduled maintenance when it occurs, to diagnose its cause, and to feed that information back into the planning of preventive maintenance.

In a maintenance culture, there is a respect for the services provided; designing and building new infrastructure without reference to the maintenance people may waste resources and impede the skilled workforces.

All the costs of training the workforce are often treated as an externality to each infrastructure sector as they are not incurred by individual SOEs. Rather they are considered part of the cost of developing the human capital of each PIC and are incurred by each government.

2.3.1 Availability of Skilled Resources

It is governments' investments in school curricula, tertiary education, on-the-job training and mentoring, including access to specialist technical advisers, that enable staff to build and maintain the skills needed to maintain infrastructure. Staff retention and supplier capacity is critical to PICs' ability to maintain infrastructure

and deliver services. Realistically, advanced levels of maturity are generally only achieved with larger populations and economies.

Funding alone cannot ensure good maintenance of infrastructure. Skilled staff are also required, with the professional and technical education sectors of each PIC providing a pool of staff trained in basic skills from which SOEs can recruit maintenance staff.

Formal Training through Accredited Courses

The South Pacific Community, the University of the South Pacific provide educational courses to residents of PICs. The European Union has a program supporting energy and climate change adaptation skills. The Australia-Pacific Technical College supports PICs developing Australian-standard skills in automotive, manufacturing, construction, and electrical trades.

The Australia-Pacific Technical College has campuses in four countries: Fiji, Samoa, Papua New Guinea, and the Solomon Islands. In addition, it works with the governments of Vanuatu, Tuvalu, Kiribati, Nauru; in total nine of the 14 PICs.

The College of the Marshall Islands offers courses in Maritime Vocational Training, Science, Technology and Mathematics and Vocational Education. Skills taught mainly relate to the maintenance of heavy equipment and buildings.

The Federated States of Micronesia (FSM) has identified the skills it needs to achieve its Development Plan goals. For example, it needs trained electrical, solar, refrigeration and air conditioning technicians to achieve its Energy Policy goals of "Electrification of 80% of rural public facilities by 2015; Electrification of 90% of rural households by 2020; Enhance supply side efficiency of utilities by 20% by 2015". It has identified that the College of Micronesia is not yet able to produce the skilled graduates needed to meet development objectives. Maintenance skills are taught in the Electronics Technology, Building Technology, Marine Science, Telecommunications and Technology and related streams. The FSM Fisheries and Maritime Institute is in Yap and offers three majors: Navigation, Marine Engineering, and Fishing Technology (http://www.comfsm.fm)

The Palau Community College offers courses in trades and electronics.

2.4 Accounting Principles across PICs

The accounting principles being applied by an entity that manages and maintains infrastructure determine what is, and is not, reported in its financial statements. The principles also determine if and how the full cost of maintenance can be reported to users of financial statements. The accounting principles being applied in PICs differ; thus, the information available publicly also differs.

The accounting standards adopted by PIC governments are illustrated in the table below. Only half (7) of PICs use the accrual-based accounting principles that require them to account for long-term fixed assets (infrastructure) in their Statement of Financial Positions:

- Three have adopted IPSAS Accrual: Vanuatu, Cook Islands and Niue.
- Three have adopted GAAP/GASB: Marshall Islands, FSM, and Palau,
- One has adopted IPSAS Modified Cash.

The remainder, that is, Solomon Islands, Fiji, Kiribati, Nauru, Tonga, and Samoa, adopt cash-based accounting principles, which does not enable governments to extract key infrastructure maintenance performance indicators from annual budgets and the consolidated whole-of-government accounts. The development and use of such indicators is dependent on the sector and availability of quantitative data for that sector. The accounting principles being applied determine, to a large extent, the data collected, collated, and publicly reported.

Those sectors using accrual accounting (that is, airports, power, and, to a lesser degree, water) generally publish more data publicly than the entities using cash accounting (that is, roads and waste management).

Table 8. Standards in Use for Whole-of-Government Accounts

Country	IPSAS Accrual	GASB Mod. Accrual	IPSAS Mod. Cash	IPSAS Cash
Melanesia				
Fiji				Yes
Papua New Guinea			Yes	
Solomon Islands				Yes
Vanuatu	Yes			
Micronesia				
Kiribati				Yes
Federated States of Micronesia		Yes		
Marshall Islands		Yes		
Nauru				Yes
Palau		Yes		
Polynesia				
Cook Islands	Yes			
Niue	Yes			
Samoa				Yes
Kingdom of Tonga				Yes
Tuvalu		Yes		

Source: Authors research of online published accounts.

Where infrastructure stewardship and maintenance responsibilities are held by state-owned enterprises in countries whose core public sector uses cash-based accounting, the major SOEs in each PIC apply accrual accounting standards, illustrated in Table 9.

Table 9. Accounting Standards Applied by SOEs in Countries Using Cash Accounting

Country	IFRS Companies	IFRS SME	IPSAS Cash
Fiji	Yes		
Papua New Guinea	Yes	Yes	
Solomon Islands	Yes		Yes
Kiribati	Yes		
Nauru			Yes
Samoa	Yes		
Kingdom of Tonga	Yes		

Source: Authors research of online published accounts.

Many of the key infrastructure maintenance performance indicators reported in Section 4 are only possible when specific accounting principles are being applied. More information on these accounting standards and their impact on the reporting of the maintenance of infrastructure assets in financial statements is discussed in Appendix A.

2.5 Maintenance Monitoring Culture

PICs have given priority to the delivery of infrastructure services, have set up SOEs to manage the infrastructure and, in doing so, have required them to report using accrual accounting. Thus, for these infrastructure sectors, there is more financial information collected and reported. The accounting principles determine the financial

information available to governments to assess the performance of infrastructure, its maintenance needs, and how best to fund them.

There is no one common sector and no one common country; all differ. The assessment of the maintenance needs depends on a thorough knowledge of the sector, and requires the involvement of stakeholders: infrastructure SOEs, operators, suppliers, staff, users, and neighbors. It requires more than financial information. In establishing a baseline to adequately describe the sectors, we have accessed non-financial as well as the financial measures collected, collated, and reported. The specific set of measures used differs from place to place and from time to time, although a desire for comparability across the Pacific region necessitates the consideration of common basic measures. **The baseline metrics available are discussed in Appendix B.**

A summary of the key principles is provided below:

- Governments using **cash accounting** do not record the replacement cost of their infrastructure assets or account for its annual depreciation. Their financial statements lack the information needed to ascertain the full value of infrastructure and rate at which it depreciates and do not contain the information needed to report most of the financial measures outlined in this report.
- Government organizations using **IPSAS Cash** or **IPSAS Modified Cash** accounting standards, prepare general purpose financial statements under the cash basis of accounting. This defines the cash basis of accounting, establishes requirements for the disclosure of information in the financial statements and supporting notes, and deals with several specific reporting issues. These entities **do not** report the information needed for the proposed benchmark measures outlined in Section 4.
- Governments using **accrual accounting** are more likely to report the information needed to understand their investment in infrastructure and the expenditure required to preserve that infrastructure.
- Government organizations and SOEs using **IFRS** or **IPSAS accrual** accounting standards, account for the gross replacement cost (GRC) or fair value, accumulated and annual depreciation of non-current fixed assets (infrastructure) in the Statement of Financial Position. SOEs that have legislated stewardship responsibilities for infrastructure report the value of the infrastructure in their financial statements. These entities are **most likely** to report the information needed for the proposed benchmark measures outlined in Section 4.
- Entities reporting using **United States GAAP/GASB** report the written down value and annual depreciation, but not the GRC and accumulated depreciation in their financial statements.

Section 3

MATURITY ASSESSMENT

There are many maturity assessment frameworks used to assess infrastructure organizations, determine a baseline, identify gaps, and guide them on a path to improvement. However, these holistic frameworks do not dive deep enough into the subtopic of maintenance; for this reason, our project team developed an infrastructure maintenance-specific framework for this assessment. The background to its development and the results from its inaugural assessment are presented herein.

PART A: Background

3.1 Asset Management Frameworks

3.1.1 Introduction

A primary objective of this technical assistance (TA) is to help raise the profile of infrastructure maintenance issues within governments and among donors and stakeholders. A well-structured maturity assessment framework can help achieve this goal by identifying the key competency areas supporting infrastructure maintenance and key requirements against each competency level (for example, having a central register of all assets). Each requirement serves to demonstrate/quantify what "good maintenance management" looks like. For example, an advanced level of maturity includes having a reliable physical asset register, in an electronic format, that also holds condition and maintenance history. It also means the entity can demonstrate the timely response to service failure notifications.

The maturity assessment framework is a diagnostic tool for decision-makers. It is also a development tool to share how the capability of infrastructure maintenance in PICs can be developed over time.

There are a few more holistic asset management maturity assessment frameworks in existence. But as yet, there is no commonly used assessment framework that specifically targets maintenance. We have reviewed three commonly used asset management frameworks below to ensure the maintenance assessment framework aligns with the concepts of robust maturity assessment in common use.

3.1.2 Asset Management Maturity Model (ISO55000)

Assets are the basis for any organization. Whether in the public or private sector and whether assets are physical, financial, human, or intangible, good asset management maximizes value-for-money. It involves coordinated and optimized planning, asset selection, acquisition/development, utilization, care and ultimate disposal or renewal of assets and asset systems.

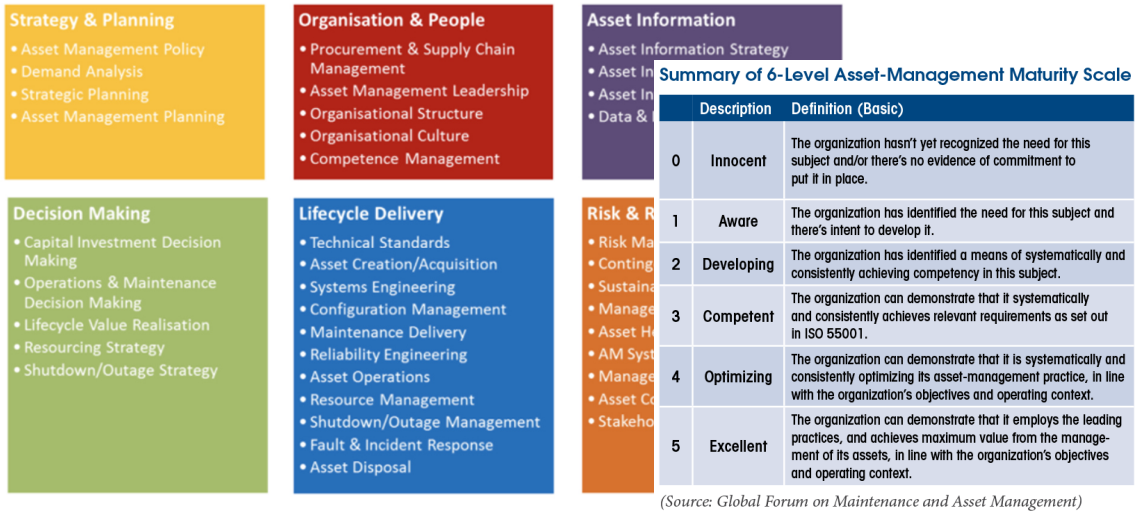
In 2002–2004, the Institute of Asset Management in conjunction with the British Standards Institution developed PAS 55, the first publicly available specification for optimized management of physical assets. The 2008 update (PAS 55:2008) was developed by 50 organizations from 15 industry sectors across 10 countries. The International Standards Organization (ISO) then accepted PAS 55 as the basis for development of the new ISO 55000 series of international standards which was first published in 2014.

The ISO 55000 family became the first set of International Standards for Asset Management and includes:

- ISO 55000 providing an overview of the subject of asset management and the standard terms and definitions.
- ISO 55001 specifies the requirements for an integrated, effective management system for asset management.
- ISO 55002 provides guidance for the implementation of such a management system.

PAS 55 and ISO 55001 provide an excellent checklist of required good practices. The Institute of Asset Management has developed and published a standardized Maturity Scale to ensure consistency of definitions and bench-marking potential across organizations.

Figure 7. Example of Asset Management Maturity Assessment Framework (IAM ISO55000)



Summary of 6-Level Asset-Management Maturity Scale

	Description	Definition (Basic)
0	Innocent	The organization hasn't yet recognized the need for this subject and/or there's no evidence of commitment to put it in place.
1	Aware	The organization has identified the need for this subject and there's intent to develop it.
2	Developing	The organization has identified a means of systematically and consistently achieving competency in this subject.
3	Competent	The organization can demonstrate that it systematically and consistently achieves relevant requirements as set out in ISO 55001.
4	Optimizing	The organization can demonstrate that it is systematically and consistently optimizing its asset-management practice, in line with the organization's objectives and operating context.
5	Excellent	The organization can demonstrate that it employs the leading practices, and achieves maximum value from the management of its assets, in line with the organization's objectives and operating context.

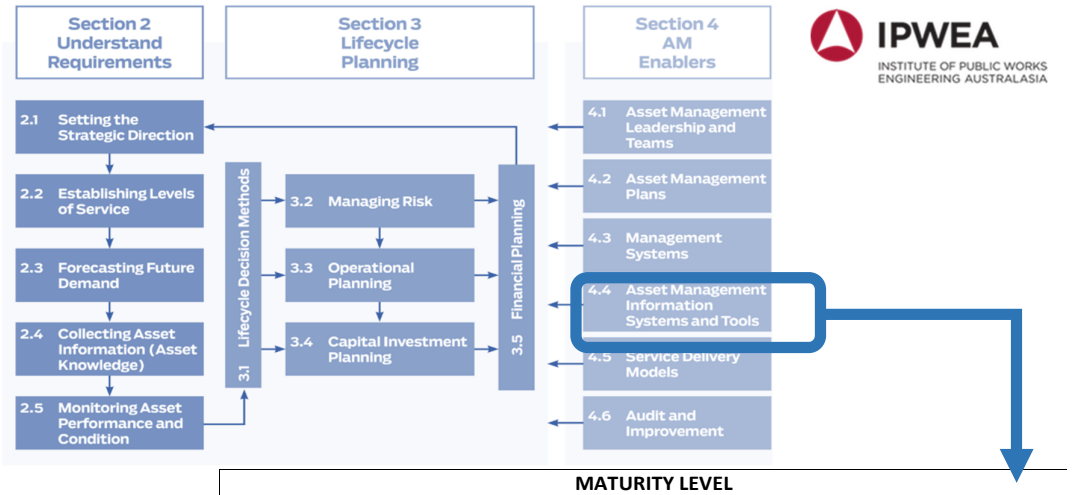
(Source: Global Forum on Maintenance and Asset Management)

Source: Extract from ISO Technical Committee for Asset Management. (2018). ISO 55002 Guidelines for the application of ISO 55001. International Organization for Standardization.

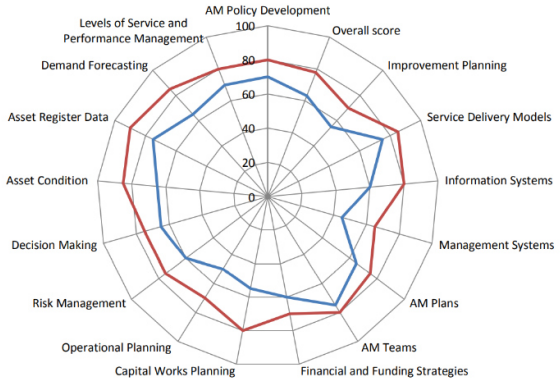
3.1.3 Infrastructure Management Maturity Assessment

The International Asset Management Manual (later, the IIMM) was first published in 2002 by New Zealand's National Asset Management Steering committee. The 3rd edition (2006) was a significant iteration of the manual and saw a continued broadening of contributors to the manual with public and private sector industry input from Australia, New Zealand, South Africa, the United Kingdom, and the United States. Custodianship of the manual transferred from the National Asset Management Steering committee to the Institute of Public Works Engineering Australasia (IPWEA) around this time. The 5th edition (2015) saw further developments of the manual to better align with ISO55000. The 6th and latest edition of IIMM was released by IPWEA in 2020. IIMM provides a Maturity Assessment Table which can be used in assessment frameworks/templates to determine an organization's progress against 16 components aligned with the IIMM knowledge areas.

Figure 8. Example of Asset Management Maturity Assessment Framework



	MATURITY LEVEL				
Assessed Component	***Aware*** *(0-20)*	***Basic*** *(21-40)*	***Core*** *(41-60)*	***Intermediate*** *(61-80)*	***Advanced*** *(81-100)*
ASSET REGISTER What sort of asset-related information does the organisation collect, and how does it ensure the information has the requisite quality (accuracy, consistency, reliability)?	*The organisation has an awareness of need to collect asset data.*	*Basic physical information recorded in a spread sheet or similar (e.g. location, size, type), but may be based on broad assumptions or not complete.*	*Sufficient information to complete asset valuation (basis attributes, replacement cost and asset age/ life) and supports prioritisation of programmes (criticality). Asset hierarchy, identification and attribute systems documented.*	*A reliable register of physical and financial attributes recorded in an information system with data analysis and reporting functionality. Systematic and documented data collection process in place. High level of confidence in critical asset data.*	*Information on work history type and cost, condition, performance, etc. recorded at asset component level. Systematic and fully optimised data collection programme with supporting metadata.*



Reference	Summary Results	Current Score	Appropriate Target	Difference
IIMM 2.1	AM Policy Development	75	80	5
IIMM 2.2	Levels of Service and Performance Management	70	80	10
IIMM 2.3	Demand Forecasting	65	85	20
IIMM 2.4	Asset Register Data	60	90	30
IIMM 2.5	Asset Condition	60	85	25
IIMM 3.1	Decision Making	65	75	10
IIMM 3.2	Risk Management	55	75	20
IIMM 3.3	Operational Planning	45	70	25
IIMM 3.4	Capital Works Planning	55	80	25
IIMM 3.5	Financial and Funding Strategies	60	70	10
IIMM 4.1	AM Teams	75	80	5
IIMM 4.2	AM Plans	65	75	10
IIMM 4.3	Management Systems	45	65	20
IIMM 4.4	Information Systems	60	80	20
IIMM 4.5	Service Delivery Models	75	85	10
IIMM 4.6	Improvement Planning	55	70	15
	Overall Score	(Core +) 62	(Intermediate) 78	16

Source: International Infrastructure Management Manual (IPWEA, 2020).

3.1.4 Asset Management Capability Maturity Model

The Asset Management Capability Maturity Model was developed by the Asset Institutes' Public Assets Collaborative Group and allows infrastructure managers and decision makers to quickly assess the level of asset management maturity held by their organization.

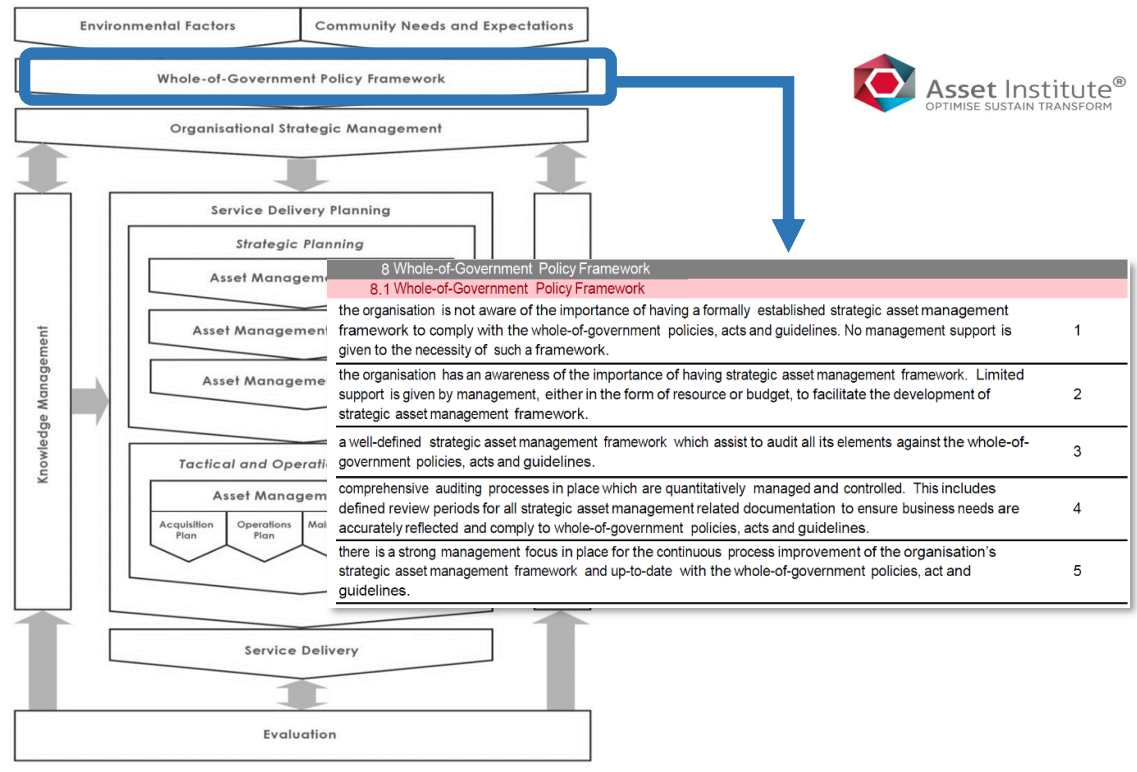
It provides managers with an easy to implement tool that gives an immediate strategic overview of organizational asset management which aligns with the requirements of international and Australian standards to manage their assets. It is a tool to provide a strategic overview of asset management and it does not replace careful monitoring and reporting of organizational requirements for asset management.

Based on international best practice benchmarks, the Asset Management Capability Maturity Model assesses the current level of asset management across 25 areas of operation, including organizational governance, service delivery planning, tactical and operational planning, service delivery, knowledge management, and management.

The framework provides a tool for organizations to assess their current capability; map the results; determine their target level (gap assessment); and finally set an improvement path.

Using an online survey with a five-point response scale, it sets out a range of responses that identify threshold activities for each level of maturity and allows a quick assessment of capability. Sub-units of an organization can undertake an assessment, and these will also be shown individually or averaged as well. The survey takes between 30 and 40 minutes to complete. The five levels range from 1 to 5, with 5 denoting optimization and the highest level of maturity.

Figure 9. Example of Asset Management Maturity Assessment Framework (Asset Institute)

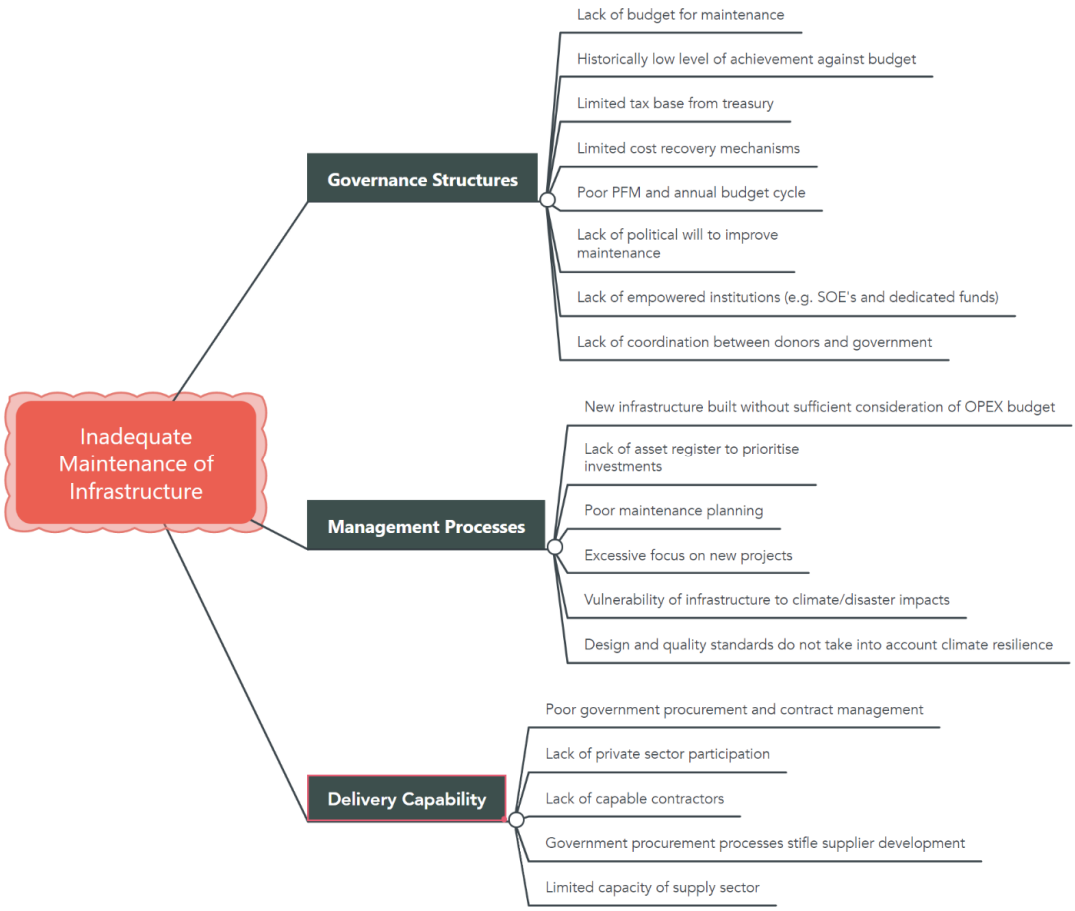


Source: Understanding and Mapping Asset Management Capability Maturity (Asset Institute, 2021).

3.2 Challenges Facing Infrastructure Managers

From previous studies, the underlying challenges contributing to the Inadequate Maintenance of Infrastructure can be grouped under three broad headings as follows.

Figure 10. The Challenges Contributing to Inadequate Levels of Maintenance



Note: Abbreviations; Public Financial Management (PFM), Operating Expenditure (OPEX) \, State Owned Enterprise (SOE)
Source: PIC Infrastructure Maintenance contract Terms of Reference (PRIF).

The problem statements above, plus an extensive literature review, guided our project team in identifying 12 core capabilities (knowledge areas) of an effective infrastructure maintenance organization. A collection of key requirements was then developed for each knowledge area to form the basis of the maintenance management maturity assessment framework presented in Part B below.

PART B: Formulation of the Assessment

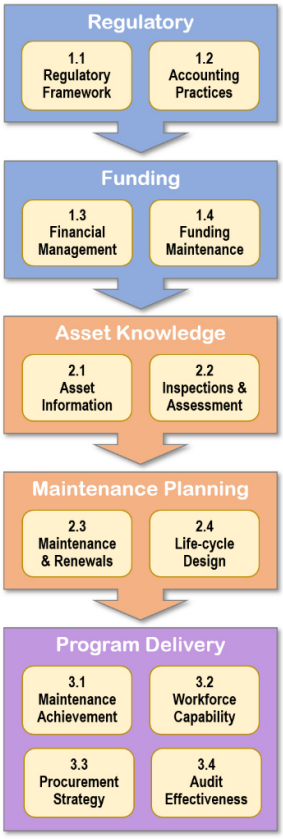
3.3 Good Maintenance Management Requirements

The three asset management frameworks above and the underlying challenges identified in previous studies have provided the guiding principles for the design of the Infrastructure Maintenance Management Assessment Framework used in this study. Our team investigated the relative merits of using one of the more holistic asset management frameworks "out of the box" but ultimately, our decision not to was based on the following assessment findings:

1. The wider domain of asset management does not adequately cover the maintenance problem areas targeted for this study.
2. The asset management assessment frameworks require a good degree of technical knowledge to understand what is being assessed and how best to self-assess an appropriate score.
3. The frameworks do not clearly present a set of requirements for the maintenance of infrastructure.

However, many of the key principles and methodologies for conducting a maturity assessment have been used in the design of our framework.

The final developed list of maturity requirements for each of the core competency areas is presented below.



3.3.1 Good Governance

Those responsible for the stewardship of infrastructure assets, including maintenance, are known and have legislative powers to fulfil their responsibilities. The legislature approves funding to manage and maintain infrastructure. Further, infrastructure managers are accountable to the legislature.

Regulated Accountability (1.1)

A good regulatory framework will clearly lay out how infrastructure is funded and who is responsible for maintaining infrastructure with those funds. It is also important that these frameworks lay out the level of service expected from these assets and the citizens they serve.

Requirements:

(i) There is a legal, planning, and policy framework for the sector that is fully implemented.
(ii) Roles and responsibilities for planning and management of the infrastructure, including maintenance, are clear.
(iii) Sector strategic plans identify service delivery required over the short, medium, and long term to meet National Development Plan goals.
(iv) Delivery of services and costs of services are monitored by the legislature directly and/or through an independent regulatory body.
(v) All necessary maintenance functions are reflected in organizational roles, including management, maintenance planning, materials procurement and administration, accounting, information management, workshops, and maintenance staff.

Accounting Practices (1.2)

Each organization's chart of accounts determines its ability to meaningfully report the actual expenditure against budgeted maintenance.

Requirements:

(i) The Fixed Asset Register (FAR) represents a structured asset hierarchy with links to the physical asset inventory.
(ii) Non-financial assets are regularly revalued. Condition-based depreciation is recorded and reported in financial statements. Straight line depreciation supports fees and charges calculations.
(iii) The chart of accounts is structured to enable managers to budget for, and identify costs of, maintenance for each class of assets.

Financial Management (1.3)

Good financial management can lead to lower long-run life cycle costs, equitable fees and charges, and the avoidance of financial shocks. Good collaboration among financial and asset managers is important, especially in relation to long-term financial forecasts. Robust financial budgets that include both capital and the consequent annual operations and maintenance costs are key.

Requirements:

(i) Financial forecasts (3–5 year) of maintenance and rehabilitation needs are submitted by managers as part of the annual budget process.
(ii) 10-year financial projections are contained within Asset Management Plans (AMPs), with detailed supporting assumptions/reliability factors.
(iii) The legislative framework enables sound taxation/fees and charges to be levied and collected.
(iv) Tariffs, rates, fees, and charges recover the costs of providing the amount and quality of service used by the customer and the marginal cost of providing and maintaining those services.

Maintenance Funding (1.4)

The budgeting for operations and maintenance funds the agreed levels of service. Each sector/organization develops its own methodology for estimating the need for maintenance. Capital budgets separately identify operations and maintenance costs as well as the anticipated need for major improvements. Annual budgets include interest and redemption payments, and operating, maintenance, and disposal costs.

Requirements:

(i) Government subsidies and/or fees and charges are levied for an agreed level of service, preferably tabled in the legislature.
(ii) Budget allocation to maintenance is fully expended, with budget proposals containing quality/quantity standards and forecasted cash flows.
(iii) When your organization contracts private sector providers to deliver maintenance services, it can guarantee the funding of that contract.

3.3.2 Effective Management

The location and physical characteristics (for example, age, dimensions, materials) of infrastructure assets are known and the condition and performance of these assets are regularly monitored. New assets are designed to be resilient and are proactively maintained to optimize the full lifecycle cost of ownership.

Asset Information (2.1)

Knowledge of infrastructure is the foundation for good maintenance. Organizations need to know what assets they are responsible for maintaining, where they are located, how they perform, what is and needs to be spent on them and the risks they are managing to ensure ongoing operation of the system.

Requirements:

(i) There is a physical inventory of assets to be maintained. The independent valuer can rely on data in the database in preparing its valuation.

(ii) Day-to-day processes and accountabilities are in place to maintain the register and it is regularly updated and accurate.
(iii) Associated information on asset failures, work history, planned maintenance etc. is recorded against the asset in electronic format.

Inspections and Assessments (2.2)

The regular inspection practice informs the maintenance schedule. Updating performance metrics keeps the organization's focus on the required level of service. Sector infrastructure is built to deliver a set level of service for a given period. Levels of service expected each year are agreed. Regular monitoring checks levels are being delivered.

Requirements:

(i) Regular inspection and performance monitoring processes are documented and followed for major/critical assets.
(ii) Inspection and condition data are actively used to identify and priorities periodic maintenance and renewals programs.
(iii) Fault and incident reporting is available to all users, and there is a target response time to clear all faults/incidents.

Maintenance Planning (2.3)

A maintenance and renewals (M&R) program record the planned maintenance and capital rehabilitation work to maintain service levels and preserve or extend the life of an asset. It is based on the organization's understanding of demand, customer requirements, the condition of the infrastructure, available skills, and funding.

Requirements:

(i) 5+ year rolling M&R program is updated annually from inventory, inspection reports, quality and quantity standards, and financial forecasts.
(ii) Decision frameworks (for example, multi-criteria analysis) and support tools are used to identify and prioritize M&R projects.
(iii) Routine, periodic, and capital maintenance budgets are delegated to managers responsible for delivering the M&R program.
(iv) The budget for routine maintenance is sufficient to ensure the agreed level of service to each user group continues to be delivered.

Whole-of-Life Design (2.4)

New infrastructure may add as much as 2%–8% of its capital costs per year to an organization's maintenance costs. The designers of infrastructure projects will consider the implications of each design on ongoing operations and maintenance and, if applicable, disposal costs. The business case of each project records the estimated costs and identifies potential sources of funds.

Requirements:

(i) The design of all new infrastructure projects includes a full study of the maintenance requirements and detail who will conduct and finance.
(ii) Designs are appropriate to the human, material, and financial resources and capabilities of intended users and those who will maintain.
(iii) National design standards are in place to ensure relevant, affordable, and consistent designs that take into consideration the specific risks from climate change and natural disasters.

3.3.3 Sustainable Delivery

Deliver a sustainable level of maintenance and ensure skilled people train the emerging workforce.

Maintenance Achievement (3.1)

When preventive maintenance is planned and scheduled at the levels required, an agency will experience fewer unplanned service disruptions, lower levels of corrective maintenance, and a longer service life of the infrastructure.

Requirements:

(i) There is a prioritized list of known corrective maintenance work (scheduled backlog), which is funded and achievable.
(ii) Unplanned events/outages/failures are measured and reported on. There are a low number, and they are proactively managed.

Workforce Capability (3.2)

Skills required to maintain infrastructure are developed over decades based on school curricula, tertiary education, on the job training and mentoring. Staff turnover and supplier capacity is critical to a PIC's ability to maintain infrastructure and deliver services. Realistically, advanced levels of maturity are generally only achieved with larger populations and economies.

Requirements:

(i) Maintenance training is routinely provided to technical and management staff by skilled staff, visiting advisers, on-the-job mentoring and, where available, through training institutes, secondments, etc.
(ii) The private sector is regularly engaged to provide both additional maintenance delivery capacity and specialist maintenance expertise.
(iii) Staff move from public to private sector and back again during their career.

Procurement Strategies (3.3)

A maintenance procurement strategy looks at the capability and capacity of internal and external providers, structures contracts and assigned responsibilities and performance objectives to ensure the required maintenance activities can be delivered in an effective manner.

Requirements:

(i) Maintenance procurement strategy exists, which reflects anticipated risks, identifies the equipment, materials and services required and assesses the benefits obtainable from alternative suppliers within the funding available.
(ii) Maintenance contracts are typically multi-year, have performance incentives to meet objectives and are closely monitored.

Review and Audit (3.4)

Effective maintenance extends the life of infrastructure and reduces the whole-of-life cost to asset owners. A structured review and audit process checks that maintenance is completed as specified and that the chosen intervention treatments achieve these objectives.

Requirements:

(i) Service-level performance metrics are included in annual reports. Asset performance metrics are monitored in-house to demonstrate to senior managers the effectiveness of the maintenance program.
(ii) Maintenance audits completed at least annually to ensure key outcomes met (for example, quality, safety, efficiency, environmental, social).

3.4 Measuring Progress (Maturity) against Requirements

3.4.1 Maturity Scale

The final set of **37 key requirements** against each competency area are presented above. Our framework then asks the responding agency to rank their progress (maturity) against each requirement using a 5-point scale similar to the ISO55000 assessment:

Table 10. Scale Used to Assess Maturity against the 37 Key Requirements

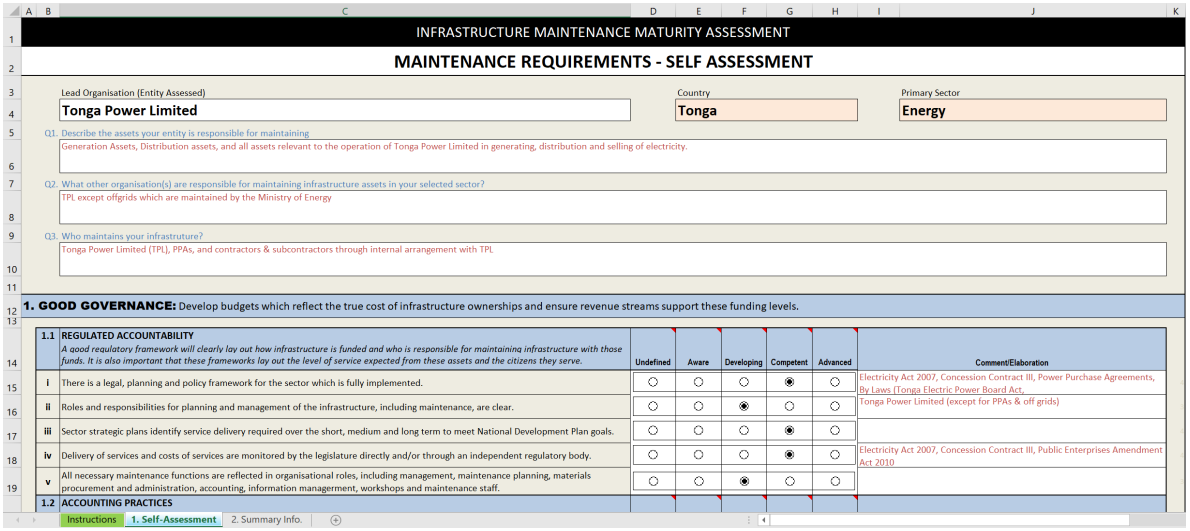
Score	Rating	Description
1	**Undefined**	The infrastructure entity has not recognized the need for this requirement and/or there is no evidence of commitment to meet this objective.
2	**Aware**	The entity has identified the need for this requirement, and there is evidence of intent to progress it.
3	**Developing**	The entity has identified the means of achieving the requirement and can demonstrate progress toward the goal. Some basic elements are in place but not fully implemented.
4	**Competent**	The entity can demonstrate that it systematically and consistently achieves the relevant objective. Foundational processes in place but maximum value is not yet being realized.
5	**Advanced**	The entity can demonstrate that it employs leading practices, fully meets, or surpasses, the requirement.

Source: Extract from ISO Technical Committee for Asset Management. (2018). ISO 55002 Guidelines for the application of ISO 55001.

3.4.2 Executing the Assessment

Assessing the maturity of infrastructure entities to maintain the services in the long-run does lend itself to an online survey methodology which would have the benefit of allowing us to monitor completion rates and validate data as it is completed. However, for this inaugural survey, a more familiar spreadsheet (Figure 11) was built, distributed, and completed by the agencies listed in Table 11.

Figure 11. Spreadsheet Template Used to Execute the Survey



INFRASTRUCTURE MAINTENANCE MATURITY ASSESSMENT

MAINTENANCE REQUIREMENTS - SELF ASSESSMENT

Lead Organisation (Entity Assessed)	Country	Primary Sector
Tonga Power Limited	Tonga	Energy

Q1. Describe the assets your entity is responsible for maintaining
Generation Assets, Distribution assets, and all assets relevant to the operation of Tonga Power Limited in generating, distribution and selling of electricity.

Q2. What other organisation(s) are responsible for maintaining infrastructure assets in your selected sector?
TPL except offgrids which are maintained by the Ministry of Energy

Q3. Who maintains your infrastruture?
Tonga Power Limited (TPL), PPAs, and contractors & subcontractors through internal arrangement with TPL

1. GOOD GOVERNANCE: Develop budgets which reflect the true cost of infrastructure ownerships and ensure revenue streams support these funding levels.

		Undefined	Aware	Developing	Competent	Advanced	Comment/Elaboration
1.1	REGULATED ACCOUNTABILITY *A good regulatory framework will clearly lay out how infrastructure is funded and who is responsible for maintaining infrastructure with those funds. It is also important that these frameworks lay out the level of service expected from these assets and the citizens they serve.*						
i	There is a legal, planning and policy framework for the sector which is fully implemented.	○	○	○	◉	○	Electricity Act 2007, Concession Contract III, Power Purchase Agreements, By Laws (Tonga Electric Power Board Act,
ii	Roles and responsibilities for planning and management of the infrastructure, including maintenance, are clear.	○	○	◉	○	○	Tonga Power Limited (except for PPAs & off grids)
iii	Sector strategic plans identify service delivery required over the short, medium and long term to meet National Development Plan goals.	○	○	○	◉	○	
iv	Delivery of services and costs of services are monitored by the legislature directly and/or through an independent regulatory body.	○	○	○	◉	○	Electricity Act 2007, Concession Contract III, Public Enterprises Amendment Act 2010
v	All necessary maintenance functions are reflected in organisational roles, including management, maintenance planning, materials procurement and administration, accounting, information management, workshops and maintenance staff.	○	○	◉	○	○	
1.2	ACCOUNTING PRACTICES						

Instructions | 1. Self-Assessment | 2. Summary Info.

Source: Authors.

3.4.3 Survey Completion Rate

In total, the survey team managed to distribute the survey to **49** entities across the six sectors of Roads, Airports, Ports, Water/Sanitation, Energy and Solid Waste. Over a period of 8 weeks, with a number of follow-ups and deadline extensions, responses were finally received from **26** entities (Table 11Table). While a greater response rate was hoped for, the final dataset was of a sufficient size to look at trends across sectors and the distribution of maturity within them. It was not sufficient to look at trends across countries.

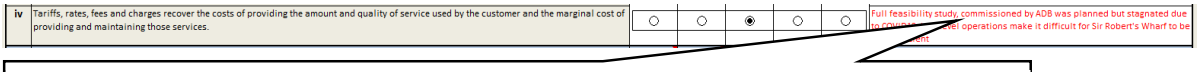
Table 11. Infrastructure Entities who Responded to the Survey (28 responses in total)

Sector	Infrastructure Entity
ROADS 	▪ Ministry of Infrastructure and Sustainable Energy (KIR) ▪ Dept of Transport, Ministry of Infrastructure (NIU) ▪ Bureau of Public Work, MPIIC (PLW) ▪ Ministry of Infrastructure Development (SOL) ▪ Department of Works (TUV)
AIRPORTS 	▪ Samoa Airport Authority (WSM) ▪ Department of Transport, Ministry of Infrastructure (NIU) ▪ Bureau of Aviation, MPIIC (PLW) ▪ Civil Aviation Authority of Solomon Islands (SOL) ▪ Department of Civil Aviation (TUV)
PORTS 	▪ Fiji Ports Corporation (FIJ) ▪ Samoa Port Authority (WSM) ▪ Department of Transport, Ministry of Infrastructure (NIU) ▪ Belau Transfer and Terminal Company (PLW) ▪ Department of Marine and Port Services (TUV)
WATER & SANITATION 	▪ Public Utilities Board (KIR) ▪ Department of Environment - Waste & Sanitation (NIU) ▪ Solomon Island Water Authority (SOL)
ENERGY 	▪ Public Utilities Board (KIR) ▪ Department of Transport, Ministry of Infrastructure (NIU) ▪ Solomon Islands Energy Authority (SOL) ▪ Tonga Power Limited (TON) ▪ Energy Fiji Limited ▪ Palau Energy Administration (PLW)
SOLID WASTE 	▪ Department of Environment - Waste & Sanitation (NIU) ▪ Division of Solid Waste Management, Bureau of Public Work, MPIIC (PLW) ▪ Department of Waste Management (TUV) ▪ Ministry of Environment, Climate Change and Disaster Management and Meteorology (SOL)

3.4.4 Validation of the Survey Responses

All responses were checked for completeness upon receipt and follow-up clarification was sought where required. The comments column helped provide our team evidence that the survey questions were understood and assessed appropriately.

Requirement 1.3 (iv) *Tariffs, rates, fees, and charges recover the costs of providing the amount and quality of service used by the customer and the marginal cost of providing and maintaining those services.*



"Full feasibility study, commissioned by ADB, was planned but stagnated due to COVID-19. Low-level operations make it difficult for Sir Robert's Wharf to be self-sufficient"

Our maturity assessment methodology is aligned with the frameworks discussed in Section 3 Part A. These frameworks typically recommend a three-step process for evaluation:

1) The organization completes a self-assessment of their progress against a defined set of criteria/requirements.
2) An authorized assessor conducts an independent assessment and onsite evaluation. Differences in scores are discussed and ratified.
3) An improvement plan is prepared based on observed gaps and a timeframe for moving to a future state (approx. 3–5 years).

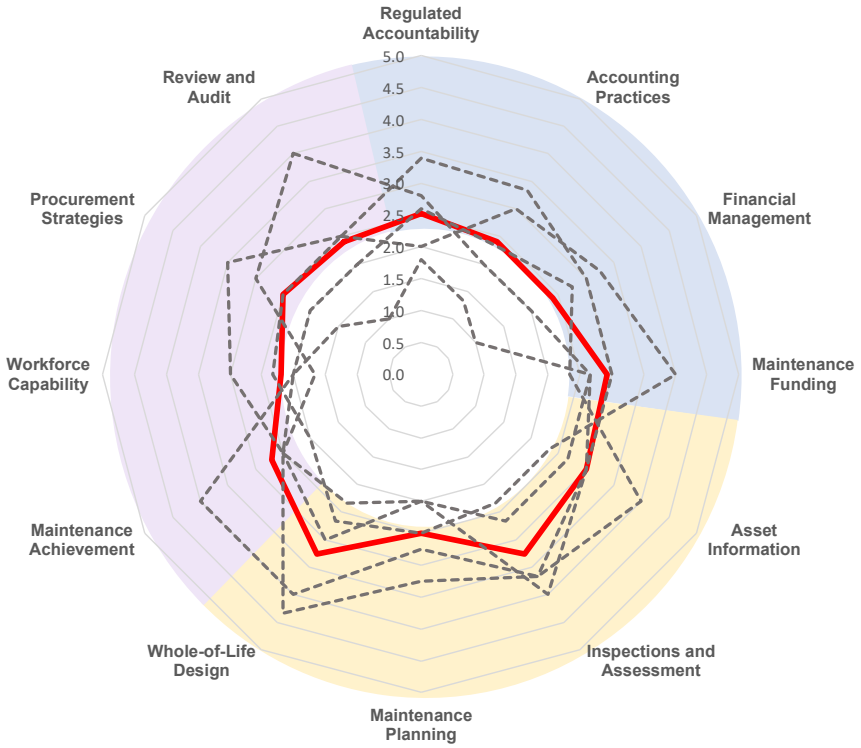
While this study has relied solely on self-assessments, there could be merit in having a peer review and/or an external assessor conduct a review across entities who may wish to participate in a deeper study.

PART C: Results

3.5 ROADS Sector

Figure 12. Results of Maturity Assessment – Road Sector

Assessment Category			Avg. Rating		Progressing Req.	
Governance	1.1	Regulated Accountability	2.5	2.6	40%	48%
	1.2	Accounting Practices	2.4		47%	
	1.3	Financial Management	2.4		50%	
	1.4	Maintenance Funding	2.9		60%	
Management	2.1	Asset Information	3.0	3.0	87%	71%
	2.2	Inspections and Assessment	3.3		87%	
	2.3	Maintenance Planning	2.5		40%	
	2.4	Whole-of-Life Design	3.3		80%	
Delivery	3.1	Maintenance Achievement	2.7	2.5	50%	44%
	3.2	Workforce Capability	2.2		47%	
	3.3	Procurement Strategies	2.5		40%	
	3.4	Review and Audit	2.4		40%	
				2.7		55%



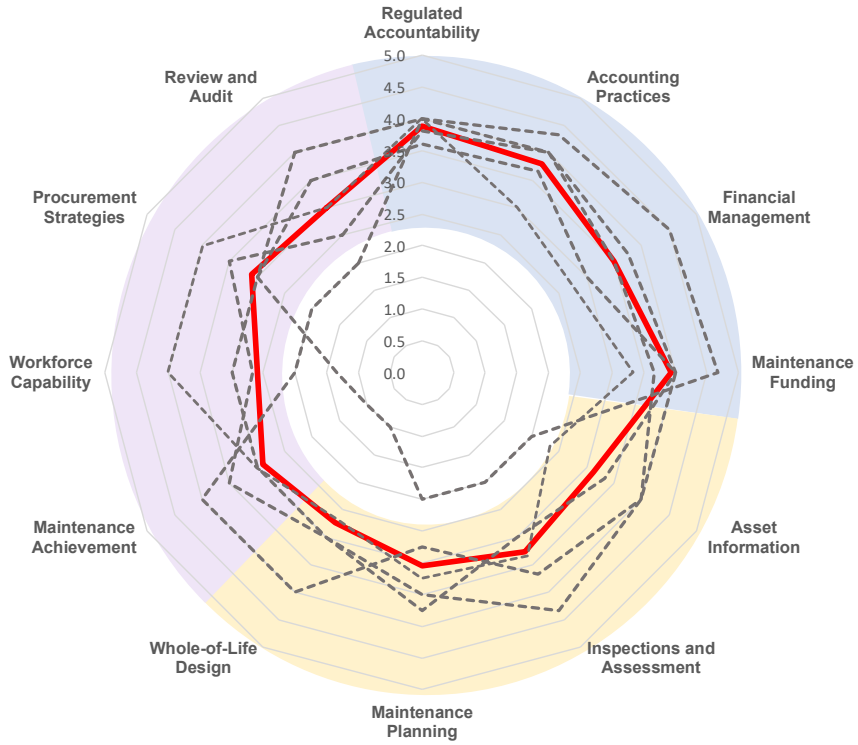
General Observations

- The responding entities did not include some of the agencies responsible for larger road networks (for example, Fiji and Samoa) and thus may underreport on maturity across this sector.
- On average, progress is being made on 55% of the assessed requirements (a score >=3, "Developing").
- The most mature area is that of "Maintenance Management," with progress being reported against 71% of the requirements assessed. *Asset Information* (87%) and *Inspections and Assessment* (87%) were considered by respondents to be the most advanced areas.
- Maintenance Delivery was the area most challenged, with 44% of requirements being progressed. *Procurement Strategies* (40%) and *Review and Audit* (40%) were reported to be the least advanced.

3.6 AIRPORTS Sector

Figure 13. Results of Maturity Assessment – Airport Sector

Assessment Category			Avg. Rating		Progressing Req.	
Governance	1.1	Regulated Accountability	3.9	3.8	100%	92%
	1.2	Accounting Practices	3.8		93%	
	1.3	Financial Management	3.5		75%	
	1.4	Maintenance Funding	3.9		100%	
Management	2.1	Asset Information	3.1	3.0	67%	71%
	2.2	Inspections and Assessment	3.3		80%	
	2.3	Maintenance Planning	3.1		70%	
	2.4	Whole-of-Life Design	2.7		67%	
Delivery	3.1	Maintenance Achievement	2.9	2.9	80%	69%
	3.2	Workforce Capability	2.6		53%	
	3.3	Procurement Strategies	3.1		80%	
	3.4	Review and Audit	3.0		70%	
				3.3		79%



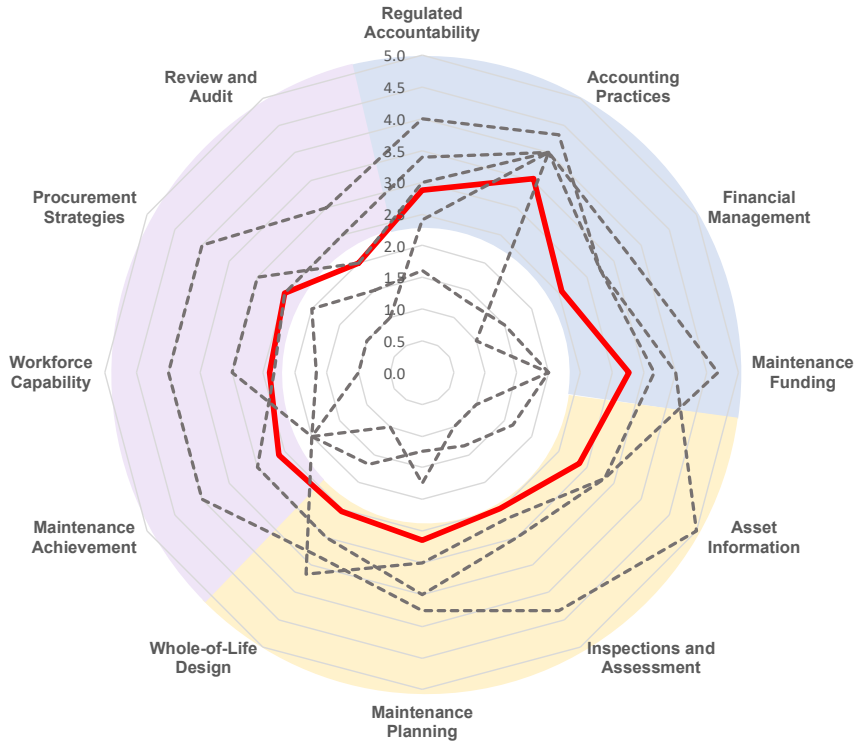
General Observations

- Airports reported to have the best Maintenance Funding mechanisms. This is likely a consequence (or driver) to them also reporting the most mature Accounting Practices and Maintenance Planning.
- On average, progress is being made on 79% of the assessed requirements (a score >=3, "Developing"), with an average maturity score of 3.3. This is the highest overall maturity assessed and is likely due to the compact nature of airport infrastructure and the level of revenue generated in this sector.
- The most mature area is that of "Governance," with progress being reported against 92% of the requirements assessed. *Regulated Accountability* (100%) and *Maintenance Funding* (100%) are considered by respondents to be the most advanced practices. This level of governance maturity is the highest observed and is likely attributed to international and regional regulatory oversight the aviation sector operates under.
- *Workforce Capability/Capacity* (Av. score 2.6) is the practice area most challenged with only 53% of requirements being progressed followed by Whole-of-life Design (2.7, 67%).

3.7 PORTS Sector

Figure 14. Results of Maturity Assessment – Port Sector

Assessment Category			Avg. Rating		Progressing Req.	
Governance	1.1	Regulated Accountability	2.9	3.1	64%	67%
	1.2	Accounting Practices	3.5		80%	
	1.3	Financial Management	2.6		60%	
	1.4	Maintenance Funding	3.3		67%	
Management	2.1	Asset Information	2.9	2.6	60%	60%
	2.2	Inspections and Assessment	2.5		53%	
	2.3	Maintenance Planning	2.7		65%	
	2.4	Whole-of-Life Design	2.5		60%	
Delivery	3.1	Maintenance Achievement	2.6	2.4	40%	42%
	3.2	Workforce Capability	2.4		47%	
	3.3	Procurement Strategies	2.5		50%	
	3.4	Review and Audit	2.0		30%	
				2.7		58%



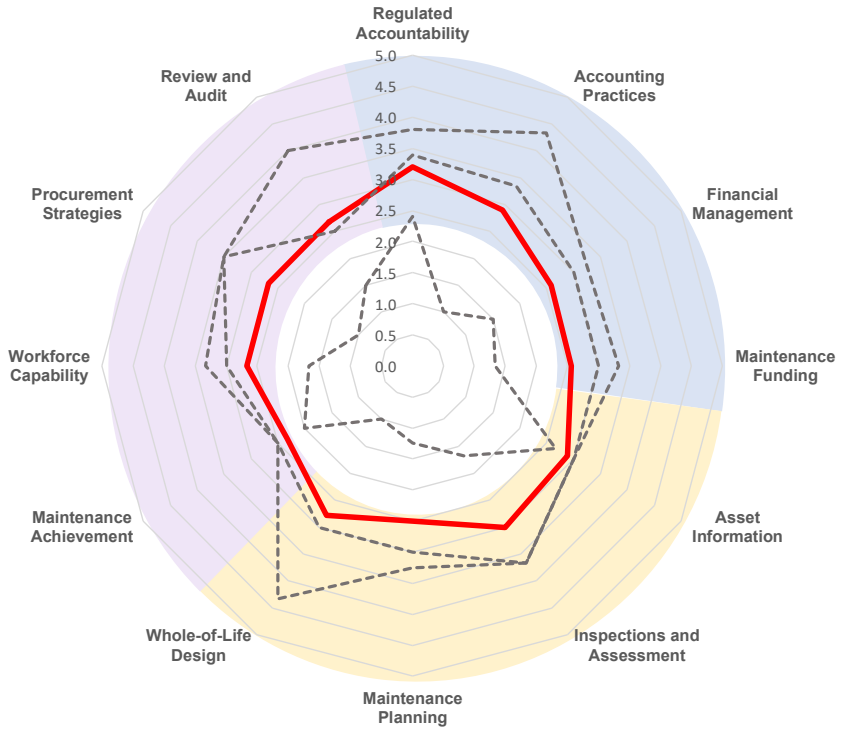
General Observations

- Ports showed a significant diversity in maturity levels as the five survey respondents included the major port authorities of Fiji and Samoa and small port authorities across Niue, Palau, and Tuvalu.
- On average, progress is being made on 58% of the assessed requirements (a score >=3, "Developing").
- The most mature area is that of "Governance," with progress being reported against 92% of the requirements assessed. *Accounting Practices* (80%) and *Maintenance Funding* (67%) are considered by respondents to be the most advanced practices. This level of governance maturity is the second highest observed across sectors, and, as with airports, is likely attributed to the international and regional regulatory oversight the maritime sector operates under.
- "Maintenance Delivery" is the most challenged competency area with progress only being reported against 42% of the requirements assessed. *Review and Audit* (Av. score 2.0) is the least-developed practice area with only 30% of requirements being progressed followed by *Maintenance Achievement* (2.6, 40%) and *Workforce Capability/Capacity* (2.4, 47%).

3.8 WATER and SANITATION Sector

Figure 15. Results of Maturity Assessment – Water/Sanitation Sector

Assessment Category			Avg. Rating		Progressing Req.	
Governance	1.1	Regulated Accountability	3.2	2.8	80%	62%
	1.2	Accounting Practices	2.9		67%	
	1.3	Financial Management	2.6		50%	
	1.4	Maintenance Funding	2.6		44%	
Management	2.1	Asset Information	2.9	2.8	89%	67%
	2.2	Inspections and Assessment	3.0		67%	
	2.3	Maintenance Planning	2.5		58%	
	2.4	Whole-of-Life Design	2.8		56%	
Delivery	3.1	Maintenance Achievement	2.3	2.6	50%	59%
	3.2	Workforce Capability	2.7		67%	
	3.3	Procurement Strategies	2.7		67%	
	3.4	Review and Audit	2.7		50%	
				2.8		63%



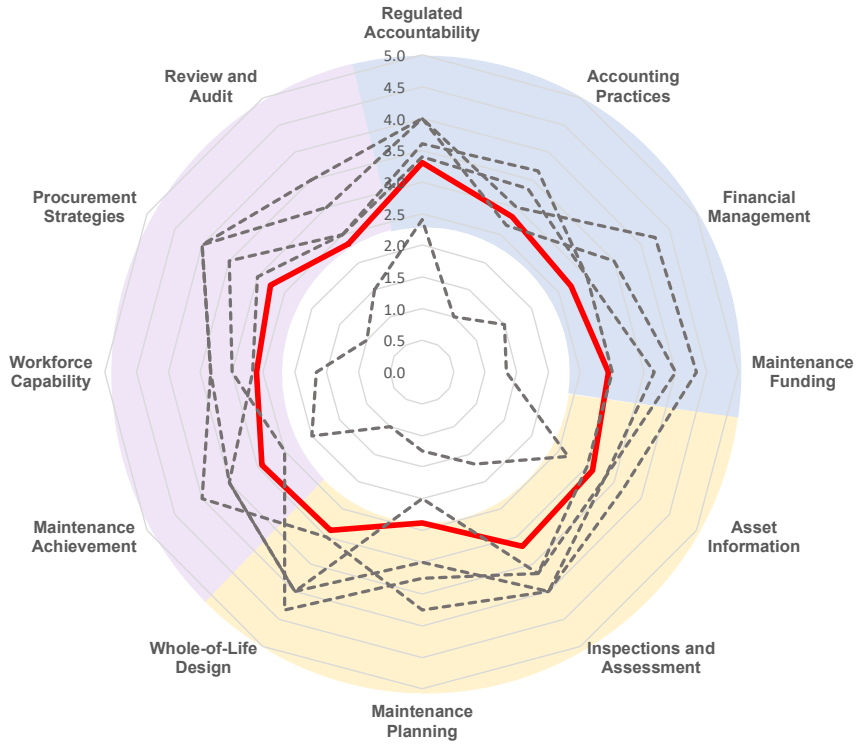
General Observations

- Three Water and Sanitation entities responded to the survey with one reporting very little progress against the requirements. This distorts the overall sector maturity scores but we can glean some general observations which align with patterns seen in other sectors.
- On average, progress is being made against 63% of the assessed requirements (a score >=3, "Developing").
- The most mature area is that of "Maintenance Management", with progress being reported against 67% of the requirements assessed. *Asset Information* (89%) and *Inspections and Assessment* (67%) were considered by respondents to be the most advanced practices within this competency area. This closely reflects the findings from Road infrastructure agencies with both having an extensive network of linear assets.
- "Maintenance Delivery" is the most challenged competency area with progress being reported against 59% of the requirements assessed. *Maintenance Achievement* (Avg. score of 2.3) is the practice area least developed with only 50% of requirements being progressed followed by *Review and Audit* (2.7, 50%).

3.9 ENERGY Sector

Figure 16. Results of Maturity Assessment – Energy Sector

Assessment Category			Avg. Rating		Progressing Req.	
Governance	1.1	Regulated Accountability	3.3	2.9	80%	64%
	1.2	Accounting Practices	2.8		61%	
	1.3	Financial Management	2.7		54%	
	1.4	Maintenance Funding	2.9		56%	
Management	2.1	Asset Information	3.1	2.9	89%	64%
	2.2	Inspections and Assessment	3.2		67%	
	2.3	Maintenance Planning	2.4		42%	
	2.4	Whole-of-Life Design	2.9		67%	
Delivery	3.1	Maintenance Achievement	2.9	2.7	67%	57%
	3.2	Workforce Capability	2.6		56%	
	3.3	Procurement Strategies	2.8		58%	
	3.4	Review and Audit	2.3		50%	
				2.9		63%



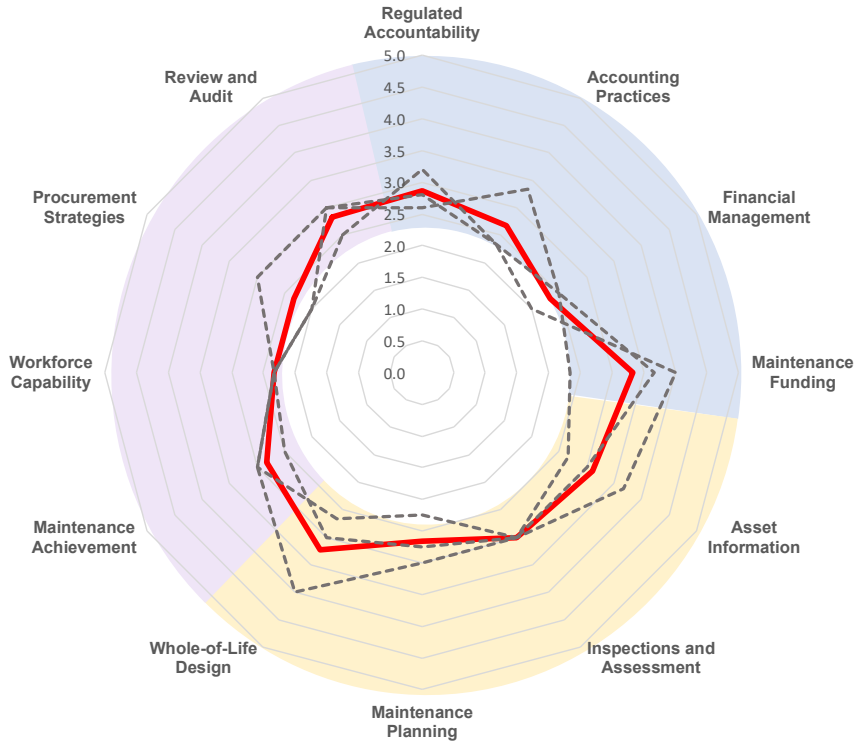
General Observations

- Energy sector showed a significant diversity in maturity levels across the six survey respondents.
- The maturity of maintenance management for relatively newly constructed renewable energy assets is generally poor across the region.
- On average, progress is being made against 63% of the assessed requirements (a score >=3, "Developing").
- The most mature areas are that of "Governance" and "Management", with progress being reported against 64% of the requirements assessed. *Asset Information* (3.1, 89%) was the highest ranked practice area followed by *Regulated Accountability* (3.3, 80%). As with the aviation and maritime sectors this is likely attributed to the regulatory oversight the energy sector operates under.
- "Maintenance Delivery" was again the most challenged competency area with progress being reported against 57% of the requirements assessed.
- *Maintenance Planning* (Avg. score of 2.4) is the practice area least developed with only 42% of requirements being progressed followed by *Review and Audit* (2.3, 50%) and *Workforce Capability* (2.6, 56%).

3.10 SOLID WASTE Sector

Figure 17. Results of Maturity Assessment – Airport Sector

Assessment Category			Avg. Rating		Progressing Req.	
Governance	1.1	Regulated Accountability	2.9	2.8	73%	60%
	1.2	Accounting Practices	2.7		56%	
	1.3	Financial Management	2.3		33%	
	1.4	Maintenance Funding	3.3		78%	
Management	2.1	Asset Information	3.1	3.0	78%	82%
	2.2	Inspections and Assessment	3.0		100%	
	2.3	Maintenance Planning	2.7		67%	
	2.4	Whole-of-Life Design	3.2		89%	
Delivery	3.1	Maintenance Achievement	2.8	2.6	83%	59%
	3.2	Workforce Capability	2.3		44%	
	3.3	Procurement Strategies	2.3		33%	
	3.4	Review and Audit	2.8		83%	
				2.8		68%



General Observations

- Responses were received from four Solid Waste management entities or ministries with oversight of local government waste management. The relative maturity was similar across all responders.
- On average, progress is being made on 68% of the assessed requirements (a score >=3, "Developing").
- The most mature area is that of "Maintenance Management," with progress being reported against 82% of the requirements assessed. *Inspections and Assessment* (100%) and *Whole-of-life Design* (89%) are considered by respondents to be the most advanced practices.
- "Maintenance Delivery" is the most challenged competency area with progress only being reported against 59% of the requirements assessed. *Procurement Strategies* (Av. score 2.3) is the least developed practice area with only 33% of requirements being progressed followed closely by *Workforce Capability* (2.3, 44%).

3.11 Observed Trends (All Sectors)

Figure 18. Summary of Maturity Assessment Results (% Requirements Being Progressed)

Source: Authors.

Figure 196. Summary of Maturity Assessment Results (Average Maturity Score)

Source: Authors.

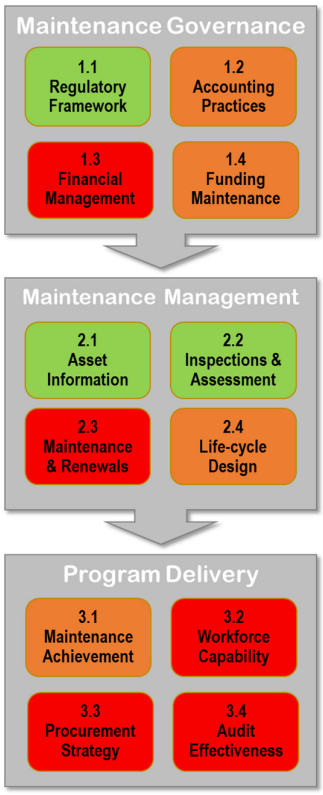
General Observations

This first step in the assessment process is primarily about setting a baseline against which infrastructure entities can monitor change/improvement. A very similar initiative has been in place for the past 8 years to track asset management maturity across Australian local governments through the "National State of the Assets" (IPWEA, 2021) assessment. The most value comes from comparing the year-on-year trend at an entity level. Aggregating results from a single year and attempting to glean defensible insights would require a peer review of the scores, which is a recommendation from this report.

However, while not statistically defensible, we can make some general observations on the aggregated self-assessment scores in Figure 19 which demonstrate how the framework data may form a basis for future interpretation. For example,

a) The most mature infrastructure maintenance "Accounting Practices" were reported in the Aviation and Port sectors, which could be attributed to the international as well as national regulatory oversight of these sectors. (For example, airports require certification to operate). Both sectors scored highly in the "Maintenance Funding" competency area.
b) There was a significant variation in assessed maturity across the "Regulatory Accountability" competency area. Possibly unsurprisingly, the roads sector reported the least maturity in this area as there is typically little independent regulatory oversight on the effectiveness of the maintenance of the road network by government public works entities.

With reference to Figure 18, we can see that overall "Maintenance Management" was the most mature competency area assessed with progress being reported against 69% of the requirements assessed. Within this area *Asset Information* (78%) and *Inspections and Assessment* (74%) ranked highest.



Most entities are familiar with the concepts of a good asset management system having been exposed to regional influences and guidance material from the United States, Australia, and New Zealand. The need for a good asset register and inspection program generally features heavily as the first steps in setting up a robust asset management system. The oversight by regional and national bodies in the aviation, maritime, and energy sectors aided the higher levels of regulatory accountability in these sectors.

There is room to improve on the planning of *Maintenance and Renewals* (55%) with progress reported on little over half of the requirements. The lack of a multi-year view of capital maintenance needs and transparent decision making around these investments are key requirements for improvement.

The next most mature competency area is "Maintenance Governance". Areas for attention include 1.2 Accounting practices and 1.4 Funding Maintenance (in orange). Entities reported progress against 64% of the requirements assessed. Infrastructure entities are by their very nature service delivery-oriented and generally operate under a strict set of legislation and regulatory oversight requirements. This is particularly so for the aviation, maritime, and energy sectors. The water and sanitation sector is also becoming more regulated in the region. It is therefore not surprising that the *Regulatory Accountability* (72%) frameworks across entities is the third most-developed practice.

The *Financial Management* functions (52%) are not yet strong. Generating sufficient income through sound taxation, fees, and charges to sustainably fund the long-term infrastructure maintenance investment levels remains an ongoing challenge.

The least mature competency area across all sectors is "Program Delivery", with progress reported against 54% of the requirements assessed. Of the underlying practice areas, *Maintenance Achievement* ranks highest, with 61% of entities reporting some level of progress against the underlying requirements of understanding their corrective maintenance needs and generally managing the number of unplanned events and outages they experience.

As possibly anticipated, *Workforce Capability* (51%) is the most challenged area reported overall because of the geographic remoteness and small populations on most Pacific Island nations. Having a strong private sector to supplement delivery and provide specialist expertise and having robust training and capability building programs for internal staff were two of the key requirements assessed within this practice area.

From the observations and insights above, we have proposed some improvement opportunities in Section 5 of this report.

Section 4

FINANCIAL MEASURES

This section provides an overview of the financial management practices that ensure infrastructure agencies adequately fund and track maintenance expenditure over their entire infrastructure portfolio. By ensuring sound accounting practices, we have a better indication of the true cost of ownership and the impact of underinvestment when it occurs.

PART A: Background

As discussed above, public sector entities and SOEs that use accrual accounting are required to report the value and depreciation of assets in their financial statements, as defined by the accounting standards in place. While there are a number of methodologies for how these valuations are conducted and kept current, particularly around what assets are currently "worth" (reported as their Fair Value or Depreciated Replacement Cost) there is more consistency in the way Gross Replacement Cost and annual depreciation expense are calculated and reported. It is these metrics we will focus on in this report.

The stock of infrastructure is captured in asset registers, with independent valuers providing regular estimates of the GRC of these assets. Thus, the value of infrastructure is generally assessed to be their acquisition costs, or GRCs. The valuation does not generally take into consideration the cost to the government or SOE of designing, planning, operating, maintaining, and disposing of the infrastructure system. First, we look at how infrastructure is valued and reported in financial statements.

4.1 The Value of Infrastructure

4.1.1 Gross Replacement Cost

Where a complete inventory of infrastructure assets exists in a physical register (such as an asset management system), it is possible for a registered valuer to assess the cost to replace the infrastructure, in today's currency and using today's equivalent construction techniques. Knowing its GRC enables us to appreciate the value of the infrastructure, and we can determine whether it is worth maintaining or replacing. If, for example, the diesel electricity generator is toward the end of its useful life, knowing its current value, and the current cost of replacing it, is useful when determining whether to and when to shift to generating renewable power.

If, for example, the diesel generator has 5 years of life left, will cost *x* to keep in operation, and *z* to replace with a diesel generator of the same or similar size, this information is helpful in planning the shift to renewables. We know we have 5 years to plan that shift, to obtain and capture renewable sources of energy, to install the new generation panels or wind turbines, etc., and to transition that power source to the network distribution. If, however, the diesel generator is only 5 years old, runs on high-quality diesel that is provided in country and, if the PIC were to shift to renewables, it would involve a capital cost several times the cost of operating and maintaining the current generator, then that information is also helpful. So too is information on whether government, schools, churches, businesses and households have already installed renewable sources of energy and will no longer be drawing from the urban grid and paying tariffs to cover the full cost of the service.

Table 12. Example Property, Plant and Equipment Valuation Reported in Financial Statement

	Land & building	Power plants & distribution assets	Office equipment & furniture	Motor vehicles	Total
Gross carrying amount					
Cost at 1st July 2016	59,795,002	413,787,301	4,297,338	12,749,370	487,629,011
Revaluation at 1st July 2016					
Cost and revaluation at 1st July 2016	56,795,002	413,787,301	4,297,338	12,749,370	487,629,011
Additions	793,933	5,240,312	197,857	80,614	6,312,717
Disposals	(174,782)	-	-	(1,274,808)	(1,449,590)
Reclassification					-
Balance at 30th June 2017	57,414,153	419,027,613	4,495,195	11,555,177	492,492,138
Additions	2,075,044	32,926,176	162,529	906,058	36,069,807
Disposals	-	(182,630)	(356,024)	-	(538,654)
Reclassification	2,570,584	(2,570,584)	-	-	-
Balance at 30th June 2018	62,059,781	449,200,574	4,301,700	12,461,235	528,023,290

Source: Electric Power Corporation. (2018). 36th Annual Report 2017-2018 p34. Apia: Government of Samoa.

Note in the energy sector example above, infrastructure accounts for 85% of the fixed assets that generate service potential or an income stream. This is typical of the capital-intensive entities in the infrastructure sector. Also, in the example above, we see that the entity completed a formal "revaluation" of its assets in July 2016 and used historic costs (additions and disposals) to update that valuation to report in it June 2018 financials. The frequency of revaluations varies significantly across entities but is required to be done every 3–5 years.

Of the PIC SOEs listed in Table 11, the following have had some or all of their infrastructure assets valued by a qualified valuer:

1. Vanuatu: Ifira Wharf & Stevedoring (1994) Limited (equipment) – 2018
2. Solomon Islands: Solomon Water (Generators, distribution network and plant and equipment) – 2015
3. Fiji Power Authority – 2016
4. Fiji Roads Authority – 2016
5. Samoa Ports Authority – 2014
6. Samoa Water Authority – 2016

Unfortunately, the valuation does not yet reflect the full cost of the infrastructure to governments and SOEs. Rather it is a proxy of the investment required by government or donors to replace all the components of the infrastructure to the standard now operating.

4.2 Estimated Life of Infrastructure Assets

4.2.1 Service Life (Maintenance Managers)

The GRC of the components of infrastructure systems in each sector changes during its useful life. Yet because infrastructure is often a system of many parts, each of which is replaced when it wears out or becomes inefficient, or fails, it is often difficult to assign a meaningful "age" to an infrastructure asset. Take, for example, a water treatment plant. It was opened 50 years ago; does that mean it is now 50 years old? Not really. There are bits of it which are 50 years old, but also bits which are much younger. Suppose that, 5 years after it opened, an additional pump was added, then 8 years later, the tank lining was replaced. Then a few years later an additional sump was added to an existing tank to reduce the fluctuations in salinity. In fact, something has been added to, subtracted from, or seriously modified about every 5 years. The water treatment plant is not one age but many.

Infrastructure assets may eventually be decommissioned, that is they may eventually come to an end, not because of age alone, but because parameters have changed that to mean it is no longer possible to perform the services required. This will most often be because we have changed our minds on what services we want. But it may be because its capacity is no longer sufficient, or perhaps climate change has meant that we need to shift the location of an asset such as a road or bridge further inland or up higher.

Infrastructure asset systems may also reach the end of their service life when it is impossible to find the components necessary to keep them going, for example, when replacement parts are no longer stocked. To equitably allocate the costs of the system across generations, most SOEs divide the value of the infrastructure across an estimated useful life of the whole system with little variation from year to year.

Unlike individual public assets that are replaced at the end of their design life, infrastructure assets, being a network of individual assets, are kept going as long as the community needs the service. We do this by replacing or refurbishing various components of the infrastructure. This happens in a piecemeal fashion, as needed. It is not smooth, it is lumpy. Infrastructure renewal reflects the actual timing of this piecemeal renewal of parts of the network.

Managers of infrastructure assets focus on the longevity of individual components, i.e., how long does this water pump in a hospital last, how long does the air conditioning last, etc. All components will have a different useful life. Knowing these lives and knowing the age of the components (not the system as a whole) is crucial for them to be kept in good order. The asset manager has this information. He or she also knows how the different components relate to each other and which ones are critical to the provision of the service.

While new infrastructure appears not to require maintenance, it is well known that funds invested in regular planned maintenance produces a more long-lived network and a cheaper result than ignoring faults and waiting until the infrastructure is no longer functioning and building new infrastructure. Project sustainability is determined by the ability of the institution to maintain and operate the infrastructure as a network.

Other factors that also ensure sustainability is the use of appropriate technology, the interaction of the network of built infrastructure with buildings, equipment and natural resources, and the ongoing source of funds, from governments, users, and donors. The government funds community service obligations, users pay fees and charges, and donors contribute grants for capital rehabilitation and new construction. The government also establishes the ability of each PIC to build the capacity of its workforce to manage and maintenance the infrastructure.

4.2.2 Skilled Workforce

Preventive maintenance is undertaken by a dedicated workforce that develops and passes on the skills of maintaining the assets. In a maintenance culture, skilled people keep assets functioning so that they deliver the standard of service required. These people have access to spare parts and materials, to specialists in maintaining the equipment/asset, to manuals, and to mentors. In a maintenance culture, apprentices learn from their elders and are available when required to keep the asset functioning. They also are available to do unscheduled maintenance when it occurs, to diagnose the cause of the unscheduled maintenance, and to feed that information back into the maintenance schedule.

All the costs of training the workforce are often treated as an externality to each infrastructure sector as they are not incurred by individual SOEs. Rather they are considered part of the cost of developing the human capital of each PIC and are incurred by each government and/or family.

The above discussion assumes PICs have access to experienced maintenance personnel and this is not the case. In fact, the maturity assessment (Figure 18) highlights Workforce Capability as the least developed area across all sectors, with only 51% of requirements being met. It is also noteworthy that three of the top four challenges identified by survey participants related to the capacity and capability of in-country resources. The shortage of specialist expertise extends well beyond maintenance and is a significant ongoing socio-economic challenge for small PICs.

4.2.3 Calculation of Fees and Charges

Fees and charges/tariffs are calculated to raise funds to operate and maintain and replace the infrastructure assets. Together with community services funded directly by governments, these are the main sources of revenue to most SOEs.

The annual costs of delivering infrastructure services are reported in each SOE's financial statements. As reported above, the actual costs incurred can differ markedly from year to year, with some years including large maintenance works and others including only planned operations and preventive maintenance. The annual costs include the depreciation of the infrastructure assets. This is calculated by dividing the GRC by the estimated useful life of the infrastructure. The fees and charges are calculated by taking into consideration the whole-of-life costs. An average of the last 5 years may miss major expenditure. Fees and charges are calculated to spread the cost of the replacement and rehabilitation of the asset components equally over the estimated useful life of the assets. This ensures equity across generations and over time, smoothing the contribution of the community to predictable fees and charges. One factor that influences the whole-of-life cost is the useful life assumed in calculating depreciation.

4.2.4 Accounting for the Useful Life of a Network of Assets

In accounting terms, **useful life** is defined as:

(a) The period over which an asset is expected to be available for use by an entity; or
(b) The number of production or similar units expected to be obtained from the asset by an entity. *(IPSAS 17)*

The useful life of most assets will depend on a wide range of environmental factors, and SOEs tend to adopt a standard useful life for a range of asset types for asset management and accounting purposes. It might make life much easier if the PRIF or regional bodies or governments published a list of default asset useful lives for sectors in PICs to use in the absence of better information.

The Local Government and Municipal Knowledge Base (www.lgam.info) is a wiki-based encyclopedia of local governments in Australia that contains a list of realistic asset useful lives. The table below lists useful lives taken from financial statements of SOEs of PICs.

Table 13. Example of Estimated Useful Lives of Individual Assets Used in Reported Valuations

Country	Solomon Is.	Fiji	Kiribati	Tonga	Samoa	Cook Is.
Ports						
Buildings			36	10–35	34	10
Wharves and associated facilities	35		26	12–40	53–60	40
Onshore equipment	14		60	4–20	8–17	5–20
Navigation				3–25		
Airports						
Infrastructure		2–80				
Plant and equipment		4–25				
Water and Sanitation						
Water Systems	20–40					
Plant and equipment	2–20					
Furniture and fittings	5–6					
Energy						
Generators	10–40					
Distribution	20–60					
Plant, tools, and equipment	10–25					
All Sectors (common)						
Buildings	20–40	3–80	36	10–35	34	10
Motor vehicles	3–5	8				

Source: Annual Reports of the entities listed.

4.3 Estimated Whole of Life Costs of Infrastructure Assets

4.3.1 Annual Depreciation Expense

Depreciation can be viewed in two ways:

1. It reflects the annual loss in service potential being provided by the asset, and the cost of its recommended routine and preventive maintenance.
2. It fairly spreads the cost of the replacement of the asset across the tariffs paid by all users of the service it provides equitably across generations.

Depreciation is accounted for as the systematic allocation of the depreciable amount of an asset over its useful life (International Public Sector Acounting Standards, 2018).

In practice most entities calculate the annual depreciation expense using a "straight-line" methodology, dividing the GRC of the asset equally each year over its estimated useful life. This takes away the "bumpiness" of tariffs that would directly reflect the actual annual depreciation of the asset. Also, if good maintenance management practices are in place and there are no significant changes in technology or demand for the infrastructure services, the entity can justify using longer useful life estimates, thus reducing the depreciation expense in their financial statements.

Note in the transport sector example below (Table 14), road infrastructure (road systems) accounts for 96% of non-current fixed assets, which is typical for this sector. The annual depreciation expense is 3.9% of the replacement cost, suggesting an average service life of 25 years weighted across all assets, using a straight-line depreciation methodology.

Table 14. Typical Property, Plant and Equipment Depreciation Supporting an Organization's Financial Statement

	Land & buildings	Motor vehicles	Furniture and fittings	Road systems	Plant and equipment	Work in Progress	Total
Cost	**$**	**$**	**$**	**$**	**$**	**$**	**$**
Balance at 1 August 2017	22,127,398	2,467,352	1,719,894	8,851,569,034	2,082,357	218,624,571	9,098,590,606
Acquisitions	4,005,030		407,026	198,872,153		91,995,315	295,279,523
Disposal		(139,642)			(68,235)		(207,877)
Balance at 31 July 2017	**26,132,428**	**2,327,710**	**2,126,920**	**9,050,441,187**	**2,014,122**	**310,619,886**	**9,393,662,253**
Depreciation							
Balance at 1 August 2017	6,851,125	1,556,721	580,845	214,405,708	1,059,853	-	224,454,251
Depreciation for the Year	440,448	236,914	431,151	143,596,385	5,561		144,710,458
Disposal		(139,642)			(68,235)		(207,877)
Balance at 31 July 2017	**7,291,573**	**1,653,992**	**1,011,996**	**358,002,093**	**997,179**	**-**	**368,956,832**
Carrying amount							
At 31 July 2017	**15,276,273**	**910,631**	**1,139,049**	**8,637,163,326**	**1,022,504**	**218,624,571**	**8,874,136,355**
At 31 July 2018	**18,840,855**	**673,718**	**1,114,924**	**8,692,439,094**	**1,016,943**	**310,619,886**	**9,024,705,421**

Source: Fiji Roads Authority. (2018). Annual Report 2017/2018. P60. Suva: Government of Fiji.

Infrastructure assets are used up over their useful life. Operations staff keeps the assets running normally. Routine Maintenance keeps the asset running in reasonable condition, and corrective maintenance restores them to the condition required to run normally when there is a fault. Rehabilitation rebuilds the asset network, after a period of use, to its new or near-new condition. Capital upgrades expand the asset network to deliver to more users or to increase the type of service it can deliver.

4.3.2 Annual Operating and Maintenance Costs

The goal of asset-intensive public sector entities is to operate assets cost-effectively, while providing an appropriate level of service and charging a fee that fairly covers the true cost of their use. There is an expectation that the relevant entity will manage its asset in order to deliver good services. It does this through asset management, financial management, and being accountable.

For the purpose of this report, we focus on two core financial management practices, namely that entities include:

- infrastructure as non-current fixed-assets in their financial statements; and
- the annual O&M costs over the useful life reported in their financial statements.

The fees and charges are usually calculated to cover the cost of delivering the service over the expected life cycle of the assets managed by each entity.

4.4 Optimizing Fees and Charges

4.4.1 Governments Subsidize Infrastructure Services

There are several ways to optimize fees and charges. The first is using government grants to offset the full cost of ownership. This occurs when fees and charges are calculated to cover only part of the cost of delivering the service, for example, access to safe drinking water, and the government pays the utility an annual contribution to enable the community to access the service without bearing the full costs of its delivery, maintenance and replacement. Keeping the fees and charges below the actual cost of delivering the service can have unintended consequences. The SOE, relying only on revenue from fees and charges, is unable to operate and maintain the infrastructure and the community suffers when breakdowns, for example power outages, occur. Government's payment of community service obligations will be subject to the normal budgetary constraints. There is a tendency for governments to ignore the lumpy cash flow required to operate infrastructure and to try to smooth out the cash paid through the annual budget allocation. This is likely to have the unintended consequences of patchy delivery of services with the impact being borne by users. The costs users incur are generally not taken into consideration when preparing the annual budget. Political pressure is out of step with the need for cash to maintain the infrastructure. Pressure on politicians occurs after the infrastructure has broken down. This is the costliest time to repair an asset. It is far more cost-effective to keep infrastructure in good order than to wait until it breaks down and to then repair it.

Another way is to ensure the fees levied cover the direct costs of delivering the service and to fully fund lumpy maintenance and replacement through the Development Budget. A third way is to estimate the full cost of operating and maintaining the service in the planning stage, build the capacity of the workforce, and identify any cost shifting or external impacts borne by other individuals, communities or entities.

Annual depreciation reflects the annual rate at which the original investment is expensed across its anticipated useful life. Rather than reflect the actual deterioration, depreciation, being a major part of the overall cost to be recovered through fees and charges, is spread evenly over the useful life of the asset. When this happens, the annual depreciation is calculated using the straight-line method, dividing the value of the infrastructure by its estimated useful life. Depreciation is the systematic allocation of the depreciable amount of an asset over its useful life (International Public Sector Accounting Standards, 2018). It is charged annually as an expense in the financial statements and is calculated with reference to the asset's expected life.

4.4.2 Scheduled Preventive Maintenance

An SOE that keeps its assets in a good condition will have a higher level of remaining service potential, a longer life of the asset, and would report a lower rate of annual depreciation expense than an entity that practices poor asset management. Even though depreciation is averaged over the life of the infrastructure, there is still a direct trade-off for users who pay fees and charges between effective maintenance and depreciation expenses. The

longer the useful life of the network of assets, the lower the annual depreciation expense, the lower the fees and charges. It is in the interests of all users for preventive maintenance to be scheduled, funded, and undertaken as planned.

4.4.3 Support Timely Payment of Fees and Charges

One contribution that governments can make is to set the standard in the community for the payment of utility fees and charges. Much preventive maintenance is deferred because the cash flow from fees and charges is not as estimated. Indeed, some governments manage their own cash flow by delaying payment of utility bills, thus depriving utilities of the cash they need to keep the service in good order. To estimate the timing of the receipt of fees and charges carefully, the overall culture must support payments. Where the community cannot afford to fully fund the service, other sources of income must be identified and guaranteed, for example, government subsidies. It is this reliable flow of cash to the utility or other infrastructure that enables managers to maintain the asset, and it is the community's expectation of paying regularly that enables this.

4.4.4 Full-cost Infrastructure at the Planning Stage

The economic cost of infrastructure includes costs external to the SOEs and their financial statements. The costs are not always taken into consideration in the planning of discrete infrastructure projects. The economic costs include costs shifted to users, the environment, and costs of using the infrastructure. For example, the building of a road may result in a shift from canoe transport to road transport. The economic costs of the project may assume no extra cost to communities of buying and operating vehicles with much larger engines than outboard motors. Similarly, the cost to villagers of local streams being polluted by the oil residue from road maintenance machinery may not always be considered when scheduling maintenance. This is why the community's involvement, including that of women and youth, is crucial to optimizing the total cost to communities of planned infrastructure.

It is at this stage that the ability of the community to use and fund the service is estimated. We have seen in the developed world that poor estimates of expected usage and underestimation of the costs of operating and maintaining infrastructure can have long-term consequences. The costs can be borne by a generation. PICs are advised to ensure the full costs of delivering the infrastructure services across the network are fully considered as each project is being planned. No one project operates in isolation. The planners should consult fully with and have a good understanding of external impacts to be borne by the community that may not be receiving the benefits identified.

To enable planners to identify the full costs, both the costs to the community and the costs incurred by the SOEs need to be fully understood. Infrastructure assets are used up over their useful life. Operations staff keeps the assets running normally. Routine maintenance keeps the assets running in reasonable condition, and corrective maintenance restores them to the condition required to run normally when there is a fault. Rehabilitation rebuilds the asset network, after a period of use, to its new or near-new condition. Capital upgrades expand the asset network to deliver to more users or to increase the type of service it can deliver. As mentioned above, the goal of asset-intensive public sector entities is to operate assets cost effectively, while providing an appropriate level of service and charging a fee that fairly covers the true cost of their use. There is an expectation that the relevant entity will manage its asset in order to deliver good services. It does this through asset management, financial management, and being accountable.

PART B: Formulation of Financial Measures

Much financial analysis is undertaken in assessing the viability of individual infrastructure projects. In the public sector, little attention is given to the balance sheet approach, whereby the impact of the cumulative stock of infrastructure on medium term expenditure is assessed. Private sector entities' analyses focus on how long it will take to recover the cost of construction. As we saw in the example in Section 1.8 "The Whole of Life Costs of Infrastructure", the construction costs of some infrastructure are a much smaller percentage of the overall cost of ownership. Therefore, in this section, we are focusing on indicators of the service being provided and the role and cost of maintenance in optimizing the overall cost of infrastructure services, not only at one point in time, but over the entire useful life of the city/areas served by the infrastructure.

4.5 Infrastructure Cost Measures

4.5.1 Unit Replacement Cost

The unit replacement cost ratio provides us an indication of the unit cost of construction. What, for example, does it cost to construct a water treatment plant to provide access to clean drinking water to 50,000 household connections? What is the minimum fixed cost? And at what size, does the variable costs begin to reduce?

Definition:

Unit Replacement Cost Ratio (by sector) = Gross Replacement Cost / *Normalizing Metric*

In order to compare GRC across entities within a sector, it is necessary to normalize the cost by an indicator of the extent of the infrastructure, for example, the length of road, total water production capacity, number of customer connections. The table below summarizes the chosen normalizing metrics in each sector.

Table 15. Gross Replacement Cost Normalizing Metrics by Sector

Sector	Metric	Unit	Description
Roads	# Vehicles	No.	Number of registered vehicles
	Length of Road	km	Length of road network
Airports	# Arrivals	No.	Number of passenger arrivals at airport
Ports	# TEUs	No.	Import volume (20 ft. equivalent units)
Water/Sanitation	# Connections	No.	Households connected to the water and wastewater systems
Energy	Peak Demand	MW	An indication of generation capacity

4.5.2 Average Useful Life

The useful life of an asset is an accounting estimate of the number of years it is likely to remain in operation for the purpose of cost-effective revenue generation. There are a variety of factors that can affect useful life estimates, including usage patterns, maintenance practices, and technological advances.

Definition:

Average Useful Life = Gross Replacement Cost (Depreciable Assets) / Annual Depreciation Expense

The depreciation of assets using the straight-line model divides the cost of an asset by the number of years in its estimated useful life to determine a yearly depreciation value. The value is depreciated in equal amounts over the course of the estimated useful life. For example, the depreciation expense of an asset purchased for $1 million with an estimated useful life of 10 years is $100,000 per year.

Figure 20. Useful Life of Assets (Fiji Airports, Ltd.)

Depreciation is calculated to write off the value of items of property, plant and equipment less their estimated residual values using the straight-line method over the estimated useful life of the asset, and is recognised in profit or loss.

The estimated useful lives of the Company's assets for the current and comparative period are as follows:

- Infrastructure - 2 - 80 years
- Buildings and improvements - 3 - 80 years
- Plant and equipment - 4 - 25 years
- Motor vehicles - 8 years
- Office furniture and fittings - 8 years and replacement basis

The assets' residual values, useful lives and methods of depreciation are reviewed at each financial year end and adjusted prospectively, if appropriate.

Source: http://www.airportsfiji.com/gallery/pic/annual_report-2019-2018-final.pdf, page 56.

4.5.3 Capital Intensity Ratio

The term "capital-intensive" refers to industries that require large amounts of investment to produce a good or service and thus have a high percentage of fixed assets, such as PP&E. Companies in capital-intensive industries are often marked by high levels of depreciation and have high levels of operating leverage, which is the ratio of fixed costs to variable costs. As a result, capital-intensive industries need a high volume of production to provide an adequate return on investment. This also means that small changes in revenue can lead to big changes in profits and return on invested capital.

Most entities in the energy and aviation sectors are regarded as capital-intensive organizations with their high fixed costs, such as the overhead of operating plants and the depreciation expense on high value mechanical and electrical equipment. However, land transport (roads and bridges) would also represent an equally highly leveraged business if we were to be more transparent and charge directly for use of that service rather than recovering through fuel excise and domestic taxes. Possibly because a large portion of the water and sanitation infrastructure is below-ground, long-life assets (for example, piped networks), entities within these sectors do not always appear as capital-intensive when reviewing their operational/capital ratios. To gain a fairer reflection, the Capital Intensity Ratio looks at the total cost of infrastructure divided by the operating revenue.

Definition:

Capital Intensity Ratio = Replacement Cost (Fixed Assets) / Revenue

4.5.4 Lifecycle O&M Ratio

When assessing capital projects, little time is put into assessing the future expenditure required to operate and maintain the infrastructure. Instead, the focus is on obtaining funds to construct and put into operation the asset, or part thereof. We can apply annual O&M costs over the average useful life of infrastructure and add this to the capital cost to get an approximation of the whole-of-life cost of infrastructure.

Whole-of-Life Cost = Capital Cost + (Annual O&M Expenditure x Average Useful Life)

This is particularly useful for governments that have, in the past, found that projects require high running costs that were not taken into consideration in the project appraisal stage. Governments are then left with the expectation that the infrastructure will operate as intended, and must then move funds from other, perhaps higher priority areas, to save the face of the donor and government caught unawares.

Definition:

Lifecycle O&M Ratio = (Annual O&M Expenditure x Average Useful Life) / Gross Replacement Cost

This ratio helps governments and SOEs to understand the ongoing liability infrastructure construction is likely to have on fees and charges or government budgets. In Table 3, the capital cost ratio is 23%; that is, 77% of the whole-of-life cost of building, operating, maintaining, rehabilitating, and disposal of the infrastructure would fall on government post-project, or, phrased another way, the ongoing liability of the project once constructed is equal to approximately **four times the capital cost** of construction.

4.5.5 User Cost Recovery Value

The users pay fees and charges and the revenue from these is offset against expenditure. It is useful to know if users can bear the full cost, or, if not, which part of the total cost of infrastructure they contribute. Similarly, governments want to know the proportion they need to budget to contribute over the life of the infrastructure.

Definition:

User Cost Recovery = Total Cost Recovered (Fees and Charges) / Total Annual Expenditure

This provides an indication of the proportion of the total cost of infrastructure services that users will cover.

4.6 Maintenance Cost Measures

4.6.1 Replacement Asset Value

One way to assess the maintenance of infrastructure is to look at the annual maintenance cost and compare it to the GRC, known as the replacement asset value (RAV) in some sectors. Essentially, we are comparing how much it costs to make repairs, perform routine maintenance, and replace parts on an asset to how much it costs to replace the entire asset wholesale. For active assets such as pumps, motors, generators, etc., the gold standard for routine maintenance and repairs is 2%–5% RAV and planners use this range to estimate the amount of money necessary for routine equipment maintenance over the life of the asset. There is less data and rule-of-thumb guidance available on %RAV ranges for longer-life passive assets such as road pavements, pipelines, and reservoirs.

Assuming a nominal service life of 15 years for active assets, routine maintenance and repair expenditure can equate to as much as 75% of the cost of building the infrastructure (Section 1.8). However, this index, commonly used in the energy sector, due to its high proportion of active assets, does not include larger capital maintenance expenditure such as pump refurbishment, impeller replacements, pipe relining, etc. How total maintenance expenditure should be accounted for is discussed in Section 1.6. The RAV proposed in this study should account for both operational and capital budgeted maintenance costs.

Definition:

Replacement Asset Value = Annual Maintenance Expenditure / Gross Replacement Cost

4.6.2 Maintenance Provision Value

In a stable system, with a regular and predictable maintenance schedule, a simple rule of thumb might be to allocate funds to annual maintenance as a proportion of revenue, with a provision set aside for future capital maintenance projects. This is similar to a sinking fund arrangement, with the maintenance provision being sufficient to cover the full cost of maintenance as scheduled. As this provision builds up, it is tempting for governments for the SOE to "borrow" funds to allocate to other uses. If the provision is merely sufficient to cover minimal maintenance in a "normal" year, the purpose of such a provision is lost.

Definition:

Maintenance Provision Value = Operational and Capital Maintenance Expenditure / Revenue

The cyclical nature of capital maintenance (rehabilitation and significant corrective repairs) in the Pacific makes this measure extremely variable for any reported year. If a fund is to be established, a rolling average of future operational maintenance and repairs should be obtained from a TA to estimate the major rehabilitation costs, expected to occur throughout the useful life. The total maintenance over the useful life is calculated and, to that, the costs of anticipated rehabilitation projects, are added. This provides the total operating expenses/capitalization expenses maintenance over the useful life. Then, the income over the useful life is estimated. The ratio is the percent of income attributable to maintenance.

4.7 Staffing Capability

4.7.1 Apprenticeships and Training

Generally, SOEs provide a training opportunity for young people entering the trades. These tradespeople, once qualified, may then go off to work in private sector entities. The private sector and civil society are thus supported by SOEs developing the skills required in the PICs trades staff.

SOEs also provide an opportunity for all tradespeople to continue their training after they become qualified. The costs of this service are not separately disclosed in financial statements. It is useful to have a budget line item for training and development of people new to the trade. This is in addition to the ongoing training and development required to meet the business needs of the SOE.

Definition:

Apprentices / Total Number of staff

This ratio provides a confirmation of the role of SOEs in building trades skills within each PIC. No data are yet publicly available.

PART C: Results

There are eight key financial measures identified above. It is hoped that over time the recording of the underlying data that inform these measures will improve and become more consistent across entities. The purpose of this section of the report is to demonstrate how these measures can be reported, the insights that can be gleaned from a comparison across entities, and to highlight the inconsistencies that currently exist.

At present, large holes in the data in some sectors and entities prohibit us from reporting all the financial measures across all sectors. We discuss these below and propose a series of improvement opportunities in Section 5.

The financial measures in the table below were extracted from the financial statements of 38 infrastructure entities. Of these, 27 (70%) had sufficient information in their financial statements to report these measures. These entities fell into four main sectors: Airports (4) Ports (9), Water/Sanitation/Energy (various mix) (9), and Energy alone (4) plus (1) a single roads authority. Key financial data from these 27 entities is reported in the Table 16 along with the calculated financial measures reported on in subsequent sections.

Table 16. Calculation of Financial Measures (All Sectors)

Sector	Utility / Entity	Fin. Year [1]	Curr.	Replace. Cost [2]	Deprec. Expense [3]	AUL [4]	Ann. Costs Recovered [5]	Annual Expend. [6]	Lifecycle Expend [7]	CIR [8]	LCR [9]	UCR [10]
Airports	Fiji Airports, FIJ	2019	FJD	521.64	21.72	**24.0**	152.79	90.90	2,183.31	**3.4**	**4.2**	**168%**
Airports	Samoa Airport Authority, WSM	2020	WST	224.19	7.83	**28.6**	16.69	22.03	630.30	**13.4**	**2.8**	**76%**
Airports	Airport Authority Cook Islands, COK	2017	NZD	84.21	2.61	**32.3**	7.56	8.83	285.27	**11.1**	**3.4**	**86%**
Airports	Airports Vanuatu Limited, VAN	2018	VT	5,715.67	97.71	**58.5**	792.57	655.40	37,405.05	**7.2**	**6.6**	**121%**
Energy	Marshall Islands Energy Co., RMI	2019	USD	30.56	1.01	**30.4**	34.86	36.39	1,105.32	**0.9**	**36.2**	**96%**
Energy	Electric Power Corporation, WSM	2019	WST	594.84	21.28	**27.9**	126.45	106.44	2,974.67	**4.7**	**5.0**	**119%**
Energy	Solomon Energy Auth., SOL	2019	SDB	1,199.77	61.68	**19.5**	489.40	407.15	7,920.04	**2.5**	**6.6**	**120%**
Energy	Tonga Power Board, TON	2020	TOP	216.15	10.46	**20.7**	67.47	68.43	1,414.13	**3.2**	**6.5**	**99%**
Ports	Cook Islands Ports Authority, COK	2016	NZD	36.52	1.19	**30.6**	3.90	4.59	140.54	**9.4**	**3.8**	**85%**
Ports	Fiji Ports Corporation Ltd, FIJ	2017	FJD	139.11	6.43	**21.6**	58.69	32.89	711.64	**2.4**	**5.1**	**178%**
Ports	Kiribati Ports Authority, KIR	2019	AUD	45.31	2.67	**30.5**	8.73	8.21	250.57	**5.2**	**5.5**	**106%**
Ports	PNG Ports Corporation Ltd, PNG	2018	PGK	1,836.43	61.61	**29.8**	274.54	210.59	6,277.37	**6.7**	**3.4**	**130%**
Ports	Samoa Ports Authority, WSM	2019	WST	216.63	4.97	**43.6**	17.80	12.33	537.10	**12.2**	**2.5**	**144%**
Ports	Solomon Islands Ports Auth., SOL	2019	SBD	662.95	26.13	**25.4**	220.11	151.36	3,840.16	**3.0**	**5.8**	**145%**
Ports	Ports Authority Tonga, TON	2018	TOP	43.25	1.90	**22.8**	12.38	7.91	180.04	**3.5**	**4.2**	**156%**
Ports	Kosrae Port Authority, FSM	2019	USD	14.65	0.70	**21.0**	0.47	1.23	26.98	**31.3**	**1.8**	**38%**
Ports	Pohnpei Port Authority, FSM	2019	USD	7.05	0.45	**15.7**	4.03	3.68	57.78	**1.8**	**8.2**	**110%**
Roads	Land Transport Authority, WSM	2019	WST	8.98	0.82	**11.0**	16.23	36.35	399.88	**0.6**	**44.5**	**45%**
Water/Sanitation	Samoa Water Authority, WSM	2018	WST	231.36	5.20	**44.5**	23.03	26.69	1,187.85	**10.0**	**5.1**	**86%**
Water/Sanitation	Solomon Water, SOL	2019	SBD	377.91	7.93	**47.7**	96.02	106.02	5,055.11	**3.9**	**13.4**	**91%**
Water	Tonga Water Board, TON	2019	TOP	38.46	2.10	**18.3**	8.93	7.55	137.90	**4.3**	**3.6**	**118%**
Water/Sanitation/Energy	Public Utilities Board, KIR	2017	AUD	69.72	4.31	**16.2**	12.32	14.83	240.03	**5.7**	**3.4**	**83%**
Water/Sanitation/Energy	Palau Public Utilities Corp., PLW	2019	USD	*155.57*	*5.71*	***27.2***	*25.89*	*34.83*	*1,006.17*	***6.0***	***6.5***	**74%**
Water/Sanitation/Energy	Pohnpei Utilities Corp., FSM	2019	USD	*30.05*	*2.10*	***14.3***	*14.41*	*15.60*	*223.52*	***2.1***	***7.4***	**92%**
Water/Sanitation/Energy	Yap State Public Service Corp, FSM	2019	USD	*18.06*	*1.26*	***14.4***	*5.79*	*6.38*	*91.62*	***3.1***	***5.1***	**91%**
Water/Energy	Chuuk Public Utility Corp., FSM	2019	USD	*22.23*	*1.19*	***19.7***	*7.13*	*7.57*	*149.26*	***3.1***	***6.7***	**94%**
Water/Sanitation/Energy	Nauru Utilities Corporation, NAU	2019	AUD	42.37	2.39	**17.7**	18.67	22.28	362.38	**22.6**	**8.6**	**84%**

Notes:

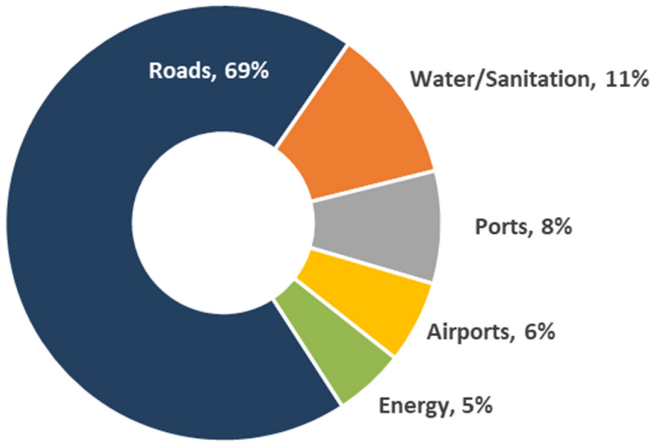
1. *Year of latest financial statement available/provided. This varies across entities and thus serve as a source of enquiry only.*
2. *Capital replacement cost of fixed infrastructure, Gross Replacement Cost (in millions). Note totals in italics are written down value, not GRC.*
3. *Annual depreciation expense of fixed assets.*
4. *Average useful life as defined.*
5. *Total cost recovered through fees, charges, and other operating income excl. grants and loans (in millions).*
6. *Total annual expenditure for entity (in millions).*
7. *Annual operating and maintenance cost x average useful life as defined (in millions)*
8. *Capital Intensity ratio - GRC / Total cost recovered.*
9. *Lifecycle O&M Cost Ratio as defined.*
10. *User Cost Recovery percentage as defined.*

4.8 Unit Replacement Cost Ratio

4.8.1 Gross Replacement Cost by Sector

As discussed, most entities responsible for maintaining infrastructure assets are regarded as capital-intensive organizations. In Samoa, we have been able to identify the GRC of infrastructure across five of the six sectors (excludes Solid Waste) and are able to report the relative scale of investment by sector as shown in the pie chart below:

Figure 21. Relative Value of Infrastructure (Gross Replacement Cost) across Sectors – Samoa



Source: Derived from valuation figures in financial statements of main infrastructure entities in Samoa.

While the road sector typically has the greatest level of capital invested in its fixed assets, the passive nature of these largely civil assets makes it less sensitive to disruption from underinvestment in maintenance when compared to sectors with a higher proportion of active mechanical and electrical assets. When roads fail, they generally continue to provide a level of service—cars continue to drive on them, just at slower speeds. When a pump or generator fails, it can lead to a wider system failure; without redundancy in the system, a generator failure can lead to an interruption in service. Similarly, when the generator fails, or power production is restricted, users use less energy and ration it to high value uses. They may swap fuels, using firewood instead of electricity for cooking and kerosene for lighting.

Note that the capital investment in building infrastructure (GRC) alone does not provide a direct indicator of the expected levels of investment to maintain and preserve that infrastructure. It is simply an indicator of the scale of investment that has been required to construct the infrastructure that the public now relies on to deliver the relevant service (for example, clean drinking water to their tap)

4.8.2 Unit Replacement Cost (Water/Sanitation)

This ratio provides an indication of the capital invested per user of the infrastructure. Sector-level metrics, in Appendix B are matched with the GRC of assets to estimate how much investment is required to provide each user (however defined by each sector) with the capital on which the service is based. Hence, this ratio is considered by sector. Further, while not all sectors yet provide the user information, some do. Where regional bodies have databases of information on entities in PICs in their sector, this information has been used to establish the service-level metrics in Appendix B. The GRC of infrastructure has been taken from the financial statements of individual SOEs per sector. For example, the Pacific Water and Wastewater Association data have

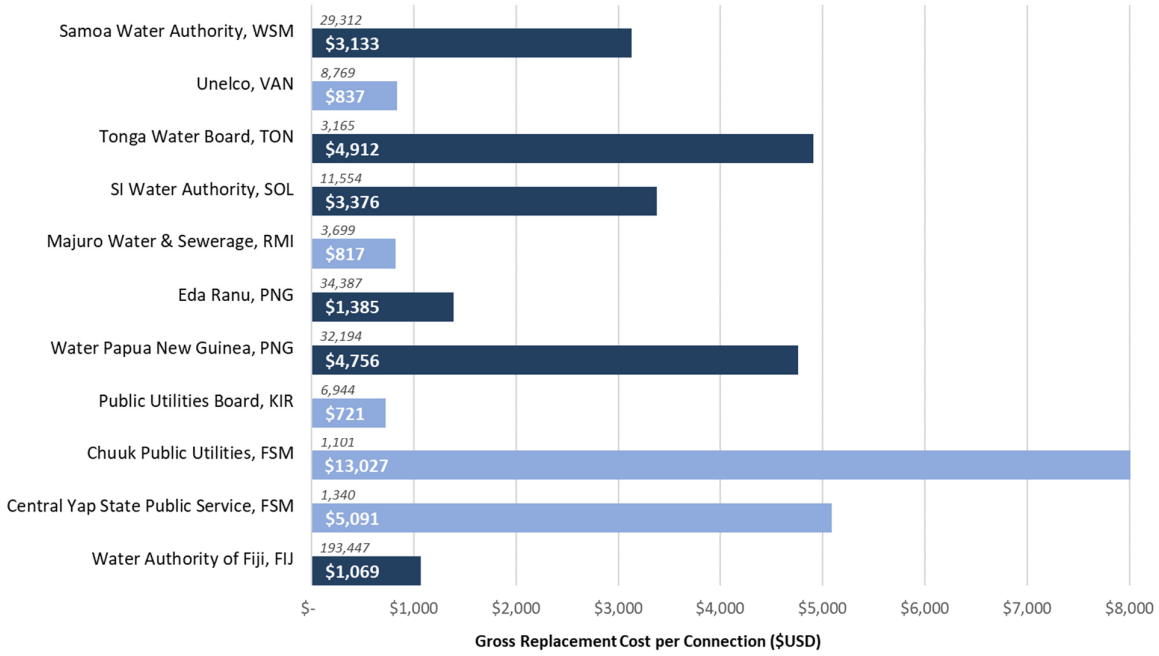
been applied in calculating the unit replacement cost per connection for water and sanitation infrastructure in PICs, and the financial statements of each water entity are the source of the financial data.

The replacement cost ratio for water/sanitation, expresses the GRCs of all fixed assets "owned" by the entity over of the total number of customer connections to the service. At a broad level, this represents the total capital invested to provide a connection with safe drinking water and/or wastewater disposal.

Unit Replacement Cost = Gross Replacement Cost / Number of Connections

The records of 19 Water/Sanitation entities were investigated. Of these, the following 11 (60%) reported GRC in the IBNET[2] database.

Figure 22. Gross Replacement Cost (USD)/Connection – Water/Sanitation Entities



Source: International Benchmarking Network Water and Sanitation Utilities, provided by PWWA, 2018 statistics.

General Observations

- This measure is influenced by how compact the network is, whether treatment plants are large and centralized or smaller and distributed and the relative costs of construction across geographies.
- An economy of scale can be seen when comparing "similar networks" across an increasingly connected population from Tonga (@$4,912/conn), Samoa (@$3,133/conn), and Fiji (@$1,069/conn).
- Majuro RMI leases its infrastructure thus does not include its capital cost in financial statements.
- UNELCO Vanuatu is a private sector entity which does not seem to publish its financial statements for activities in Vanuatu separately from its French controlling entity's financial statements.
- Chuuk, Kosrae, Pohnpei and Yap deliver public utilities through entities that are component units of each State or of the National FSM government. Complying with GASB, they disclose the net value of assets, rather than the gross less accumulated depreciation.

When we remove the outliers and inconsistencies highlighted above, we get an aggregated weighted average infrastructure investment cost of **$3,105** per active connection.

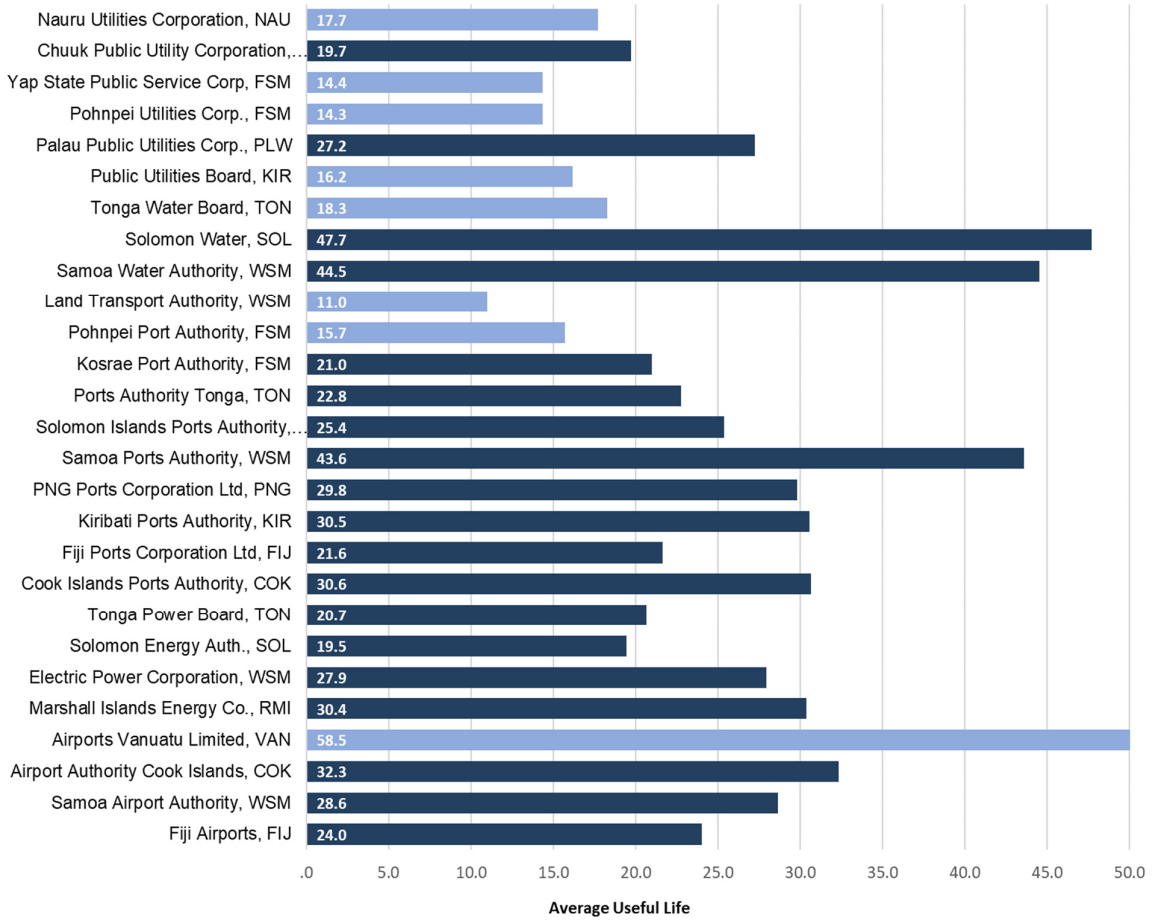
[2] *International Benchmarking Network (IBNET) Database - Water and Sanitation Utilities.*

4.9 Average Useful Life

The average useful life expresses the average GRC of the assets allocated to the number of years they are expected to be in service. The number of years is usually an estimate determined by the managers of the SOE. Average useful life differs from one country to another, from one climate to another, and from one type of asset to another. It also differs within asset classes. For example, the useful life of a two-lane highway differs from that of a dirt country road. The average reflects not only the useful life of the whole stock of assets, but also their mix. When most of the investment is in long-lived assets, the useful life will be longer than, for example, when most of an entity's assets are invested in shorter-term assets like information technology systems, motor vehicles, and meters. This measure reflects differences across sectors as well as across PICs.

Average Useful Life = Gross Replacement Cost (Depreciable Assets) / Annual Depreciation Expense

Figure 23. Average Useful Life (years) – All Sectors



Source: Annual reports and financial statement published by entities (refer Table 16).

General Observations

- Average useful life smooths into one figure the various useful lives of components and asset classes.
- The useful life of motor vehicles varies across each sector and among PICs. The better the roads, the longer the useful life. For example, Samoa expects to get 10 years from motor vehicles (on average), Fiji expects 8 years and Papua New Guinea 3 years.
- There is no standard useful life. Rather. it reflects the external conditions, the construction quality, the maintenance undertaken, and the natural disasters expected to reduce the intended useful life of assets.
- Further analysis would need to be informed by each SOE's operating environment.

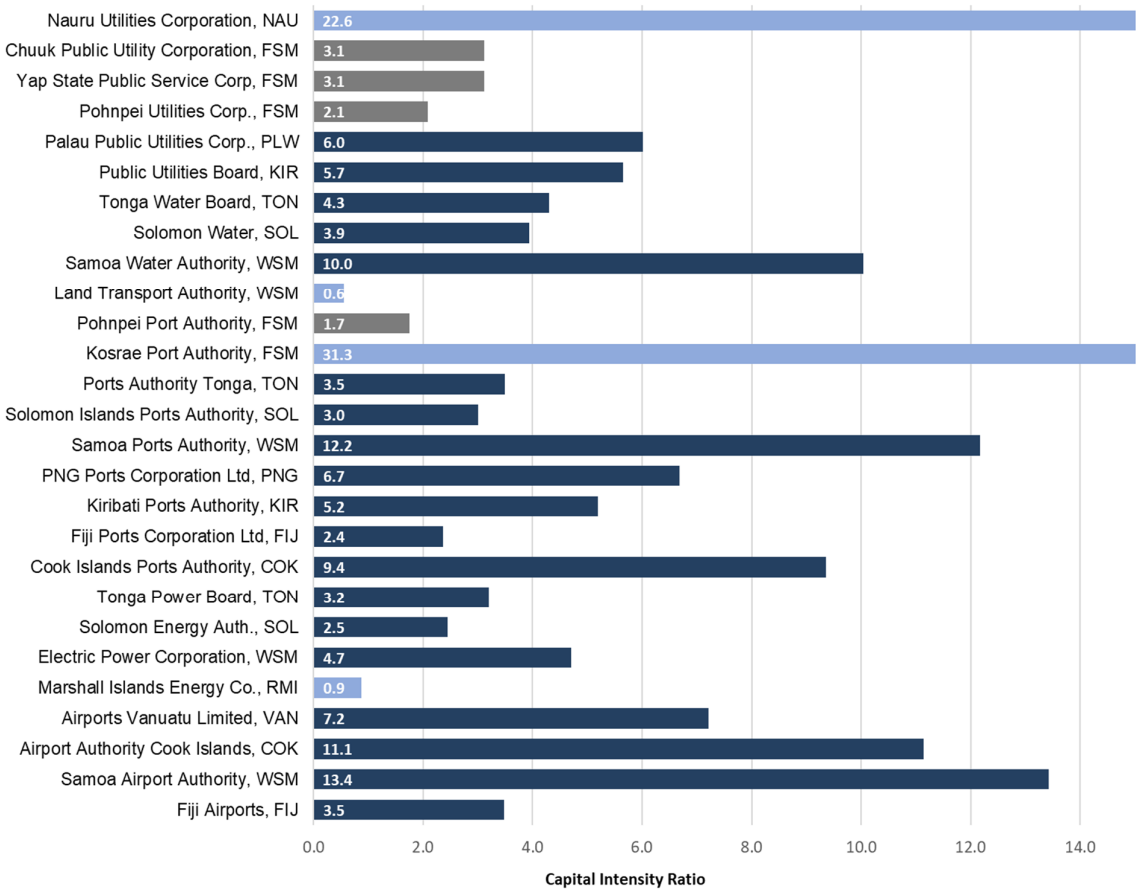
4.10 Capital Intensity Ratio

The capital intensity ratio expresses the challenge each entity faces in funding the replacement of assets. The higher the number, the greater the entity's reliance on its capital infrastructure to deliver services and the more difficult they are to replace from normal income. The lower the number, the easier it is for the entity to replace the infrastructure from fees and charges and other trading revenue generated by the SOE. A higher capital intensity ratio entity must pay more attention to its reliance on external sources of funding to replace its asset stock. Thus, it is in its interest to extend the life of infrastructure as much as possible by carrying out regular maintenance.

Capital Intensity Ratio (CIR) = Replacement Cost (Fixed Assets) / Annual Revenue

The same 27 entities who had sufficient data to report the average useful life formed the sample size for this metric. The reported income data excludes government community service obligations / subsidies to the SOE, as well as income from donor projects / funds recognized in the year. It reflects only fees from user charges and other trading activities. The ratio assumes that all income can be applied to replacing the asset. This is not so. Only the net income is available, not the gross which is allocated to salaries, operating and maintenance costs, and finance costs. The ratio illustrates how many years of income would be required to replace assets, without allocating that funding to any other costs.

Figure 24. Capital Intensity Ratio – All Sectors



Source: Annual reports and financial statements of infrastructure entities (refer Table 16).

General Observations

- It is difficult to compare entities, given that they each have different responsibilities and different make up of their asset stock.
- Where the GRC of assets is not disclosed, the capital intensity ratio is very low, for example, Samoa Land Transport Authority and Marshall Islands Energy Co.
- The FSM and RMI entities record carrying amount, so their capital cost is net, rather than gross.
- The higher the ratio, the greater reliance of the SOE to external sources of funding to rehabilitate and replace its asset stock.

When we exclude the exceptions/outliers highlighted in the figure above, we get an average Capital Intensity Ratio of 6.2. In other words, the average capital value of fixed infrastructure across all sectors is 6.2 times greater than the annual revenue generated by the service providers in these sectors. As a comparison, the Coca-Cola Company, which has a large asset base to produce beverages, has a CIR = 1.72. Public sector entities in the water sector have CIRs greater than this because of the significant investment in piping and pumping the water to households.

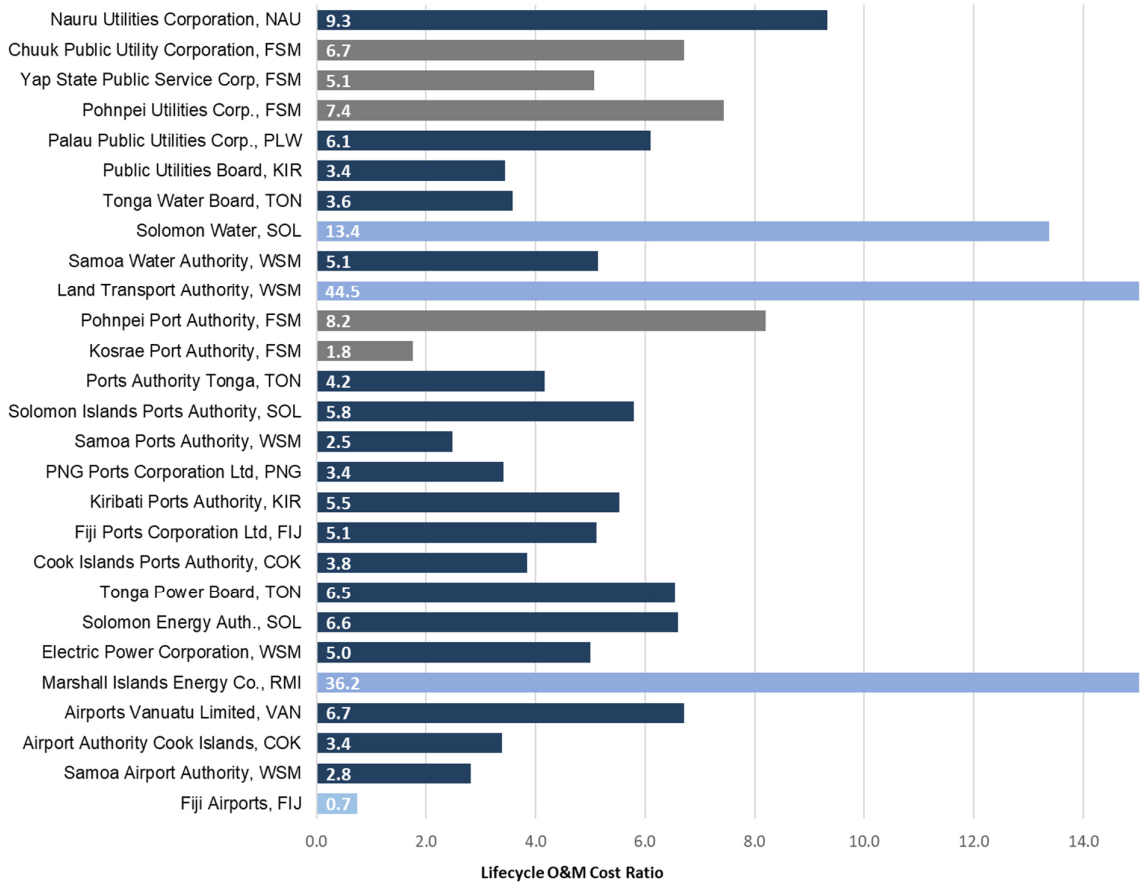
4.11 Lifecycle O&M Cost Ratio

The lifecycle operations and maintenance cost ratio is expressed as a proportion of the total lifecycle cost of infrastructure. It is calculated by multiplying the annual O&M expenditure by the average useful life of infrastructure and dividing it by the GRC of all fixed assets. This provides governments and SOEs with another way of visualizing the ongoing call on recurrent budgets to fund the operating and maintaining infrastructure beyond the initial capital expense of building it.

Lifecycle O&M Cost Ratio = (Annual O&M Expenditure x Average Useful Life) / Gross Replacement Cost

The consistent observation is that the capital cost of infrastructure is generally a minor part of the overall cost of operating and maintaining it. Most SOEs disclose the full cost of operating and maintaining an asset and delivering the service/s. The estimated useful life provides a benchmark to estimate the full cost of the infrastructure. Investing in regular maintenance will extend the useful life. Managers and governments face the challenge of identifying the point in time when it is cheaper and more desirable to replace infrastructure rather than continue to spend funds maintaining it. There comes a time when any further maintenance is wasting funds, and it is preferable to replace the asset entirely.

Figure 25. Lifecyle O&M Cost Ratio – All Sectors



Source: Annual reports and financial statements of infrastructure entities (refer Table 16).

General Observations

- Those shaded 'grey' disclose only written down value, without accumulated depreciation.
- The Federated States of Micronesia and Republic of the Marshall Islands entities record carrying amounts, so their capital cost is net, rather than gross.
- Land Transport Authority of Samoa does report the valuation of its infrastructure in its financial statements, but only its moveable PP&E.
- Incomplete valuations of assets show up in a large ratio of O&M to Capital.
- Revaluations or change in depreciation policy in 2019 showed up as a large ratio for Solomon Water. This is a 1-year aberration.
- The users and governments fund three (3) to seven (7) times the amount funded by donors/to construct the asset.

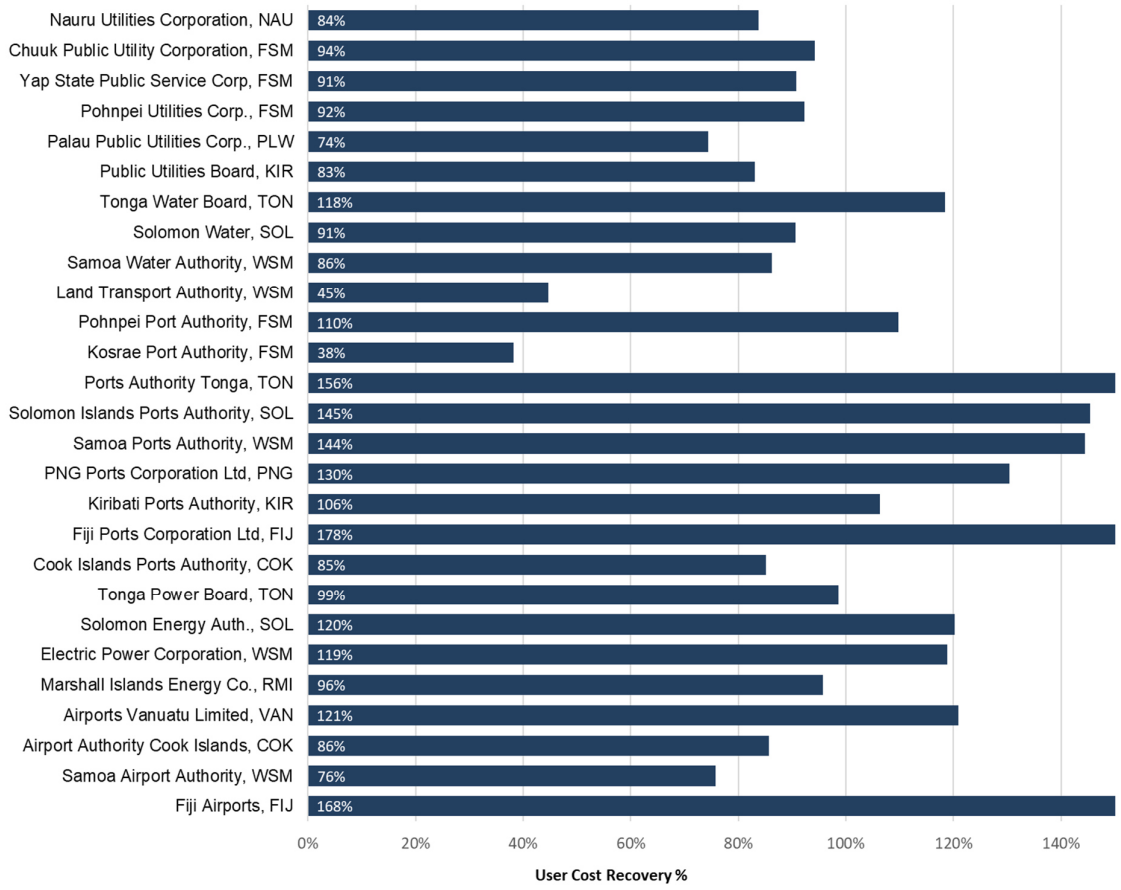
When we exclude the exceptions/outliers highlighted in the figure above, we get an average lifecycle O&M ratio of 4.3. In other words, the ongoing liability of operating and maintaining infrastructure assets across these entities is **4.3 times (430%) more than the capital cost of constructing** that infrastructure; expressed another way, the capital cost of infrastructure is around 19% of the total cost of ownership.

4.12 User Cost Recovery Value

This measure provides an indication of the ability of users to fund the annual operating and maintenance costs for the year selected.

User Cost Recovery = Total User Income (Fees and Charges) / Total Expenditure

Figure 26. User Income to Expenditure – All Sectors



Source: Annual reports and financial statements of infrastructure entities (refer Table 16).

General Observations

- The quality of the underlying data affects the usefulness of this ratio. Where the year selected is not indicative of all years, the ratio may be skewed.
- Of the 27 entities, nine recovered over 100% of annual expenditure in the year selected.
- Of the remaining entities, nine recovered over 90% of expenditure in the year and nine recovered less than 90% relying on government and donor grants to cover the shortfall.

4.13 Maintenance Cost Measures

The annual maintenance expenditure is separately reported in only 12 of the SOEs financial statements that were reviewed. The reporting indicated considerable variability in the way maintenance costs were coded. It is not clear if the figure reported applies only to the materials used in maintenance of sector specific infrastructure, or also to the contracts entered into for the maintenance of office equipment, motor vehicles, buildings, etc. It may include the salaries of maintenance staff, or only direct costs, excluding staff. The following table reports expenses reported as repairs and maintenance / maintenance in the operating statements.

Table 17. Calculation of Financial Measures (All Sectors)

Sector	Utility / Entity	Fin. Year [1]	Curr.	Repl. Cost [2]	Maint. Exp. [3]	Revenue [4]	RAV [5]	MCR [6]
Airport	Fiji Airports, FIJ	2019	FJD	521.64	3.37	143.96	0.6%	2.3%
Airport	Samoa Airport Authority, WSM	2020	WST	224.19	0.39	117.31	0.2%	0.3%
Airport	Airport Authority Cook Islands, COK	2017	NZD	84.21	0.30	9.61	0.4%	3.2%
Energy	Electric Power Corporation, WSM	2019	WST	594.84	3.29	129.19	0.6%	2.5%
Ports	Cook Islands Ports Authority, COK	2016	NZD	36.52	0.16	3.93	0.4%	4.1%
Ports	Kiribati Ports Authority, KIR	2019	AUD	45.31	0.10	11.08	0.2%	0.9%
Roads	Land Transport Authority, WSM	2019	WST	8.98	28.28	42.90	314%	67%
Water	Samoa Water Authority, WSM	2018	WST	231.36	0.96	26.91	0.4%	3.6%
Water	Solomon Water (SIWA), SOL	2019	SBD	377.91	12.36	108.34	3.3%	11.4%
Water	Public Utilities Board, KIR	2017	AUD	69.72	0.29	13.46	0.4%	2.1%
Water	Nauru Utilities Corporation, NAU	2019	AUD	42.37	1.84	19.44	4.3%	9.5%

Notes:

1. *Year of latest financial statement available/provided. This varies across entities and thus serve as a source of enquiry only.*
2. *Capital replacement cost of fixed infrastructure, GRC (in millions)*
3. *Routine, periodic and corrective maintenance and rehabilitation expenditure, excl operating expenses (in millions)*
4. *Total revenue from all sources including grants, fees, charges and other operating income (in millions)*
5. *Replacement Asset Value as defined.*
6. *Maintenance Cost Value as defined*

Source: Authors research of online published accounts.

General Observations

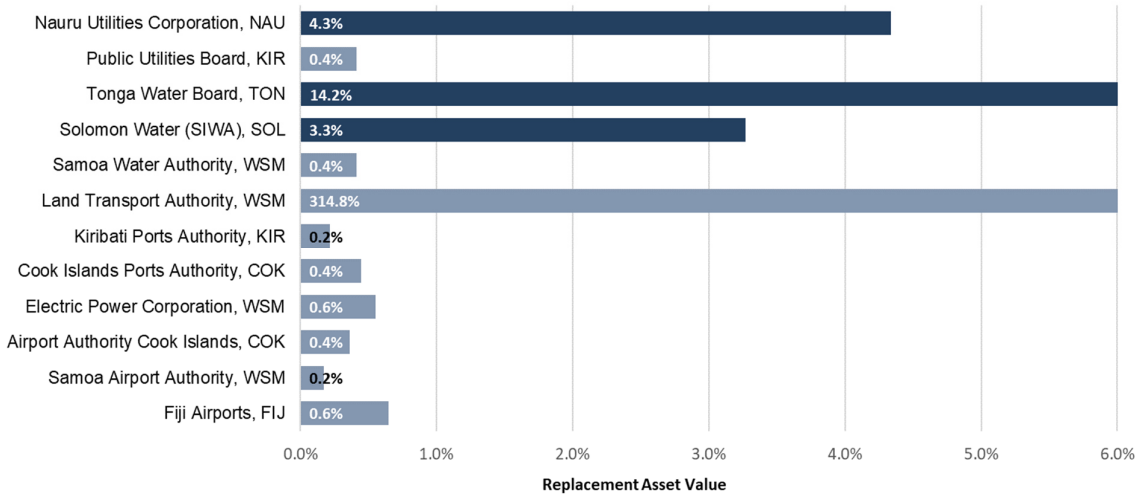
- The items separately reported in financial statements are usually material items. It may be that the maintenance expenditure of some SOEs was not material (that is, significant or over 10% of expenditure) and hence was reported as part of operational expenses or differently classified.
- It may be that regional sector bodies have more interest in the maintenance expenditure, and its breakdown, and could report these as part of their general database.
- Financial statements will continue to report material items, which will include large maintenance, including rehabilitation works.

4.13.1 Replacement Asset Value

This measure compares how much it costs to make repairs, perform routine maintenance, and replace parts on an asset to how much it costs to replace the entire asset wholesale. For active assets such as pumps, motors, generators, etc., the gold standard for routine maintenance and repairs is 2%–5%RAV and planners use this range to estimate the amount of money necessary for routine equipment maintenance over the life of the asset. There is less data and rule-of-thumb guidance available on %RAV ranges for longer life passive assets such as road pavements, pipelines, and reservoirs.

Replacement Asset Value = Annual Maintenance Expenditure / Gross Replacement Cost

Figure 27. Replacement Asset Value – All Sectors



Source: Annual reports and financial statements of infrastructure entities (refer Table 16).

General Observations

- As discussed earlier, the inconsistent coding and capture of routine maintenance, periodic maintenance, and rehabilitation expenditure and the separation of this from operating costs makes the reporting of this measure extremely unreliable at this stage.
- Trend analysis over time for each entity is required if this ratio is to provide meaningful information.
- Tonga Water Board undertook a large rehabilitation project in the 2019 year, thus raising the ratio.
- Land Transport Authority of Samoa also has good records but because they do not record the replacement cost of infrastructure in their financial statements their RAV is distorted.

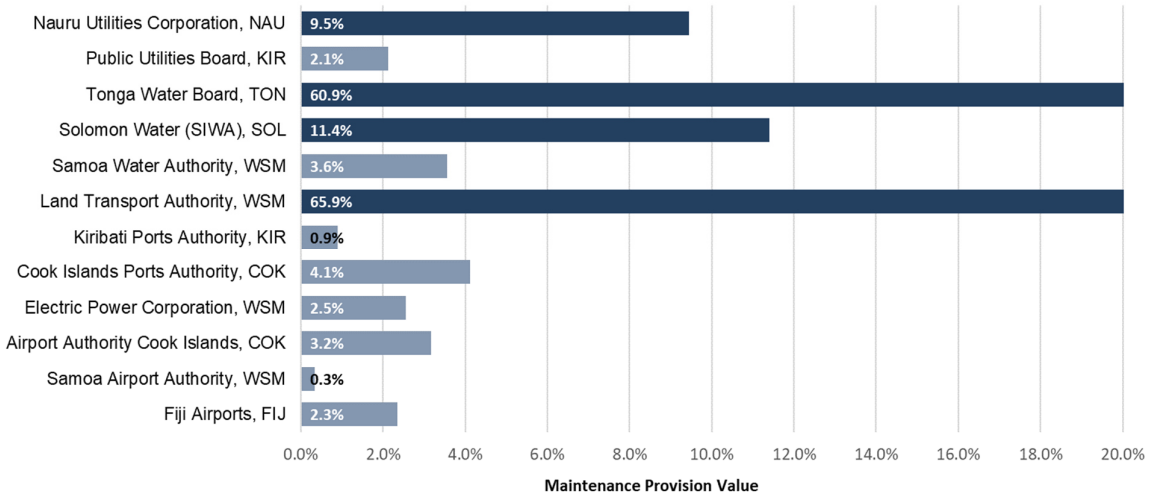
For those **two remaining entities** (both in the water sector) who do appear to have reasonable maintenance expenditure records (in dark blue) the average **RAV is 3.8%,** which is in the 2%–5% range anticipated for infrastructure entities.

4.13.2 Maintenance Provision Value

This measure expresses the proportion of revenue spent on routine, periodic, and corrective maintenance and on rehabilitation each year. Due to the often-cyclical nature of capital maintenance expenditure, this number can vary a lot from year to year and thus it should be tracked over time with a rolling average determined.

Maintenance Provision Value = Operational and Capital Maintenance Expenditure / Annual Revenue

Figure 28. Maintenance Provision Value – All Sectors



Source: Annual reports and financial statements of infrastructure entities (refer Table 16).

General Observations

- Trend analysis over time for each entity is required if this ratio is to provide meaningful information.
- For the four entities who do appear to have reasonable maintenance expenditure records, the average maintenance provision ranges between 9% and 66% thus showing the volatility of this measure in any given year.

Section 5

OPPORTUNITIES FOR DEVELOPMENT

This section provides executive managers and international development partners with a series of succinct improvement opportunities aimed to enhance the way infrastructure entities fund and account for maintenance expenditure and deliver more sustainable levels of maintenance across the Pacific. These focus on areas that warrant further investigation.

5.1 Accounting for Maintenance

Financial Statements are not always the best source of information on maintenance. Unless entities select to separately report the breakdown of operating expenses, separately identifying maintenance expenditure, in the notes to the accounts, users of financial statements won't have access to information on maintenance. Even that data may be incomplete if activity-based costing is not used. Staff may work on maintenance activities, normal operating activities and even office activities on any one given day. To garner the true cost of maintaining assets, all costs, including direct costs of materials, staff time, management supervision costs, and planning time, need to be coded as maintenance. SOEs may have internal management accounting systems that report this information, but it will not generally be available in the financial statements. It could be reported in annual reports if users seek it consistently.

Our inability to report meaningful financial maintenance performance measures (Section 4.6) and infrastructure valuations (Section 4.5.2) is not because of any weakness of SOE financial statements. The current lack of access to management data on the full cost of maintenance, the complete value of infrastructure at the component level, and the annual depreciation of each component means the above initial assessment can only get better over time.

There is a temptation to direct infrastructure entities toward advanced maintenance management concepts to improve their overall performance, such as having a rigorous condition monitoring program and deterioration modelling algorithms to predict when to intervene. However, there is much lower-hanging fruit, including maintenance in the notes to the accounts, and explaining the policy used in accounting for maintenance that will enhance the ability of users of financial statements to better assess each SOEs maintenance performance. Internal activity-based costing systems, which code all expenditure, including the cost of staff time, on maintenance to the different types, will allow SOE managers as well as maintenance management specialists to assess the maintenance performance.

5.1.1 Key Observations

(i) The accounting standards adopted by PIC governments are illustrated in the table below. Only half (7) of the 14 PICs use the accrual-based accounting principles which require them to account for long-term fixed assets (infrastructure) in their Statement of Financial Positions:
- Three have adopted IPSAS Accrual: Vanuatu, Cook Islands, and Niue.
- Three have adopted GAAP/GASB: Marshall Islands, Federated States of Micronesia, and Palau.
- One has adopted IPSAS Modified Cash.

The remaining countries, using cash accounting, do not yet record the value of their infrastructure assets or account for the annual depreciation expense in their financial statements. As a result, it is extremely difficult,

from a financial standpoint, to know whether they are being fiscally responsible with the infrastructure upon which their service is based. That is, are their revenues and capital maintenance levels sufficient to sustain the long-term performance of their infrastructure or are they simply covering the short-term operating costs and immediate maintenance requirements?

(ii) Under accrual accounting standards (IFRS, IPSAS Accrual), infrastructure is considered a non-current long-term fixed asset, and, as such, its value and annual depreciation are accounted for in the Statement of Financial Position. State-owned enterprises, with legislated stewardship responsibilities for infrastructure, report the value of the infrastructure in their financial statements.

(iii) The extent of assets included in the FAR is not always complete and is almost never held at a component level but rather based on historic project costs (for example, construction of a new treatment plant) and an overall useful life assigned to an entire facility.

(iv) There is variability in the way depreciation of non-current fixed assets is reported in financial statements. Those entities who may be under-reporting the replacement cost of all infrastructure, have a relatively low depreciation figure. In this case the entity may report annual depreciation as an operating expense. The entities that have a higher value of infrastructure may report the expense after operating surpluses as in the table below.

Table 18. Example of Depreciation Expense in Financial Statement

	Notes	31 July 2018	31 July 2017
		$	$
Income			
Grants and contributions	2 (a)	25,490,614	15,854,174
Amortisation of deferred income	11	165,216,118	152,874,640
Other income	2 (b)	887,846	1,999,193
Total income		**191,594,578**	**170,728,007**
Expenditure			
Employee related expenses	3 (a)	(10,779,437)	(7,796,813)
Other operating expenses	3 (b)	(5,606,126)	(12,041,631)
Maintenance	3 (c)	(117,190,592)	(100,988,152)
Total Expenditure		**(133,576,155)**	**(120,826,596)**
Surplus from operations		**58,018,423**	**49,901,411**
Depreciation and amortisation	7 & 8	(145,102,107)	(144,801,194)
Deficit for the period/year		**(87,083,684)**	**(94,899,783)**
Other comprehensive income			
Total comprehensive (loss)/income for the period/year		**(87,083,684)**	**(94,899,783)**

Source: Fiji Roads Authority Statement of Comprehensive Income 2017/18

(v) Very few infrastructure entities have completed robust asset valuations in line with the relevant accounting standards such as:

- International Financial Reporting Standard (IFRS13): Fair Value, IASB, 2011;
- International Accounting Standards (IAS16): Property, Plant and Equipment, IASB, 2003; and
- International Public Sector Accounting Standard (IPSAS17).

Generally, the greatest areas of non-compliance with the guiding principles of these standards are FARs not assessing the value and remaining life of an asset at a component level and those registers being incomplete.

(vi) Given the financial statements line items are generally material in nature or amount, smaller expenditure, such as on maintenance in some entities, would be reported as part of a catch-all such as "operating expenditure". The accounting standards do not require the separate reporting of maintenance. But it can be separately reported in the notes to the accounts. Because the maintenance expenditure may not always be material (over 10% of expenditure) there is a tendency to report it with operating costs since expenditure largely relates to routine repairs done by salaried staff also responsible for operating the assets. The costs of parts and materials to affect the repair are usually also reporting under operating expenditure. This convention means that the financial statements are not a good source of information on the cost and breakdown of maintenance. For example, smaller entities would tend not to separately report preventive and capital maintenance expenditure, even in the notes to the accounts.

5.1.2 Focus Areas for Improvement

To encourage a move toward more transparent accounting for infrastructure depreciation and maintenance expenditure, we suggest improvements in the following key focus areas:

a) Improve the coding of maintenance expenditure across infrastructure

There needs to be a greater level of guidance delivered to finance departments on how they should be coding maintenance expenditure. Until we better track what is being spent on maintenance, it will be impossible to convince politicians and decision makers that the amount being spent is not sustainable. As an example, New Zealand's central road funding agency requires all 74 councils to code road maintenance expenditure against 22 "work categories". These accounting classifications enable budgets and expenditure to be tracked by work type and cost comparisons to be made between organizations and regions.

Table 19. Example Road Maintenance Accounting Codes/Categories (NZ Transport Agency)

WC 111: Sealed pavement maintenance	WC 151: Network and asset management
WC 112: Unsealed pavement maintenance	WC 171: Financial grants
WC 113: Routine drainage maintenance	WC 211: Unsealed Road metaling
WC 114: Structures maintenance	WC 212: Sealed Road resurfacing
WC 121: Environmental maintenance	WC 213: Drainage renewals
WC 122: Traffic services maintenance	WC 214: Sealed Road pavement rehabilitation
WC 123: Operational traffic management	WC 215: Structures component replacements
WC 124: Cycle path maintenance	WC 221: Environmental renewals
WC 125: Footpath maintenance	WC 222: Traffic services renewals
WC 140: Minor events	WC 231: Associated improvements
WC 141: Emergency works	WC 241: Preventive maintenance

Source: Waka Kotahi NLTP guidelines
https://www.nzta.govt.nz/planning-and-investment/planning-and-investment-knowledge-base/archive/201821-nltp/.

b) Report maintenance expenditure in the notes to the financial statements

To assist the government, legislature and other users estimate the ability of each SOE to maintain its infrastructure, and to separately report maintenance expenditure in the notes to the accounts.

c) Account for the depreciation of infrastructure in financial statements

Understanding the scale of infrastructure (GRC), its assessed current fair value (generally the depreciated replacement cost) and the level of annual depreciation is important if these capital-intensive infrastructure entities are to ensure their tariffs and budgets reflect the full cost of sustaining this infrastructure. The calculation of annual depreciation expense needs to be based on a realistic understanding of the expected useful life of the components within the network that makes up each class of assets. To assist in this, the FARs need to be complete, with individual components that meet the recognition criteria for being an asset, all included, with its useful life identified.

5.2 Planning and Budgeting for Maintenance

Maintenance is budgeted according to the type of maintenance anticipated. Ongoing operations are funded annually, from the recurrent budget of either the government or the SOE. Depreciation, under accrual accounting, is treated as an expense and calculated by dividing the capital cost of the infrastructure by its anticipated useful live (straight line method) and bringing the cost to account each year. It is not always funded, and the expense does not usually equate to the need for maintenance. This approach works well for motor vehicles, computers, and printers with clear useful lives. However, it is not as helpful when it is applied to infrastructure, defined as:

- part of a system or network;
- specialized in nature and do not have alternative uses; and
- immovable, and may be subject to constraints on disposal.

The budgeting required is different. In addition to funding capital maintenance, the maintenance budget is not equal year to year. It is lumpy. While components that have warranties, for example, generators, have maintenance schedules determined by suppliers, the servicing required will generally happen over 5–10 years, rather than annually. Budgeting last year's allocation plus an adjustment for changes in price is not effective in budgeting for the maintenance of infrastructure.

5.2.1 Key Observations

(i) Maintenance costs are optimized by taking multiple factors into consideration. Just as the useful life of, for example, wharves, differs across the Pacific, so too do the maintenance needs of the infrastructure from country to country, meaning the type of maintenance to be undertaken differs. Each entity, in preparing its maintenance schedule, can ensure that the overall costs of maintenance are optimized. The tendency to wait until the infrastructure breaks down and then to repair it is generally the least cost-effective option. The cheaper option is to keep new infrastructure in good condition by maintaining it from the outset.

(ii) There is a dilemma in budgeting maintenance. The availability of funds last year is not a good indicator of the need for maintenance funds this year and next year. Rather, it is the maintenance strategy that determines the need for funds. The sources of these funds must be identified well in advance of the financial year in which they will be applied. The flow of funds from a consistent revenue generated from fees and charges is often inadequate. While in some years there will be a surplus, in others, there will be a large deficit to fund. This needs to be acknowledged and determined in the planning stages of new projects.

(iii) Further, the future costs of not maintaining assets in the current year are not immediately obvious. This makes it difficult for politicians to resist the pressure to reallocate funds away from, for example, maintaining a new highway, to other uses. While the other use may have immediate political support, the cost of the degradation of the highway is incurred by everyone using the road. It is a version of the tragedy of the commons.

(iv) While the O&M costs differ from sector to sector and from PIC to PIC, they are significant. What they will be is determined in the planning stage and PIC governments and SOEs sometimes find themselves with a cost commitment they are not in a position to meet.

5.2.2 Focus Areas for Improvement

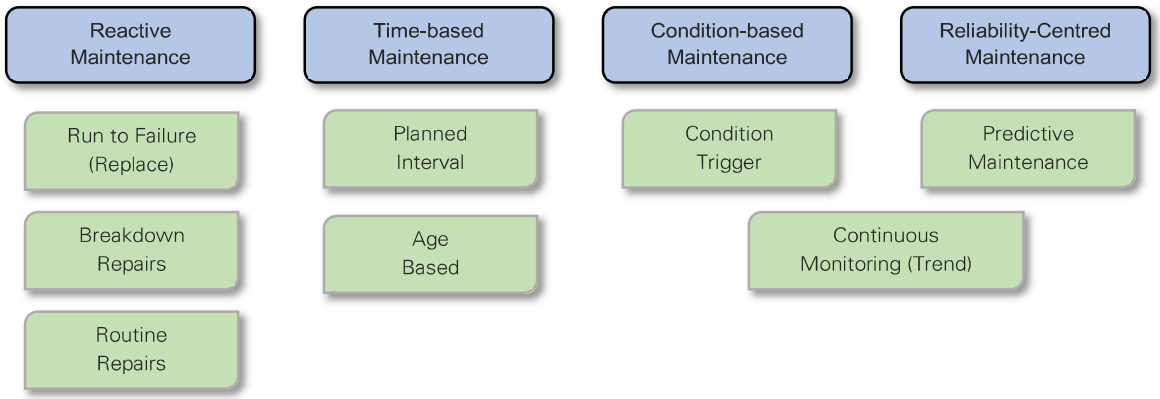
To encourage a move toward a scheduled and risk-based budgeting for maintenance, we suggest improvements in the following key focus areas:

a) Develop a Maintenance Strategy appropriate to the asset

The maintenance strategy is prepared by maintenance staff and specialist advisers. For example, a generator or solar farm supplier will nominate the operations required as well as the type and timing of ongoing maintenance to keep each component of the asset in good working condition. Where materials and replacements aren't readily stocked in the PIC, it is crucial that the entity prepare a formal operations strategy and maintenance strategy. These identify the forward maintenance required, its timing, the skilled personnel required to complete the maintenance and the equipment and parts required. Maintenance projects require formal management if they are to be completed in a way that optimizes the maintenance budget. Detailed planning, budgeting, and staff allocation are required, as with a capital project.

To encourage a move toward a realistic maintenance schedule that will optimize both access to services and costs of maintenance of services, PICs are encouraged to include maintenance scheduling within the initial capital project planning. At this stage, they have access to specialist infrastructure advisers who can identify both operating and maintenance costs for the lifetime of the asset as well as assist in preparing the lifetime maintenance schedule.

Figure 297. Developing a Maintenance Strategy



Source: Adapted from IPWEA. (2020). International Infrastructure Management Manual (6th Edition). Institute of Public Works Engineering Australasia.

b) Align budgets with maintenance categories

Budget and cash flow estimates are determined by the SOE and MoF staff with reference to available sources of funding. The cash flow required in future if current maintenance is not completed is added to the planning documents, including the Medium-Term Expenditure Framework (MTEF). Predicting forward cash flow and identifying the sources of the funds over time is a crucial part of the financial management of infrastructure.

The cost and timing of cash flows for the capital maintenance of infrastructure is included in the MTEF. Also included is the cost incurred in the 3–5-year budget period by foregoing maintenance in the current year.

Table 20. Budgeting for Maintenance in Key Investment Plans

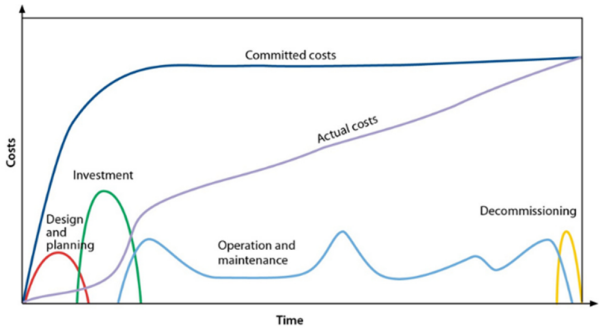
Budget Category	Maintenance Category	Description	Budget Plan [1]						
			Nat./Corp Plan	NIIP	MTEF	Disaster Fund	Capital Plan	Operation Plan	Stakeholders [6]
Capital Development	Replace/Renew	Significant capital expense that replaces an *existing asset* like-for-like. Planned and scheduled against asset (project level). Handled internally to the PIC.	X	X	X	X	X		SOE, PO, MOF, LG, Donor
	Rehabilitate	Often considered as a project expense rather than maintenance. Involves major planned work on an asset to prolong its service life (for example, generator overhaul). It is usually a large expense and needs to be added into the capital budget for a 1–5 year planned horizon. Should be identified in capital planning documents.	X	X	X	X	X		SOE, PO, MOF, LG, (Donor)
	Major Corrective Work	Often occurs after a natural disaster. Involves major unplanned work on an asset to reinstate its service life. Frequently independent of the SOE budget in the first instance. Part of Disaster Relief Funding Tranche. Disaster Response Funding.				X	X	X	SOE, PO, MOF, LG, Donor
Capital (Recurrent)	Preventive Maintenance	Typically, time or condition-based, scheduled maintenance. Occurs less frequently than routine maintenance and on a larger scale. Can be budgeted by work category (not at asset level).			X		X	X	SOE, PO, MOF, LG

Budget Category	Maintenance Category	Description	Budget Plan [1]						
			Nat./Corp Plan	NIIP	MTEF	Disaster Fund	Capital Plan	Operation Plan	Stakeholders [6]
	Corrective Maintenance/ Repair	Typically triggered by breakdown or observed wear-and-tear that requires urgent repair to return asset to service. Smaller repairs often covered under Operating budget. Some larger repairs may need to be capitalized.			X	X	X	X	SOE, MOF, LG
Operating (Recurrent)	Routine Maintenance	Conducted on a regular basis, designed to optimize wear-and-tear, and maintain assets in operational condition. Budgets typically set on historic levels and volumes.						X	SOE / MOF

Notes:

1. *Work to be identified in relevant strategic planning framework. 10-30 year National/Corporate Plan, National Infrastructure Investment Plan (NIIP), Medium-Term Expenditure Framework (MTEF), Disaster Relief Funding Tranche/Response Funding, Annual Capital or Operational Budget request.*
2. *SOE – State Owned Enterprise, PO – Planning Office or equivalent, MOF – Ministry of Finance, Bureau of Budget and Planning or equivalent, LG – local government body, Donor – all development partners, OPM – Office of Prime Minister or equivalent.*

c) Incorporate ongoing maintenance into the economic evaluation of capital projects



As discussed throughout this report, infrastructure entities are responsible for funding about four or five times the cost of the initial capital project (Section 1.8 and 4.11). The impact of this forward commitment needs to be taken into consideration in the initial planning stages when there is still flexibility in committing future costs. The NIIP can identify ongoing costs that are then to be taken into the MTEF. These would include education and trade training costs as well as the capital costs of machinery, access to materials not readily available, identifying potential sources of income, and the management of the delivery of the maintenance schedule.

While some maintenance treatment options can extend the useful life of the asset, others may be required if the PIC infrastructure is to adapt to climate change (for example, bridge protection works). This may result in what would have been preventive maintenance being replaced by new work, for example when climate risk is such that the infrastructure needs to be shifted and rebuilt in a new location.

USAID completes a due diligence process prior to investing $1 million or more in a private sector entity to assess its reputational risk. It gathers information on the prospective private sector partner through a series of questions. USAID uses publicly available information and partners often are quite proactive in providing information. This type of initiative could be adapted in reviewing infrastructure projects to ensure designers adequately consider the ongoing burden of their designs.

It is too late to begin budgeting for operation and maintenance after the project has been signed off through the Office of the Prime Minister or the Donor Collaboration Group. These costs need to inform design and forward planning and budgeting.

d) Optimizing design to reduce ongoing maintenance costs

Initial project design needs to be tasked with optimizing the operation and maintenance costs together with the capital project costs, so that the design chosen optimizes the whole-of-life levels of service and operating and

maintenance costs. It is at this stage that community consultations through civil society and local government, involving town planners, that the sustainability of PICs can be fully addressed. While this report considers only the maintenance of built infrastructure, it is in the planning stages that the integration of the planned infrastructure project with natural infrastructure, including sources of fresh water, fisheries nurseries, and other crucial natural infrastructure in PICs, can be considered and managed.

5.3 Funding of Capital Maintenance

One of the most significant shortfalls in investment across the Pacific is for capital maintenance, i.e., significant corrective maintenance repairs, planned preventive (periodic) maintenance, and asset rehabilitation (refurbishment). If an agency wishes to optimize the whole-of-life cost of operating and maintaining its infrastructure, it needs to have a robust capital maintenance program. Research has shown that the current build-neglect-rebuild pattern ultimately results in higher costs to government and infrastructure entities. However, some perverse incentives remain that enable this pattern, or at very least do nothing to encourage a move away from it.

5.3.1 Key Observations

(i) Many government departments responsible for managing infrastructure receive annual grants to cover their operating, maintenance, and capital costs. Typically, these grants come from a general fund with entities having to compete based on perceived urgency/criticality of works. This does not favor planned preventive work which does not have the same perceived urgency as the replacement of a failed piece of equipment.

(ii) The construction of infrastructure using donor funds strengthens the incentive bias against provision of maintenance. According to Ostrom, Schroeder, and Wynne (Elinor Ostrom, 1993), governments in developing countries will not invest in maintenance if they believe that a donor will replace infrastructure once it is no longer operational. Donor provision of infrastructure thereby creates perverse incentives for partner governments not to invest in infrastructure maintenance. (Dornan, Aid and the Maintenance of Infrastructure in the Pacific, 2012)

(iii) Evidence of routine operational maintenance activities (for example, patching, digouts) is visible on many sealed roads across the Pacific as these activities are generally completed by in-house government crews and with operating budgets consisting largely of wage- and fleet-based costs. However, capital maintenance on these same roads is far less obvious. Capital maintenance requires more proactive planning and a higher level of asset management maturity than routine maintenance. Often the government crews and plant/equipment capabilities deployed for routine maintenance cannot be scaled up to tackle the more extensive capital maintenance works, but mostly, the limitation is finding funding for the higher proportional material, parts and equipment costs of capital maintenance works.

We generally see higher levels of capital maintenance in the aviation and energy sectors where revenues are tariff-based, and entities get a greater level of autonomy around optimizing their whole-of-life costs. Entities operating within these predominantly SOE structures appreciate that preventive maintenance expenditure saves them money in the long run and have the autonomy to make these investment decisions. There is room for improving planning and investment in asset rehabilitation and refurbishment across the sectors.

5.3.2 Focus Areas for Improvement

To encourage a move toward a more proactive, capital maintenance regime, we suggest improvements in the following key focus areas:

a) Develop a 3-year rolling view of capital maintenance needs

It is common practice among mature infrastructure maintenance entities to develop a medium-term view of their corrective, preventive, and rehabilitation requirements. These 3-year capital maintenance investment plans (next budget year +2) identify work volumes and budgets by asset and treatment type, as compared with operating budgets which are largely based on salary and historic disbursement levels. Capital maintenance plans are

compiled based on a range of inputs such as maintenance history, condition, prioritization/criticality assessment, inspections, and historic trend analysis. They rely on a combination of expert assessment (field) and analytic techniques to determine the cost vs. benefit of the capital maintenance investment.

The majority of entities surveyed have a reasonably robust inventory of their assets and their condition but almost all rated their ability to plan maintenance lower (45% of respondents had made little to no progress against the core requirements of good maintenance planning). Strengthening the annual budget cycle to include capital maintenance requirements budget year and ensuing 2 years (rolling cycle) will allow entities to better commit to funding levels and enable the additional improvements suggested below.

b) Seek development partner assistance and government grants to fund capital maintenance

Donors have traditionally funded new infrastructure projects instead of maintenance of existing infrastructure. In part, this is due to the view that aid is not permanent. Donor aid for infrastructure is instead provided to spur economic growth, often in poor regions, with the idea that this growth will subsequently fund the ongoing operation and maintenance of infrastructure.

There is precedence of development assistance funds being used for infrastructure maintenance. A few examples in the Pacific include:

- Tuvalu road and runway resurfacing program (WBG Pacific Aviation Investment Program 2012-2017)
- Pacific aviation infrastructure maintenance support contract (WBG 2021-; refer case study Section 6.2)
- Solomon Islands Road maintenance program (Australia DFAT 2019)

c) Create a separate fund for maintenance

While not common, some governments have implemented "special revenue funds"[3] for infrastructure maintenance:

- Solomon Islands - National Transport Fund *(Case study is reported in Section 6)*
- Kiribati - Infrastructure Maintenance Fund *(Case study is reported in Section 6)*

In New Zealand, revenue collected from fuel excise duty, road user charges, vehicle and driver registration and licensing, state highway property disposal and leasing and road tolling is credited to the National Land Transport Fund. These funds are used to pay for all investments in land transport activities, including capital maintenance.

Establishing dedicated maintenance funds for public assets only makes sense if done in conjunction with some or all of the initiatives below. There is no point establishing a dedicated fund unless there is the capacity to plan and deliver the capital maintenance program within the overall priorities of the government approved by the legislature. Determining the scale of the fund should also consider a suitably robust assessment of the priority of the infrastructure service, the annual depreciation expense of the infrastructure assets as well as the optimal useful life of the capital maintenance being funded.

d) Establish term maintenance contracts

Packaging capital maintenance and other high priority programs into multi-year contracts for the private sector and civil society can improve policy security. For example, multi-year contracts can be entered into to implement adaptation measures, as well as mitigation measures in high priority areas. These multi-year tendered contracts tend to provide funding certainty for the duration of the contract; it is difficult and expensive to reduce payment under the terms of these contracts. Mutually, the local contracting industry has greater certainty over work volumes and can thus train staff and invest in the upfront plant and equipment costs to deliver the program, something which is difficult to justify with annual contracting methods.

[3] *GASB definition: "Special revenue funds are intended to be used to report specific revenue sources that are limited to being used for a particular purpose, such as transportation aid. In practice, governments also use them to report: all of the financial activities associated with a single function (such as road maintenance); classes of revenues (for example, all federal grants); and "rainy day" resources."*

5.4 Suggestions for Next Steps

Table 21. Suggested Actions for Development Partners and PICs to Improve Maintenance

Development Opportunity	Potential Actions for Development Partners	Potential Actions for PICs
Theme 1: ACCOUNTING FOR MAINTENANCE		
a) Improve the account codes for maintenance expenditure across sectors. b) Fully report maintenance expenditure in the notes to the financial statements c) Account for the accumulated and annual depreciation of all infrastructure in financial statements.	▪ Conduct a study to identify how maintenance expenditure is being coded and present a best-practice guideline that meets the needs of PIC SOEs and Ministries of Finance. ▪ Conduct a study to identify how affordable asset valuations can be completed and present a best-practice guideline for PICs. ▪ Promote TAs that assist entities survey their assets, develop robust valuation methodologies (rates, useful life, etc.) and report these in their physical asset registers and in asset registers in their accounting systems and hence in the financial statements.	▪ Improve the general ledger coding to enable entities to separately identify recurrent and capital maintenance, and operational expenses in multi-year and annual budgets. ▪ Assist Ministries of Finance to cooperate in developing affordable and reliable asset valuation methodologies. ▪ Consider the impact on the MTEB of funding depreciation of the infrastructure of SOE/Departments. ▪ Build the financial management capacity of SOEs to achieve clear audit opinions on their financial statements.
Theme 2: PLANNING AND BUDGETING MAINTENANCE		
a) Develop a Maintenance Strategy appropriate to the infrastructure assets. b) Budgets for maintenance per category. c) Incorporate the required lifetime maintenance and operating expenses into the economic evaluation of capital projects.	▪ Ensure all **new** infrastructure funded under IDA is supported by a full lifecycle economic analysis of ongoing operation and maintenance costs. Require donors and governments to identify revenue streams to support the ongoing O&M. ▪ Promote TAs that assist entities develop 10-year systematic maintenance strategies: methods, forecast expenditure and revenue streams.	▪ Ensure medium-term expenditure frameworks set budgets for routine/corrective maintenance, preventive maintenance, rehabilitation, and renewal of infrastructure. ▪ Ensure maintenance crews are an integral part of developing forward budgets. ▪ Require entities to provide a maintenance plan in their budget proposals.
Theme 3: FUNDING CAPITAL MAINTENANCE		
a) Develop a 3-year rolling budget for funding capital maintenance. b) Look to development partner assistance and government grants to fund capital maintenance. c) Create a separate fund for maintenance. d) Establish term-maintenance contracts.	▪ Conduct a pilot study across 5–6 entities that manage a robust capital maintenance program and disseminate best practices. ▪ Promote TAs that assist entities survey their assets and develop forward plans of capital maintenance requirements. ▪ Support TA to assess the savings from funding capital maintenance. ▪ Increase the volume of funding assistance allocated to infrastructure maintenance, in particular, preventive maintenance and rehabilitation of existing infrastructure. ▪ Identify skill requirements and support apprenticeships and other ways for the skills of maintaining infrastructure to be developed and shared in and among PICs and across generations.	▪ Ensure medium-term expenditure frameworks are in place and that annual budget requests include 3+ year projection of capital maintenance requirements. ▪ Improve the budget process to separate recurrent and capital maintenance from operational budgets. ▪ Investigate packaging maintenance into longer-term contracts for the private sector and civil society to promote greater cost certainty and investment in equipment and staff development.

The table above summarizes the near-term tactical actions that could be taken to help address the improvement opportunities identified within this chapter.

To retain momentum and achieve a key goal of the report, that of raising awareness of the importance of routinely maintaining infrastructure, stakeholders need to also forge key linkages across sectors and between and among countries, support maintenance staff and contractors to develop and pass on their skills to future generations and promote designs that optimize the ongoing burden of maintenance.

To allow the tactical improvements recommended in Table 20 to be actioned, a wider set of enabling activities will need to be in place. Some ideas for stakeholders to consider are provided below.

Development Partners

- Distribute the report to each entity listed in Table 11 as well as to all Ministries of Finance.
- Set up TA to facilitate the engagement and promotion of key findings across stakeholder groups.
- Coordinate presentations from consultants to relevant working groups, for example, the Sustainable Infrastructure Management Working Group (SIM WG).
- Coordinate presentations from consultants to the regional teams of donor agencies (for example, ADB).
- Coordinate a PRIF workshop to assign priorities to actions, identify hurdles to adoption, and scope future TAs that build on the success that SOEs and departments have achieved in maintaining infrastructure.
- Integrate into development programs the future annual cost to PICs of capital works programs.
- Work with PICs to identify revenue streams to fund the consequent operating and maintenance costs.
- Conduct a review of recently completed infrastructure and identify sources of funding for the consequent operating and maintenance costs.
- Ensure all capital programs build in the implications of the design and build for future operations and maintenance of the infrastructure in PICs, including skills transfer.

Governments

- Establish a cross-sector maintenance (or asset management) working group.
- Incorporate the identification of future revenue streams to cover the whole-of-life costs of projects in the pipeline, including interest and redemption, operating and maintenance costs.
- Encourage development partners to design infrastructure that is fit for purpose and affordable.

Infrastructure Entities

- Volunteer to be part of a team to peer review infrastructure maintenance maturity assessments.
- Include the maintenance teams in planning and budgeting maintenance.
- Participate in sector regional bodies.

Regional Bodies

- Ensure maintenance is discussed at conferences.
- Capture maintenance data in regional databases (for example, PWWA IBNET).
- Manage peer reviews of regular maturity assessments.
- Advocate with development partners for fit for purpose and affordable infrastructure projects.

Professional Bodies

- Include the implications of planning and funding maintenance on the program of conferences and in professional development activities.
- Reach out to other bodies to engage in cross-sectoral and multi-dimensional discussions about the impact of infrastructure plans in the long-term.

Section 6
CASE STUDIES

This section provides several case studies that support the suggested improvement opportunities in Section 5 and provide examples of the practice in place across the Pacific.

6.1 Selection of Case Studies

We have included a few case studies in this section that showcase some of the challenges and solutions being adopted to improve maintenance across the Pacific.

Table 22. Selection of Case Studies Highlighting Maintenance Challenges and Solutions

Sector	Country	Case Study	Description
Aviation	Regional	Pacific Aviation Infrastructure Maintenance Support	Provide local maintenance practitioners with supplementary technical support (beyond the skills available in-country) and provide a mechanism to make specialist repairs and parts available through a centralized contract and budget.
Public Financial Management	Vanuatu	Vanuatu Infrastructure Valuation	A country-wide valuation of its entire public infrastructure portfolio.
Water, Sanitation and Energy	Kiribati	Kiribati Public Utilities Fiscal Gap	PUB has a deficit for the year of $1.2 million before abnormal items.
Public Financial Management	Kiribati	Establishing a Maintenance Fund	In Kiribati, the reconstruction of key infrastructure – particularly transport and energy infrastructure – has meant that other infrastructure improvements (such as hospitals and clinics) have not had the financial resources to go ahead.
Transport – Air, Land and Sea	Solomon Islands	Solomon Islands National Transport Fund	A review of the Solomon Islands National Transport Fund in 2014 found that "needed maintenance and rehabilitation works (especially of roads) were not being carried out to the extent required".

Source: Authors.

6.2 Pacific Aviation Infrastructure Maintenance Support

The Challenge

Through the Pacific Aviation Infrastructure Program, the World Bank and other donor partners have invested over $200 million between 2012 and 2021 to improve the infrastructure at nine airports across the Pacific. **To protect this investment** into the future, it is being proposed that a regional 5-year term maintenance contract be developed, tendered, and implemented. This contract will provide on-call expertise and funding to support local maintenance teams with larger more complex and expensive maintenance interventions.

Scope of the Project

The scope of the project is to provide local maintenance practitioners with supplementary technical support (beyond the skills available in-country) and provide a mechanism to make specialist repairs and parts available through a centralized contract and budget. The focus will be on mechanical and electrical (active) assets whose failure would result in safety being compromised and/or associated disruption to aircraft operations. The broad scope of services is presented below.

Figure 30. Scope of Contract and Assets for Inclusion

Capture and Update Asset Information	Establish a baseline of attribute information about the airports infrastructure and its role in maintaining safe airport operation.
Develop Corrective Maintenance Plan	Assess asset criticality and condition to develop a corrective maintenance plan and budget for repairs.
Implement a Preventive Maintenance Program	Develop a consistent approach to planned maintenance across all airports and support airport management to implement in a move towards a more proactive regime.
Specialist Repairs and Maintenance	Supervise contractors for (or in some cases perform) specialist repairs where in-country capability does not exist. Source specialist parts and materials when they are required.
Respond to Emergency Events and Natural Disasters	Mobilise support services at short notice to assist with reinstatement of operations and support aid services following a natural disaster. Assist with post-disaster recovery.
Capability Uplift and Training	Build local capacity and coordinate supplementary training and knowledge transfer initiatives.

Area	Asset Class
Runway Lighting and Signage	▪ Signs ▪ Stake lights ▪ In-pavement lights ▪ Approach Lights
Visual and Navigation Aids	▪ Rotating beacon ▪ Runway-end identifier strobe light (REIL) ▪ Visual approach slope indicator (VASI) ▪ Precision approach path indicator (PAPI) ▪ Segmented circle ▪ Wind sock ▪ Localizer
Fuelling Systems	▪ Storage Tanks ▪ Piping and Valves ▪ Filter system ▪ Hoses ▪ Fuelling station
	Class
	OS/ASOS
	X telephony
Electrical Vault Equipment	▪ AFTN equipment ▪ VHF/UHF communications ▪ ATC consoles ▪ Standby generators ▪ Current Regulators ▪ Regulators ▪ Panels and Control Boards ▪ Lighting contactors ▪ HVAC System
Civil Infrastructure	▪ Security fencing ▪ Drainage culverts ▪ Pumping facilities
Critical Vehicles	▪ Fire trucks ▪ Fuel trucks ▪ FOD bosses ▪ Tugs
Landside	▪ Security Screening

Source: Draft terms of reference for Pacific Aviation Infrastructure Maintenance Support contract (Section VII – Work Requirements).

Outcomes

The success of the maintenance support contract will be measured against the following key outcomes:

- A systematic approach to preventive maintenance
- Reduced number of unplanned outages
- Rapid response and resolution of faults and outages where specialist support is required
- Rapid response and recovery from natural disasters
- Less downtime awaiting parts and spares
- Provision of specialist advisors to support local staff
- Effective knowledge transfer to local staff
- Effective use of local maintenance resources
- Robust maintenance funding forecasts and budgets
- Continuous compliance with regulatory requirements

For more information, contact **Satoshi Ogita,** Transport Specialist, the World Bank Group (sogita@worldbank.org)

6.3 Vanuatu Infrastructure Valuation

The Challenge

The Government of Vanuatu adopted accrual based IPSAS standards and in 2016 appointed consultants to help identify the major assets of the whole-of-government and to develop a strategy and policy to value them in accordance with IPSAS17 for the first time. To deliver a successful outcome, there were several issues and challenges that needed to be overcome, including the following:

- Limited understanding of the government's actual assets in terms of types and materiality
- Asset registers were incomplete, inaccurate, inconsistent, or required consolidation of multiple sources of different types of data
- Low levels of knowledge and capability to assess asset extent and value
- Lack of dedicated budget for the operational aspects of completing valuations (travel costs, etc.)
- Limited access to technology and physical tools
- Poor levels of communication and collaboration among the various departments

Scope of the Project

The Department of Finance and Treasury is the advisor to the Government on economic, financial, and regulatory policy. In 2016, the Asset Registry and Valuation division of DoFT embarked on a country-wide valuation of its entire infrastructure portfolio. The scope included:

a) Initial analysis and development of valuation strategy by a central Asset Management Valuation Unit (AMVU) with a high level of discussion and collaboration with key finance units and infrastructure entities.
b) A range of workshops, presentations and in-field training with the wider group including representatives of the key departments and Auditor-General's Office.
c) Detailed training on accounting standards and policy deferred for the AMVU.
d) Inspecting 100% of public infrastructure on all islands and asset classes. This included all buildings, roads, bridges, and other infrastructure.
e) Successful development of a project budget put together by AMVU and subsequently approved by DoFT. This provided for travel costs, etc. to enable the AMVU to undertake the physical inspections.
f) Provision of Windows-based tablets and a range of physical tools (such as measuring wheels, laser measuring devices, etc.), along with appropriate training in their use.
g) Sourcing appropriate staff from other agencies to form the AMVU field survey teams.



Outcomes

From start to finish, the project took 15 months and resulted in the successful valuation of all infrastructure assets. The outputs are to be incorporated into the whole-of-government accounts and financial statements for the following infrastructure:

- Land
- Road Infrastructure
- Drainage Infrastructure
- Wharves
- Information technology Infrastructure
- Energy Infrastructure
- Water Infrastructure
- Major plant and facilities
- Buildings (houses, education, health, government)

6.4 Kiribati Public Utilities Maintenance

The Kiribati Public Utilities SOE provides infrastructure service in energy, water, and sanitation.

Water Sector	Sanitation Sector	Energy Sector
4,641 urban properties are connected to the water reticulation network. The network is delivered through a distribution network measuring 184 km. It produces 597,000 m^3 per year. The GRC of water assets is $8.7 million, with an estimated life of 24 years.	2,376 sewer connections in residential and non-residential properties are served through a sewer network 58 km long. The network collects 253,000 m^3 of wastewater per year. The GRC of sanitation assets is $8.6 million with an estimated life of 4 years.	91% of Kiribati households on Tarawa have access to the power grid. The generators are small, generating 5 megawatts during peak demand. The load factor is 72%, indicating it is stretched during peak demand periods. Renewables constitute 8% of generated power. The GRC of energy assets is $47.5 million, with an estimated life of 30 years.

The Challenge

The Public Utilities Board (PUB) in 2017 raised $12.3 million in fees and charges, and received a $1.1 million government grant. Its total expenditure in 2017 was $14.7 million, leaving a deficit for the year of $1.2 million before abnormal items. It relied on a drawdown from the aid reserve to continue as a going concern. Kiribati has control over pricing: the government owns the power plant and has a controlling interest in the Kiribati Oil Ltd, which is the main retailer of transport fuels. Governance is also quite centralized, with senior local government positions filled by secondments from the national government. Power is sold to households for a subsidized price of 10c per kWh, recently reduced from 35c per kWh. Commercial and industrial users still pay the higher price.

Maintenance is a major challenge for the energy sector, with generators not being serviced in accordance with supplier warranty requirements. Only one-sixth of mandated maintenance for generators has been completed over the last 20 years. The current condition of the generators threatens protracted blackouts that could take over 12 months to rectify. The risk to the supply of electricity is extreme. With the generators offline for considerable periods of time, there will be flow-on consequences for the people, and the economy arising from the inability of government and the private sector to deliver services. PUB's maintenance-to-revenue ratio is low at 2.3%. Its maintenance cost ratio is 0.41%, similar to that of the Samoa Water Authority in 2018. The user cost recovery ratio is 83% of expenditure, indicating it cannot function only from user charges and will continue to rely on government and donor subsidies.

The operations and maintenance costs are 344% of its capital costs, assuming capital costs are fully funded by donor grants with no more call on PUB funds. Thus, for every capital project, PUB needs to generate 3.4 times the capital cost in future funding to cover resulting new operating and maintenance costs.

The main power plant in the eastern part of South Tarawa is around 20 years old, and relies largely on imported diesel, for which it pays $1.30 per liter. It consumes around 8M liters per annum. Power generation is not very efficient at around 3.8kWh per liter (i.e., costing around 35c/kWh). Substitution of biodiesel for imported diesel as a fuel for the power plant is not advisable, as this could damage the "O" rings which are an expensive component, so any use of biodiesel for power generation would have to be through a separate generator. PUB overhaul maintenance is 6 years overdue, and PUB is forecasting 12 months of severe load shedding.

Outcomes

The success for the maintenance of PUB assets will depend on:

- Successful delivery of current renewable energy and generator replacement projects.
- Governance improvements including the Financial Recovery Action Plan which aims to set appropriate tariffs for the business as well as establishing accrual accounting practices.
- Ability to comply with manufacturer's servicing conditions.
- The proportion of preventive maintenance being completed.
- Repairs and maintenance cost of sector assets.
- Physical description of sector assets.
- Improving the performance of engineering and planning.

6.5 Establishing a Maintenance Fund - Kiribati

The Challenge

A 2019 (Webb, Assessment of Kiribati Public Asset Management, 2019) review found the following challenges:

- "In Kiribati, the reconstruction of key infrastructure – particularly transport and energy infrastructure – has meant that other infrastructure improvements (such as hospitals and clinics) have not had the financial resources to go ahead."
- A "lack of preventative maintenance and minor repair has led to the significant degradation of capital, with a large portion of older infrastructure investments unserviceable well before the end of their design life. Indeed, many of the new investments over the past 5 years have simply restored the functionality of ageing or degraded capital rather than expanding the capital stock and broadening the delivery of services to the public."

In addition, local councils have limited funds to maintain local infrastructure:

- Resources available to maintain infrastructure and deliver council services are limited. For example, Arorae Island Council had, in 2018, an annual income of AUD297,720 to serve a population of 983 (Auditor General of Kiribati, 2020), or $303 per capita.

Scope of Infrastructure Maintenance Fund

A dedicated Infrastructure Maintenance Fund was established to meet future road and other infrastructure operational and maintenance costs. $2 million a year was appropriated in the 2019 budget. In 2020, it was raised to $2.5 million and, in the 2021 budget, to $6 million. The 140% increase over 2020 reflects the plan to include land transport and coastal protection infrastructure maintenance (Kiribati Government, 2020). As at the end of 2020, the fund had accumulated a balance of $31,406.

The Ministry of Infrastructure and Sustainable Energy is tasked to design, build, maintain, and monitor infrastructure investments, along with a responsibility to enforce the building act and develop and manage the energy sector. More specifically, the Ministry is tasked to implement a structured maintenance program to plan infrastructure improvements, and to better manage and maintain new and existing infrastructure; enhance and increase the supply and access to power and renewable energy sources; to enhance accessibility to adequate, safe, and sustainably managed water resources and sanitation. The above will be executed with close consideration of the limited domestic public financial resources available for infrastructure investment and limited institutional capacity to absorb and execute infrastructure investment (Kiribati Government, 2020).

Webb noted that "given the approximate $96 million invested in the reconstruction of just the South Tarawa Road network over the past 5 years and the additional $44.3 million scheduled for rebuilding the Betio causeway, it is unlikely that this funding will be sufficient to meet the significant infrastructure servicing needs of all major assets. With a limit on the expected long-term fiscal financing available to the government, adequate asset maintenance will significantly improve the infrastructure carrying capacity of the Kiribati national budget". (Webb, Preparing to graduate: Issues, challenges and strategies for Kiribati's LDC graduation, 2019).

Kiribati ports have assets of $45 million, and PUB $69.7 million. Given our data, the estimated operation and maintenance required on just these two projects would be approximately $27 million a year if all the assets have a 40-year life span; many, being plant and equipment, have a much shorter lifespan. Some of these funds are provided by Ports and PUB. $8 million is raised by Ports and $12 million by PUB, leaving a deficit of approximately $7 million per year to be funded annually by other sources.

Outcomes

The success of the Maintenance Fund will depend upon the following factors:

- The maintenance strategy to apply to the components of all infrastructure assets, of all ages.
- Preventive maintenance is scheduled in accordance with manufacturer's warranty requirements.
- Rehabilitation of assets is planned through development/capital budget processes.

6.6 Solomon Islands National Transport Fund

The Challenge

A review of the Solomon Islands National Transport Fund (NTF) in 2014 found that "needed maintenance and rehabilitation works (especially of roads) were not being carried out to the extent required". It found "The support that is currently being delivered is not well aligned with the current requirements of the NTF Board and Ministry of Infrastructure Development and is not focused on the achievement of the targets for maintenance and rehabilitation works. Substantial adjustments are required to make the support more effective" (Solomon Islands Government ADB and DFAT, 2014).

In response, it recommended that "Infrastructure maintenance (including emergency works) should always be the top priority for NTF's expenditure, followed by rehabilitation and then new works". The National Transport Plan (NTP) 2017-2036 identified a need for multi-year funding agreements, as well as to increase the recurrent budget allocation to maintenance to free up capital funding for new investment. It confirmed that maintenance is the highest priority of the Ministry of Infrastructure Development.

Scope of the National Transport Fund

NTF priorities are guided by the National Development Strategy that provides a 20-year strategic framework to guide development in the Solomon Islands. NTF was established as a special fund for the purposes of maintaining, developing, and managing (air, land, and sea) transport infrastructure in Solomon Islands. It serves as a mechanism for the government and development partners to fund the transport sector. The NTP contains a priority list of projects selected as part of the NIIP using multi-criteria analysis. Essential expenditure includes the maintenance of the road, maritime, and air infrastructure, and the maintenance of maritime navigational aids. It was noted that it was desirable to maintain air navigational aids and to expand these infrastructures.

The NTP noted it is directed only at planned infrastructure investments. Maintenance is a recurrent activity, considered separately in the Medium-Term Transport Action Plan. However, maintenance of existing infrastructure, including projects newly built under this plan, will likely consume a very large share of Solomon Islands' available resources for many years to come. That share will be ever greater if appropriate maintenance is deferred and not provided and sustained.

Key activities to be undertaken from the SBD$45 million appropriated in the 2021 budget include:

- Ongoing maintenance and rehabilitation of:
  - Honiara Road improvement program.
  - Maintenance of Provincials Roads.
- Rehabilitation of wharves and bridges.
- Emergency Disaster Relief.
- Technical Training, Institutional Strengthening.

Strategic considerations are:

- Transport safety
- Environmental and social safeguards
- Land Acquisition and Resettlement
- Climate change resilience
- Transport maintenance
- Gender equality
- Transport Sector Inventory.

Outcomes

The success for the maintenance of transport assets will depend on:

- A common set of criteria being applied to prioritize the maintenance of all infrastructure.
- The cost-benefit of maintaining an asset/not maintaining an asset be determined by Ministry of Finance.
- Funds be allocated to the NTF to optimize the benefit from current infrastructure and, where necessary, applied to replace infrastructure no longer viable to maintain.
- Preventive maintenance is given priority over the acquisition of new assets.
- Recurrent budget funding is allocated to maintenance in accordance with the overall prioritized multi-year schedule.

APPENDIX A

ACCOUNTING STANDARDS AND THEIR RELATIONSHIP TO INFRASTRUCTURE

This appendix explains the different accounting standards being applied by the various entities responsible for the maintenance of infrastructure in all six sectors across the 14 Pacific Island Countries.

A.1 Cash versus Accrual Accounting

A.1.1 Cash Accounting

Entities that use **cash accounting**, for example, the Ministry of Infrastructure Development in the Solomon Islands, account for transactions finalised through their or the government's bank accounts. Financial assets are those held in bank accounts or equivalents. They can be turned into cash within twelve months. Only Financial Assets are reported by entities using cash accounting. For example, the Solomon Islands National Transport Fund, established as a special fund for the purposes of maintaining, developing and managing transport infrastructure in Solomon Islands, reports annual cash movements through the Development Budget and the Recurrent Budget of the Solomon Islands Government.

It is difficult to account for the fixed assets cash accounting entities hold. They report only for the cash paid to acquire those assets in the year the cash is paid out. When PICs receive assets through grants from donors, for example a project that electrified an area of town, they often do not record the assets that were passed into their responsibility at the end of the project. And they often did not know whether they had sufficient cash to pay to maintain those assets in the future.

Entities using cash accounting do not record the full value of their infrastructure assets or account for the annual depreciation expense. Their financial statements lack the information needed to ascertain the full value of infrastructure and rate at which it depreciates.

A.1.2 Accrual Accounting

Entities using **accrual accounting** account for all obligations and uses of resources during the financial year, whether or not the expense has been paid out of the bank accounts (accounts payable is reported) or whether the income has yet been received in the bank (accounts receivable are accounted for.) Using accrual accounting, entities can report non-current assets and liabilities as well. The accrual based financial statements include a Statement of Financial Performance, a Statement of Financial Position and a Cash Flow Statement. See for example, the financial statements of Fiji Ports Corporation Ltd (FPCL).

The Statement of Financial Position reports assets as current assets, which can be converted to cash in one year or less; and non-current or long-term assets, which cannot. Non-Current assets include infrastructure,

When governments began implementing **accrual accounting**, they started to record the assets they held, and they started to recognize non-cash costs, for example the value of assets used up during the year. This led them to identify how much it will cost them to replace the assets in the future. This brought their attention to the cost they were incurring by not maintaining them regularly. Once they valued assets, like infrastructure, they realized that it would be cheaper to maintain them regularly and to retain their value to the community over a longer period of time, than to let them run down quickly and hope a donor would help the government to replace them. The information on the value of infrastructure is reported in the financial statements of SOEs. SOEs prepare financial statements using accounting standards accepted throughout the world.

Entities using accrual accounting are more likely to have the information we need for this study in their financial statements.

A.2 Accounting Standards

Accounting Standards are a set of principles that entities follow when they prepare and publish their **financial statements**. Harmonized accounting standards, in use by entities throughout the world, arise from the conviction that transparency provided by high-quality financial reporting standards contributes significantly to sound economic growth (IFAC, 2021). There are different accounting standards for entities that make a profit and for governments, for small and medium enterprises and for charities.

When accounting for infrastructure, PICs use the standards for profit making entities (**IFRS**) and public sector standards (**IPSAS**). Publicly accountable entities, such as corporations or SOE/GOE's[4] are legally required to publish their financial statements in accordance with agreed accounting standards.

Currently, the following accounting standards are in use by PICs and are described in the sections below:

1. International Financial Reporting Standards (IFRS) for SMEs
2. International Public Sector Accounting Standards (IPSAS) (both cash and accrual)
3. Standards issued or adopted by national professional accounting bodies (e.g., Fiji Institute of Accountants issues Fiji Accounting Standards almost entirely predicated on IFRS)
4. U.S. Governmental Accounting Standards, which are applicable to state and local government accounting and financial reporting, including insular area governments.

A.2.1 International Financial Reporting Standards (IFRS)

The International Financial Reporting Standards (IFRS) are accounting standards issued by the IFRS Foundation and the International Accounting Standards Board (IASB). They constitute a standardized way of describing an organization's financial performance and position so that company financial statements are understandable and comparable across international boundaries. IFRS are global accounting standards that provide high quality transparent and comparable information in general purpose financial statements[5]. IFRS are designed to apply to the general-purpose financial statements and other financial reporting of profit-oriented entities (IFRS, 2021). IFRS for Small and Medium Enterprises (SMEs) are the standards adopted by some SOEs in PICs, for example, Airports Vanuatu Limited.

The conceptual framework of IFRS defines assets and liabilities, revenue and expenses and when and how to recognize them in general purpose financial statements. A statement of financial position (previously called a balance sheet) is a financial statement that reports a company's assets, liabilities, and shareholders' equity at a specific point in time and provides a basis for computing rates of return and evaluating its capital structure. It

[4] Entities where the government or state has significant control through full, majority, or significant minority ownership.

[5] The objective of general-purpose financial statements is to provide financial information about the reporting entity that is useful to existing and potential investors, lenders, staff, suppliers, other creditors, and the media in making decisions relating to providing resources to the entity (IFRS, 2021). General purpose financial statements are prepared by reporting entities to meet the information needs common to users who are unable to command the preparation of reports tailored to satisfy, specifically, all of their information needs.

is a financial statement that provides a snapshot of what an entity such as an SOE owns and owes, as well as the amount invested in it by the government and other shareholders. Of relevance to this report, SOEs applying IFRS measure the infrastructure they use to deliver services and revalue assets every three to five years. COVID has made it difficult for SOEs to comply with this requirement.

Accounting for 'Fixed Assets' under IFRS

Infrastructure managed by SOEs is considered a fixed asset of that entity if it generates service potential or an income stream in the future and it is controlled by the SOE. Most SOEs are controlled by the government, who hold them as steward for the people of the PIC. For example, Infrastructure Cook Islands holds a portfolio of SOEs. In PNG the assets of SOEs are vested in the Government Business Trust (GBT), managed by the Independent Public Business Corporation (IPBC). Like in the Cook Islands and PNG, SOEs control the infrastructure, and they are, in turn, fully owned by the government. Others lease the infrastructure from the government, which, in turn, reports it as an asset of the government. For example, Majuro Water and Sewer Co. in the Marshall Islands.

Infrastructure is reported as a Non-Current, Long-Term Fixed Asset:

- Fixed assets are items, such as property, equipment or infrastructure, an SOE plans to use over the long-term to deliver services and to generate income.
- Fixed assets are most commonly referred to as property, plant, and equipment (PP&E) on the balance sheet.
- Fixed assets are subject to depreciation to account for the *loss in value as the assets are used*.

In summary, under IFRS, infrastructure is considered a non-current long-term fixed asset, and as such its value and annual depreciation should be accounted for in the Statement of Financial Position. State-owned enterprises with legislated stewardship responsibilities to manage infrastructure, report the value of the infrastructure in their financial statements. These entities are most likely to report the information we need for this study in their financial statements.

A.2.2 International Public Sector Accounting Standards (IPSAS)

International Public Sector Accounting Standards (IPSAS) are the benchmark for financial reporting in the public sector and the means for governments to signal their commitment to transparency (IFAC, 2021). IPSAS are accounting standards issued by the IPSAS Board (IPSASB). The IPSASB issues IPSASs dealing with financial reporting under the cash basis of accounting and the accrual basis of accounting. The method of accounting used by public sector entities is determined by the method used in the Annual Budget.

IPSAS Accrual standards are international accrual-based accounting standards, for use by governments and other public sector entities around the world. The accrual IPSASs are based on the IFRSs, issued by the International Accounting Standards Board (IASB) where the requirements of those Standards are applicable to the public sector: national / local governments and related governmental entities (e.g., agencies, boards and commissions). They also deal with public sector specific financial reporting issues that are not dealt with in IFRS.

IPSAS Cash Basis of Accounting (IPSAS Cash) standards set out the requirements which are applicable to all public sector entities preparing general purpose financial statements under the cash basis of accounting. It defines the cash basis of accounting, establishes requirements for the disclosure of information in the financial statements and supporting notes, and deals with a number of specific reporting issues.

IPSAS Modified Cash standards contain accounting policies and disclosures additional to IPSAS Cash that a public sector entity is encouraged to adopt to enhance the usefulness of its financial statements for accountability and decision-making purposes and to support its transition to the accrual basis of financial reporting and adoption of accrual IPSAS.

A.2.3 Financial Statements

IPSAS Accrual requires an entity (whether the whole of government or an individual SOE) to prepare and present financial statements which include the following components:

1. Statement of financial position
2. Statement of financial performance
3. Statement of changes in net assets/equity
4. Cash flow statement
5. When the entity makes publicly available its approved budget, a comparison of budget and actual amounts either as a separate additional financial statement or as a budget column in the financial statements
6. Notes, comprising a summary of significant accounting policies and other explanatory notes; and
7. Comparative information in respect of the preceding period.

Most IPSASs consist of International Financial Reporting Standards (IFRSs) that are modified to meet the needs of the public sector. Public sector specific IPSASs were also developed to address the following:

- Disclosure of financial Information about the general government sector
- Revenue from non-exchange transactions (taxes and transfers)
- Presentation of budget information in financial statements
- Service concession arrangements - grantor
- First time adoption of accrual basis IPSASs
- Public sector combinations
- Social benefits. (INTOSAI, 2021)

Accounting for 'Fixed Assets' under IPSAS

IPSAS Accrual requires entities to account for Infrastructure, Plant and Equipment as part of the Non-Current Assets in the Statement of Financial Position. See Government of the Cook Islands Financial Statements. IPSAS Modified Cash budgets are prepared by functional classification. Financial statements prepared using IPSAS Modified Cash standards (also called Elementary Accrual) generally report long-term fixed assets on an accrual basis and short-term assets on a cash basis. For example, Tuvalu Government Financial Statements for the year ended 31 Dec 2018 changed its accounting policies to report using IPSAS Modified Cash. However, given the transition has just begun, for now, property, plant and equipment, and public entities' net assets have been excluded from the Statement of Financial Position. See also Republic of Palau Financial Statements.

IPSAS Cash reports only cash movements during the year, authorized through the recurrent and development budgets. In addition, any grant funds received directly from donors, or managed by donor project management units, and not included in the government budget, may not be reported. While public financial legislation generally requires departments and related public sector entities to record basic inventories, many PIC governments are still preparing complete asset registers of public assets held, including infrastructure. Asset registers generally record descriptions of infrastructure, for example kilometers of road by type (paved, unpaved) rather than a complete record of all components of the infrastructure and the cash spent to achieve those assets.

In summary, government organizations using IPSAS Accrual are required to account for the value and annual depreciation of non-current fixed assets (infrastructure) in the Statement of Financial Position. These entities are likely to report the information we need for this study in their financial statements.

A.2.4 US Generally Accepted Accounting Principles (GAAP), GASB

The Governmental Accounting Standards Board (GASB) was established in 1984. The GASB works to improve financial accounting and reporting standards for US state and local governments. One of the GASB's statements, number 34, issued in June 1999, requires government entities to report infrastructure assets in their statement of net assets. One of the objectives of the government-wide financial statements issued using

GASB is to understand the extent of government investment in capital assets, including roads, bridges, and other infrastructure assets.

Most US governmental utilities and private sector companies use accrual accounting. Such statements prepared using US GAAP, measure not just current assets and liabilities but also long-term assets and liabilities (such as capital assets, including infrastructure, and general obligation debt). It also reports all revenues and all costs of providing services each year, not just those received or paid in the current year or soon after year-end. See, for example, the financial statements of the Federated States of Micronesia.

In summary, government organizations using US GAAP (GASB) are required to account for the value and annual depreciation of long-term fixed assets (infrastructure) in the Statement of Financial Position. These entities are likely to report most of the information we need for this study in their financial statements.

A.2.5 National Accounting Standards – superseded by IFRS

Of the fourteen PICs reviewed, Fiji and PNG have national accounting professional bodies that do, or did, issue national accounting standards. The Papua New Guinea Accounting Standards Board is committed to IFRS and requires all publicly listed companies to comply with IFRS. The government of PNG will require endorsement of new IFRS Standards are they are issued. The Fiji Institute of Accountants has adopted IFRS standards for all accounting periods beginning 2007. The IFRS for SMEs were adopted from 2011.

APPENDIX B

NATIONAL AND SECTOR METRICS

B.1 Introduction

The geography and demographics of the Pacific have a major impact on infrastructure needs and challenges. Most of the PICs have a small land mass, are located in a relatively isolated part of the world and have limited natural and human resources to deliver and maintain complex infrastructure. With small populations, slow economic growth and a trade deficit, the ability to sustainably fund infrastructure is a challenge. Additional challenges to maintaining infrastructure arise from providing infrastructure services to a high proportion of PIC populations living in low lying coastal areas, from the increasing frequency of natural disasters, and the other impacts of climate change.

The sections below present key comparison metrics representing the geographic, environmental, economic, and social situation across PICs.

B.2 National Demographic Metrics

Demographic measures are reasonably commonplace in infrastructure assessment reports as they infer the populations' demand for services. Urban areas receive higher standards of infrastructure services (for example, sewer and water reticulation) due to the density of dwellings. These services can be delivered more efficiently when properties are more compact and densely populated as is the case in urban environments. Where populations, and by consequence infrastructure, are in low-lying coastal areas, we see a higher exposure to the impact of climate change and natural disasters. Storm events, sea-level rise, erosion, marine corrosion, and tsunamis all put an increased burden on the maintenance of coastal infrastructure.

Table B.1. Demographic metrics (2020)

Country	Pop.[1]	Land Area[2]	Pop. Density[3]	Urban Pop.[4]	Coastal Pop.[5]
Melanesia					
Fiji	894.9	18,270	49	59%	27%
Papua New Guinea	8,934.5	452,860	20	13%	8%
Solomon Islands	712.1	27,990	25	23%	65%
Vanuatu	294.7	12,190	24	24%	64%
Micronesia					
Kiribati	118.7	810	147	56%	100%
Federated States of Micronesia	105.5	700	151	21%	89%
Marshall Islands	54.6	180	303	70%	100%
Nauru	11.7	20	584	100%	93%
Palau	17.9	460	39	99%	93%
Polynesia					
Cook Islands	15.3	240	64	75%	91%
Niue	1.5	260	6	46%	25%
Samoa	198.6	2,830	70	18%	61%
Kingdom of Tonga	99.8	720	139	24%	84%
Tuvalu	10.6	30	353	62%	100%

Source: SPC Statistics for Development Division (SDD), population density dataset 2020 year
https://www.unescap.org/sites/default/d8files/knowledge-products/SDD-PS-data-sheet-2020-v6-1.pdf

Notes:

1. *Population in thousands*
2. *Land area in square kilometers*
3. *Population density, people per square kilometer*
4. *Percent of population living in urban areas*
5. *Percent of population living within 1km of coast*

Infrastructure services are generally more concentrated in urban areas, with roads, wharves and airfields connecting rural and urban peoples. Including PNG, 19% of the peoples of PICs live in urban areas, with 81% living in rural areas with limited access to infrastructure services. Excluding PNG, 61% of PIC peoples live in rural areas and 39% in urban areas with access to some infrastructure services.

B.3 National Economic Metrics

Governments are finding it challenging to fund the maintenance of an ever-growing stock of infrastructure. Government's tax revenues may not be growing sufficiently to fund the added operating and maintenance costs required of existing and new infrastructure. The core economic indicators/metrics represented below provide a broad country-level overview of the economic health across PICs and the respective challenges they face funding an ever-growing stock of infrastructure.

Table B.2. Economic metrics

Country	GDP (USD) [1]	GDP per Capita [2]	Tax Rev. % GDP [3]
Melanesia			
Fiji	5,483	6,152	17.7
Papua New Guinea	24,960	2,854	13.0
Solomon Islands	1,599	2,296	22.9
Vanuatu	939	3,259	17.7
Micronesia			
Kiribati	181*	1,631	24.9
Federated States of Micronesia	402*	3,831	19.2
Marshall Islands	237	4,338	17.4
Nauru	133*	11,667	30.5
Palau	280	15,649	20.9
Polynesia			
Cook Islands	379	24,908	-
Niue	30*	18,680	-
Samoa	846	4,284	-
Kingdom of Tonga	508	5,077	-
Tuvalu	44	4,192	-

Source: Pacific Region Infrastructure Facility (PRIF), Pacific Community (SPC). (2021). Review of Economic Infrastructure in the Pacific (PIPIs).

Notes:

1. *Nominal GDP in million US dollars for 2019*
   ** 2019 figures were not available for all PIC's so the following were used, Kiribati (2016), FSM, Nauru, Niue (2018)*
2. *GDP (USD) per person using latest reported GDP and reported population for that year ()*
3. *Tax revenue as percent of GDP (Source: World Bank Group performance indicators for 2019). Not all countries reported. '-' not available or not reported*

B.4 Sector Level Metrics

Sector level metrics provide a consistent set of measures that allow the extent of infrastructure to be compared within sectors and across countries. In addition to providing insight of the relative extent of infrastructure, the metrics also help to normalize financial reporting measures for the purpose of comparison (for example, maintenance spend per kilometer of road).

The sector level statistics presented in the subsequent tables are primarily sourced from regional datasets and online publications.

B.4.1 Roads Sector Metrics

The road network in the PICs is important for both economic and social development, including access to markets and services such as government offices, educational and health facilities. Key summary metrics for the sector are presented below:

Table B.3. Roads sector metrics

Country	Network Length [1]	% Sealed [2]	# Registered Vehicles [3]	Network Density [4]
Melanesia				
Fiji	3,440	49%	119,960	19
Papua New Guinea	8,740	39%	100,993	2
Solomon Islands	1,494	12%	-	5
Vanuatu	2,911	10%	-	24
Micronesia				
Kiribati	800	17%	3,706	99
Federated States of Micronesia	388	47%	-	55
Marshall Islands	2,028	4%	-	1,127
Nauru	30	80%	-	150
Palau	125	71%	7,592	27
Polynesia				
Cook Islands	295	70%	-	123
Niue	234	90%	-	90
Samoa	2,340	50%	25,235	83
Kingdom of Tonga	680	27%	-	94
Tuvalu	8	100%	-	27

Source: Pacific Region Infrastructure Facility (PRIF), Pacific Community (SPC). (2021). Review of Economic Infrastructure in the Pacific.

Notes:

1. *Total road network in kilometers (kms)*
2. *% of network that is paved/sealed*
3. *Number of motor vehicles registered*
   ** Latest records in PIPI dataset Kiribati, FSM, PNG and Samoa (2016), Fiji and Palau (2018)*
4. *Total length of road divided by land area (km/100sq.km)*

General Observations and Notes

- The total road network across the PICs is estimated to be approximately 46,847 kilometers, the majority of which is in Melanesia.
- The network density highlights that not all countries are reporting road lengths consistently. Some include local access roads (for example, RMI) and some only report the main network (for example, PNG figures do not include the ~21,000km of subnational roads)
- Motor vehicle registration data is a strong indicator of road usage however, the PIPIs benchmark database holds little recent information as good records are not publicly available.
- Countries with a very low network density generally have a large land mass or a lot of inaccessible land (for example, PNG, Solomon Islands and Vanuatu). Countries with higher network densities generally have a smaller land mass (for example, Nauru). In addition, higher population density tends to be positively correlated with higher network density (for example, Marshall Islands)
- The statistics are provided by the main transport departments in each country so may miss access roads and outer island networks. The entities who have provided data to PRIF are: Fiji Roads Authority (FIJ; Department of Transport & Infrastructure (PNG); Ministry of Infrastructure Development (SOL); Public Works Department (VAN); Ministry of Public Works and Utilities (KIR); Pohnpei Transport Authority, Chuuk State Government, Kosrae State Department of Transportation, and Yap State Public Works Department (FSM); Ministry of Works, Infrastructure and Utilities (RMI); Department of Transport (NRU); MPIIC, Bureau of Public Works (PLW); Infrastructure Cook Islands (COK); Land Transport Authority (WSM); Ministry of Works (TON); Public Works Department TUV).

B.4.2 Airport Sector Metrics

Aviation services are crucial for economic and social development in the Pacific – including international business, tourism, transport of certain kinds of freight, and access to medical expertise. There are at least 25 airlines operating internationally in and out of the PICs, as well as those servicing domestic travel routes (Pacific Region Infrastructure Facility (PRIF), Pacific Community (SPC), 2021). Key summary metrics for the sector are presented below:

Table B.4. Airport sector metrics

Country	# Airports [1]	# Sealed [2]	International Flights/wk. [3]	Passenger Seats/Wk. [4]
Melanesia				
Fiji	32	4	139	27,001
Papua New Guinea	578	27	60	8,818
Solomon Islands	37	3	20	2,815
Vanuatu	29	3	37	4,831
Micronesia				
Kiribati	24	4	9	1,060
Federated States of Micronesia	13	6	12	1,860
Marshall Islands	30	4	10	1,515
Nauru	1	1	7	927
Palau	3	1	17	2,671
Polynesia				
Cook Islands	11	1	19	4,414
Niue	1	1	2	335
Samoa	4	1	48	5,557
Kingdom of Tonga	6	1	18	2,971
Tuvalu	1	1	4	238

Source: Pacific Region Infrastructure Facility (PRIF), Pacific Community (SPC). (2021). Review of Economic Infrastructure in the Pacific
Notes:

1. *Total number of domestic and international airports across all islands*
2. *Number of airports with paved runways*
3. *Total number of inbound international flight arrivals per week (on average) – reported for 2019*
4. *Estimated number of available passenger seats per week (on average based on aircraft capacity and number arriving) – reported for 2019*

** Latest records in PIPI dataset 2019*

General Observations and Notes

- There are around 770 airports across the Pacific with 88% of these in Melanesia (75% in PNG).
- 7% of airports have sealed pavements. All international airports have sealed runways along with 32 domestic airports (72% PNG)
- The international passenger arrival numbers were reported for 2019 (pre-COVID numbers)
- The entities who have provided data to PRIF are: Airports Fiji Limited (FIJ); National Airports Corporation Limited (PNG); Civil Aviation Authority of Solomon Islands (SOL); Airports Vanuatu (VAN); Ministry of Communications Transport and Tourism Development (KIR); Pohnpei, Chuuk, Kosrae, and Yap International Airports (FSM); Marshall Islands Airport Authority (RMI); Department of Civil Aviation (NRU); MPIIC, Bureau of Aviation (PLW); Airport Authority Cook Islands (COK); Samoa Airport Authority (WSM); Tonga Airports Ltd (TON); Department of Civil Aviation (TUV).

B.4.3 Port Sector Metrics

Most trade with countries outside the Region is achieved through international shipping, with cargo such as agricultural and marine products travelling to Asia, Australia, Europe, New Zealand, North America and elsewhere. Imports include petroleum products, manufactured goods, machinery and other equipment, medical and chemical goods, tobacco, processed food and beverages. In addition, over the 10 years prior to the Covid-19 pandemic, the cruise industry grew enormously with increasing numbers of ships and visits to Pacific Island Countries. Key summary metrics for the sector are presented below:

Table B.5. Port sector metrics

Country	# International Ports [1]	Container Units (TEU) [2]
Melanesia	**39**	**689,552**
Fiji	5	145,782
Papua New Guinea	18	338,300
Solomon Islands	14	128,035
Vanuatu	2	77,435
Micronesia	**12**	**129,771**
Kiribati	3	52,100
Federated States of Micronesia	4	25,234
Marshall Islands	3	30,711
Nauru	1	5,327
Palau	1	16,399
Polynesia	**8**	**117,331**
Cook Islands	2	8,106
Niue	1	-
Samoa	1	27,221
Kingdom of Tonga	3	76,854
Tuvalu	1	5,150

Source: Pacific Region Infrastructure Facility (PRIF), Pacific Community (SPC). (2021). Review of Economic Infrastructure in the Pacific (PIPIs).

Notes:

1. *Number of international ports in operation*
2. *Number of 20ft equivalent units (TEU) of goods moving through ports per year (https://data.worldbank.org/indicator/IS.SHP.GOOD.TU)*

General Observations and Notes

- There are around 59 major shipping ports across the Pacific with 66% of these in Melanesia.
- 74% of freight volume across the Pacific is in Melanesia (TEU's).
- There are a considerable number of domestic wharfs and portages not included in the above statistics.
- The chronic difficulties with port infrastructure maintenance in the Pacific are widely acknowledged and have been frequently reported in previous studies. The Pacific Regional Transport Study (AusAID, 2004) noted that "A lack of maintenance was noticeable in many ports".
- The entities who have provided data to PRIF are: Fiji Ports Corporation (FIJ); PNG Ports Corporation (PNG); Solomon Island Port Authority (SOL); Department of Ports and Marine (VAN); Kiribati Port Authority (KIR); Pohnpei Port Authority, Chuuk Transportation and Public Works Dept, Kosrae Ports Authority and Yap State Public Works Department (FSM); Marshall Islands Port Authority (RMI); Marine Department (NRU); Port of Malakal (PLW); Cook Islands Ports Authority (COK); Ministry of Infrastructure (NIU); Samoa Port Authority (WSM); Ports Authority of Tonga (TON); and Department of Marine and Port Services (TUV).

B.4.4 Water/Sanitation Sector Metrics

Water and Sanitation is crucial to health and well-being of current and future generations. The Pacific region lags behind other parts of the world in terms of water, sanitation and hygiene development. It relies far more heavily on surface water than other parts of the world. Approximately 52% of the population do not yet have access to basic drinking water and 69% do not have basic sanitation. Importantly, improvements have not yet kept pace with population growth so that the situation has remained static for more than two decades. Key metrics for the sector are presented below.

Table B.6. Water/Sanitation sector metrics (2019*)

Country	Water Connect. [1]	Water Piped [2]	Water Prod. [3]	Sewer Connect. [4]	Sewer Piped [5]	Sewer Collect. [6]
Melanesia						
Fiji	162,595	4,025	131,898	30,852	811	21,243
Papua New Guinea [7]	48,289	1,346	90,770	19,447	649	26,721
Solomon Islands	11,099	324	12,854	762	36	513
Vanuatu [7]	12,650	316	9,167	-	-	-
Micronesia						
Kiribati	4,641	184	597	2,376	58	253
Federated States of Micronesia [7]	2,095	122	2,026	1,180	46	807
Marshall Islands	1,561	116	439	2,498	17	n.a.
Nauru	-	-	211	-	-	-
Palau	-	-	-	-	-	-
Polynesia						
Cook Islands	3,800	150	21	-	-	-
Niue	-	-	-	-	-	-
Samoa	30,001	1,253	25,436	114	11	221
Kingdom of Tonga	11,964	262	4,167	-	-	-
Tuvalu	1,400	-	28	0	0	80

Source: International Benchmarking Network Water and Sanitation Utilities, provided by PWWA, 2019 statistics unless otherwise stated.
Notes:

1. *Total number of properties connected to water reticulation network.*
2. *Total length of the distribution network (excluding transmission lines and service pipes) in kilometers.*
3. *Total volume of water produced for the service area, that is, leaving treatment works and purchased treated water, if any x 1,000 m3/year.*
4. *Total number of sewer connections (residential and non-residential).*
5. *Total length of the sewerage network (excluding service connections) in kilometers.*
6. *Volume of wastewater collected through the sewer system or by tanker x 1,000 m3/year.*
7. *PNG metrics for Eda Ranu and Water PNG combined. Vanuatu metrics for Dept. of Water and UNELCO combined (2018). FSM metrics for Chuuk, Yap and Kosrae combined.*

'-' not available in PWWA database (unlikely to be zero), '0' reported as zero

General Observations and Notes

- Most water and sewer networks are managed by a single entity.
- There are gaps in the Pacific Water and Wastewater Association (PWWA) database because some utilities did not participate in 2018/2019.
- The statistics are provided by the main W&WW utilities in each country so may miss private schemes and outer island services. The utilities who have provided data to PPWA are: Water Authority of Fiji (FIJ); Water Papua New Guinea and Eda Ranu (PNG); Solomon Water Authority (SOL); UNELCO and Department of Water (VAN); Public Utilities Board (KIR); Central Yap State Public Service, Pohnpei Utilities, Kosrae Utilities, and Chuuk Public Utilities (FSM); Majuro Water & Sewerage (RMI); Nauru Utilities (NRU); Palau Water and Sewerage (PLW); To Tatou Vai (COK); Public Works Department (NIU); Samoa Water Authority (WSM); Tonga Water Board (TON); Public Works Department (TUV).

B.4.5 Energy Sector Metrics

Improving energy sector infrastructure and service delivery is a key priority and a key challenge for PICs. There are a range of energy producers, types of energy products and end users throughout the Pacific. Given the lack of reserves (apart from PNG) there is heavy reliance on imported fuel with long supply chains and transshipment making the fuel expensive. In turn, Pacific countries mostly cannot achieve cost effective economies of scale that would be typical for power utilities elsewhere (for example, in procurement of equipment, storage of fuel, and power generation).

Table B.7. Energy sector metrics (2019*)

Country	Urban Power Grid Access [1]	Peak Demand [2]	Load Factor [3]	Renewable Percent [3]
Melanesia				
Fiji	96%	160	-	62%
Papua New Guinea	47%	256	64%	38%
Solomon Islands	57%	16	64%	2%
Vanuatu	64%	12	61%	11%
Micronesia				
Kiribati	91%	5	72%	8%
Federated States of Micronesia	68%	12	74%	-
Marshall Islands	99%	11	-	-
Nauru	99%	5	79%	3%
Palau	99%	13	77%	2%
Polynesia				
Cook Islands	99%	5	71%	15%
Niue	100%	1	-	-
Samoa	98%	28	-	46%
Kingdom of Tonga	98%	10	69%	10%
Tuvalu	100%	1	71%	8%

Source: Pacific Power Association, Benchmarking Portal (https://www.ppa.org.fj/benchmarking-portal/) annual benchmark reports
Notes:

1. *% of households with access to power grid*
2. *Peak Demand (Megawatts) is an indication of the utility size (<5 Megawatt (MW) - small, 5-30 medium, > 30 large)*
3. *Load Factor (%) is the annual generation Megawatt hours (MWh) divided by the peak hourly demand (MW)*8,760hr. Higher load factors indicate the network may be stretched during peak access times.*
4. *Annual renewable energy (MWh) divided by total electricity produced (2018/19)*

'-' not available in PPA database (unlikely to be zero)

General Observations and Notes

- There has been a significant investment in renewable energy and solar power farms across the Pacific. These facilities are distributed across many outer islands and often managed by local island councils or government entities and hence are not yet accurately reported in the production figures above.
- While households in Polynesia rely almost entirely on grid connections, access to the grid is not as widespread in the other two sub-regions. In almost half of the PICs off-grid power is 5% or less of the total energy mix. However, across the region, it equates to a (weighted) average of 30% of households that have off-grid electrification with high levels in Kiribati, the Solomon Islands, PNG and RMI.
- The statistics are provided by the main energy utilities in each country so may miss private schemes and outer island. The utilities who have provided data to PPA are: Energy Fiji Limited (FIJ); PNG Power Ltd (PNG); Solomon Power (SOL); UNELCO Vanuatu Limited (VAN); Public Utilities Board (KIR); Yap State Public Service Corporation, Pohnpei Utilities Corporation, Kosrae Utilities Authority, and Chuuk Public Utility Corporation (FSM); Kwajalein Atoll Joint Utility Resources and Marshall Energy Company (RMI); Nauru Utilities Corporation (NRU); Palau Public Utilities Corporation (PLW); Te Aponga Uira O Tumu - Te-Varovaro (COK); Niue Power Corporation (NIU); Electric Power Corporation (WSM); Tonga Power Limited (TON); Tuvalu Electricity Corporation (TUV).

B.4.6 Solid Waste Sector Metrics

Countries in the Pacific face significant challenges in developing and maintaining sustainable solid waste management systems, with limited land. Most landfill sites are near the coast making them vulnerable to extreme weather events. Leachate and other waste can leak from the sites, polluting freshwater sources as well as the ocean. There are a variety of waste management techniques used within and across PICs. Progress has been steady with all countries now having some type of legislation, strategy or plan for the management of waste. Most have user pays schemes for rubbish collection or disposal. Recycling and repurposing are now established processes. In urban areas solid waste collection is generally undertaken by local councils or private contractors. All imports contain some packaging which needs to be disposed of after use. The cost for this disposal is borne mainly by users and local councils. This includes the disposal of hazardous waste, shipping waste and liquid waste.

Table B.8. Waste Management Sector Metrics

Country	Waste Generation Rate (1)			Waste Disposal in PICs		
	Household Waste	Commercial Waste	Total Urban MSW	Temporary Unregulated Dumps	Authorized Open Dumps	Quantity of Asbestos stockpiles
	Kg/p/day	Kg/m^2/day	Kg/p/day	Number	Number	sq. (2)
Regional Actual						**187,891**
Melanesia						
Fiji (Nadi)	0.4		1.9	1	4	2,305
PNG, Port Moresby	0.36	0.09		>21	-	
SOL, Honiara	0.9	0.09 *kg/p/day*		ND	>3	3,150
VTU, Port Vila	0.4			ND	-	19,330
Micronesia						
Kiribati				ND	ND	39,992
FSM				20	14	3,557
Marshall Islands	0.4		1.1	1	1	860
Nauru				ND	ND	52,874
Palau				10	2	2,514
Polynesia						
Cook Islands				ND	10	6,520
Niue				-	3	46,428
Samoa	0.4	0.01		ND	-	5,260
Tonga / Vava'u	0.5			ND	-	4,850
Tuvalu				ND	9	251

Source: SPREP. (2016). Cleaner Pacific 2025: Pacific Regional Waste and Pollution Management Strategy 2016-2025. Apia, Samoa: SPREP. Retrieved from https://www.sprep.org/attachments/Publications/WMPC/cleaner-pacific-strategy-2025.pdf

(1) Waste Generation and composition in selected PICs

(2) Table 10 Confirmed Asbestos-Containing Materials in PICs

General Observations and Notes

- There is limited data available, including on the number and type of waste disposal facilities in PICs. Some landfill sites have expected useful lives of 70 years, while others are already at capacity.
- The "Cleaner Pacific 2025 Strategy" contains data as well as goals for PICs. The 2025 goal for Asbestos stockpiles is 131,500m3. The current reported total is 187,891m3, excluding PNG
- The PRIF has prepared a methodology for the audit of solid waste management.
- A number of PICs have prepared Waste Management Strategies.
- Many of the data available are from local council sites, and thus there is limited collated national data. For example, there is no indication of the number of official landfill sites in PNG, with most villages disposing of their waste themselves, and municipal councils having limited funding for waste management.

APPENDIX C

MATURITY ASSESSMENT FRAMEWORK

INFRASTRUCTURE MAINTENANCE MATURITY ASSESSMENT

SUMMARY OF ASSESSMENT AND CLOSING COMMENTS

CLOSING REMARKS

Q1. List your three BIGGEST CHALLENGES

Considering your response to the questionnaire and the assessment above, what do you think are your three biggest challenges/hurdles to maintaining your sector's infrastructure?

1	
2	
3	

Q2. List your three BIGGEST ACCOMPLISHMENTS

Considering your response to the questionnaire and the assessment above, what strategies or practices most help you to maintain the infrastructure?

1	
2	
3	

Q3. Recent Valuation

Are you aware of any recent valuation being done for your infrastructure assets? (can we please have a copy?)

<enter details of valuation. by who and when>

Q4. Tracking Maintenance Expenditure

Is your Accounts Department able to please provide a copy of the maintenance codes and associated budget figures so we may better understand how you track (and code) infrastructure maintenance expenditure?

<Yes/No or contact email for someone in accounts>

Q5. Financial Statement

Are you able to please provide a copy of your latest Financial Statement (or Annual Report)

<Yes/No, contact email, or link to website?>

Q6. Point of Contact

Thank you for taking the time to complete this survey. Is there a person we could contact should we have any further questions?

<name, job position and email>

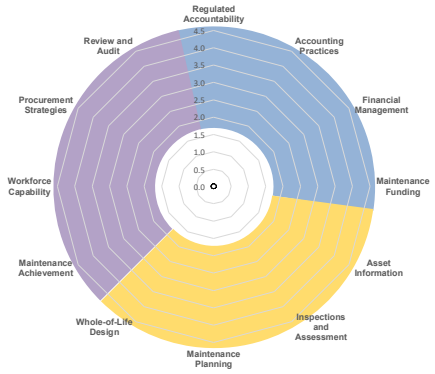
Thank You for Your Time

Once you have completed the survey please return this spreadsheet and attachments to:

Glenn Fawcett glenn@gfcnz.com

YOUR ASSESSMENT SUMMARY

Assessment Category			Rating	Avg	%> Threshold
Governance	1.1	Regulated Accountability	0.0	0.0	0%
	1.2	Accounting Practices	0.0		
	1.3	Financial Management	0.0		
	1.4	Maintenance Funding	0.0		
Management	2.1	Asset Information	0.0	0.0	0%
	2.2	Inspections and Assessment	0.0		
	2.3	Maintenance Planning	0.0		
	2.4	Whole-of-Life Design	0.0		
Delivery	3.1	Maintenance Achievement	0.0	0.0	0%
	3.2	Workforce Capability	0.0		
	3.3	Procurement Strategies	0.0		
	3.4	Review and Audit	0.0		



INFRASTRUCTURE MAINTENANCE MATURITY ASSESSMENT

MAINTENANCE REQUIREMENTS - SELF ASSESSMENT

Lead Organisation (Entity Assessed)

Country: Country

Primary Sector: <select>

Q1. Describe the assets your entity is responsible for maintaining
<describe extent of asset base, contracting methods etc>

Q2. What other organisation(s) are responsible for maintaining infrastructure assets in your selected sector?
<describe who else maintains infrastructure (e.g. outer islands)>

Q3. Who maintains your infrastruture?
<describe how services are procured, internal and/or external resources, expertise, terms contracts, etc>

1. GOOD GOVERNANCE: Develop budgets which reflect the true cost of infrastructure ownerships and ensure revenue streams support these funding levels.

		Undefined	Aware	Developing	Competent	Advanced	Comment/Elaboration
1.1	**REGULATED ACCOUNTABILITY** *A good regulatory framework will clearly lay out how infrastructure is funded and who is responsible for maintaining infrastructure with those funds. It is also important that these frameworks lay out the level of service expected from these assets and the citizens they serve.*						
i	There is a legal, planning and policy framework for the sector which is fully implemented.	○	○	○	○	○	
ii	Roles and responsibilities for planning and management of the infrastructure, including maintenance, are clear.	○	○	○	○	○	
iii	Sector strategic plans identify service delivery required over the short, medium and long term to meet National Development Plan goals.	○	○	○	○	○	
iv	Delivery of services and costs of services are monitored by the legislature directly and/or through an independent regulatory body.	○	○	○	○	○	
v	All necessary maintenance functions are reflected in organisational roles, including management, maintenance planning, materials procurement and administration, accounting, information management, workshops and maintenance staff.	○	○	○	○	○	
1.2	**ACCOUNTING PRACTICES** *Accounting standards adopted determine the accounting treatment of maintenance. Each organisation's chart of accounts determines its ability to meaningfully report the actual expenditure against budgeted maintenance.*	Undefined	Aware	Developing	Competent	Advanced	Comment/Elaboration
i	The Fixed Asset Register (FAR) represents a structured asset hierarchy with links to the physical asset inventory.	○	○	○	○	○	
ii	Non-financial assets are regularly revalued. Condition based depreciation is recorded and reported in financial statements. Straight line depreciation supports fees and charges calculations	○	○	○	○	○	
iii	The chart of accounts is structured to enable managers to budget for, and identify costs of, maintenance for each class of assets.	○	○	○	○	○	
1.3	**FINANCIAL MANAGEMENT** *Good financial management can lead to lower long run life cycle costs, equitable fees and charges, and the avoidance of financial "shocks". Good collaboration among financial and asset managers is important, especially in relation to long term financial forecasts. Robust financial budgets that include both capital and the consequent annual operations and maintenance costs are key.*	Undefined	Aware	Developing	Competent	Advanced	Comment/Elaboration
i	Financial forecasts (3-5 year) of maintenance and rehabilitation needs are submitted by managers as part of the annual budget process.	○	○	○	○	○	
ii	10- year financial projections are contained within Asset Management Plans (AMPs) with detailed supporting assumptions/reliability factors.	○	○	○	○	○	
iii	The legislative framework enables sound taxation / fees and charges to be levied and collected.	○	○	○	○	○	
iv	Tariffs, rates, fees and charges recover the costs of providing the amount and quality of service used by the customer and the marginal cost of providing and maintaining those services.	○	○	○	○	○	
1.4	**MAINTENANCE FUNDING** *The budgeting for operations and maintenance funds the agreed levels of service. Each sector / organisation develops its own methodology for estimating the need for maintenance. Capital budgets separately identify operations and maintenance costs as well as the anticipated need for major improvements. Annual budgets include interest and redemption payments, operating, maintenance and disposal costs.*	Undefined	Aware	Developing	Competent	Advanced	Comment/Elaboration
i	Government subsidies and/or fees and charges are levied for an agreed level of service, preferably tabled in the legislature.	○	○	○	○	○	
ii	Budget allocation to maintenance is fully expended, with budget proposals containing quality/quantity standards and forecasted cash flows.	○	○	○	○	○	
iii	When your organisation contracts private sector providers to deliver maintenance services, it can guarantee the funding of that contract.	○	○	○	○	○	

2. EFFECTIVE MANAGEMENT: Ensure assets are designed to be resilient and are proactively maintained to reduce whole-of-life costs.

		Undefined	Aware	Developing	Competent	Advanced	Comment/Elaboration
2.1	**ASSET INFORMATION** *Knowledge of infrastructure is the foundation for good maintenance. Organisations need to know what assets they are responsible for maintaining, where they are located, how they perform, what is and needs to be spent on them and the risks they are managing to ensure ongoing operation of the system.*						
i	There is a physical inventory of assets to be maintained. The independent valuer can rely on data in the database in preparing its valuation.	○	○	○	○	○	
ii	Day-to-day processes and accountabilities are in place to maintain the register and it is regularly updated and accurate.	○	○	○	○	○	
iii	Associated information on asset failures, work history, planned maintenance etc. is recorded against the asset in electronic format.	○	○	○	○	○	
2.2	**INSPECTIONS AND ASSESSMENT** *The regular inspection practice informs the maintenance schedule. Updating performance metrics keeps the organisation's focus on the required level of service. Sector infrastructure is built to deliver a set level of service for a given period. Levels of service expected each year are agreed. Regular monitoring checks levels are being delivered.*	Undefined	Aware	Developing	Competent	Advanced	Comment/Elaboration
i	Regular inspection and performance monitoring processes are documented and followed for major/critical assets.	○	○	○	○	○	○
ii	Inspection and condition data are actively used to identify and prioritise periodic maintenance and renewals programme.	○	○	○	○	○	
iii	Fault and incident reporting is available to all users. And there is a target response time to clear all faults/incidents.	○	○	○	○	○	
2.3	**MAINTENANCE AND RENEWALS PLANNING** *A maintenance and renewals (M&R) program records the planned maintenance and capital rehabilitation work to maintain service levels and preserve or extend the life of an asset. It is based on the organisation's understanding of demand, customer requirements, the condition of the infrastructure, available skills, and funding.*	Undefined	Aware	Developing	Competent	Advanced	Comment/Elaboration
i	5+ year rolling M&R program is updated annually from inventory, inspection reports, quality and quantity standards and financial forecasts.	○	○	○	○	○	○
ii	Decision frameworks (e.g. multi-criteria analysis) and support tools are used to identify and prioritise M&R projects.	○	○	○	○	○	
iii	Routine, periodic and capital maintenance budgets are delegated to managers responsible for delivering the M&R program.	○	○	○	○	○	
iv	The budget for routine maintenance is sufficient to ensure the agreed level of service to each user group continues to be delivered.	○	○	○	○	○	
2.4	**WHOLE-OF-LIFE DESIGN** *New infrastructure may add as much as 2-8% of its capital costs per year to an organisation's maintenance costs. The designers of infrastructure projects will consider the implications of each design on ongoing operations and maintenance and, if applicable, disposal costs. The business case of each project records the estimated costs and identifies potential sources of funds.*	Undefined	Aware	Developing	Competent	Advanced	Comment/Elaboration
i	The design of all new infrastructure projects includes a full study of the maintenance requirements and detail who will conduct and finance.	○	○	○	○	○	
ii	Designs are appropriate to the human, material and financial resources and capabilities of intended users and those who will maintain.	○	○	○	○	○	
iii	National design standards are in place to ensure relevant, affordable, and consistent designs that take into consideration the specific risks from climate change and natural disasters.	○	○	○	○	○	

3. SUSTAINABLE DELIVERY: Deliver a sustainable level of maintenance and ensure skilled people train the emerging workforce.

		Undefined	Aware	Developing	Competent	Advanced	Comment/Elaboration
3.1	**MAINTENANCE ACHIEVEMENT** *When preventive maintenance is planned and scheduled at the levels required, an agency will experience less unplanned service disruptions, lower levels of corrective maintenance and a longer service life of the infrastructure it manages and maintains.*						
i	There is a prioritised list of known corrective maintenance work (scheduled backlog) which is funded and achieveable.	○	○	○	○	○	○
ii	Unplanned events/outages/failures are measured and reported on. There are a low number and they are proactively managed.	○	○	○	○	○	
3.2	**WORKFORCE CAPABILITY** *Skills required to maintain infrastructure are developed over decades based on school curricula, tertiary education, on the job training and mentoring. Staff turnover and supplier capacity is critical to PIC's ability to maintain infrastructure and deliver services. Realistically, advanced levels of maturity are generally only achieved with larger populations and economies.*	Undefined	Aware	Developing	Competent	Advanced	Comment/Elaboration
i	Maintenance training is routinely provided to technical and management staff by skilled staff, visiting advisers, on-the-job mentoring and, where available, through training institutes, secondments etc.	○	○	○	○	○	
ii	The private sector is regularly engaged to provide both additional maintenance delivery capacity and specialist maintenance expertise.	○	○	○	○	○	
iii	Staff move from public to private sector and back again during their career.	○	○	○	○	○	
3.3	**PROCUREMENT STRATEGIES** *A maintenance procurement strategy looks at the capability and capacity of internal and external providers, structures contracts and assigned responsibilities and performance objectives to ensure the required maintenance activities can be delivered in an effective manner.*	Undefined	Aware	Developing	Competent	Advanced	Comment/Elaboration
i	Maintenace procurement strategy exists which reflects anticipated risks, identifies the equipment, materials and services required and assesses the benefits obtainable from alternative suppliers within the funding available.	○	○	○	○	○	
ii	Maintenance contracts are typically multi-year, have performance incentives to meet objectives and are closely monitored	○	○	○	○	○	
3.4	**REVIEW AND AUDIT** *Effective maintenance extends the life of infrastructure and reduces the whole-of-life cost to asset owners. A structured review and audit process checks that maintenance is completed as specified and that the chosen intervention treatments achieve these objectives.*	Undefined	Aware	Developing	Competent	Advanced	Comment/Elaboration
i	Service level performance metrics are included in annual reports. Asset performance metrics are monitored inhouse to demonstrate to senior managers the effectiveness of the maintenance program.	○	○	○	○	○	○
ii	Maintenance audits completed at least annually to ensure key outcomes met (e.g. quality, safety, efficiency, environmental, social).	○	○	○	○	○	

End of ASSESSMENT - Go to Tab 2

APPENDIX D

KEY POINTS OF CONTACT

Country	Organization/Entity	Name and Position
Melanesia		
Fiji	Ministry of Economy	**Kamal Krishnan Gounder** Manager/Coordinator, Infrastructure Sector kamal.gounder@economy.gov.fj
	Fiji Ports Corporation Limited (FPCL) and Fiji Ships & Heavy Industries Ltd (FSHIL)	**Tomasi Sauqaqa** Manager Projects & Assets tomasis@fijiports.com.fj
	Water Authority of Fiji	**Manasa Tusulu** Executive Officer manasa.t@waf.com.fj
	Energy Fiji Limited	**Bobby Naimawi** Chief Executive Officer bobbyc@efl.com.fj **Jitendra Kumar** General Manager Network jvkumar@rfl.com.fj **Eparama Tawake** General Manager Generation EparamaT@efl.com.fj
Solomon Islands	Ministry of Finance & Treasury Honiara	**Barnabas Vote** bvote@mof.gov.sb
	Ministry of Finance & Treasury Honiara	**Christina Kimitora** Financial & Economic Development Unit (FEDU) ckimitora@mof.gov.sb
	Ministry of Infrastructure	**Moffat HOAWE** Senior Road Asset Engineer: Mhoawe@mid.gov.sb>
	Civil Aviation Authority Solomon Islands - CAASI	**Brian Halisanau** Director halisanau_b@caasi.com.sb
	Solomon Water Honiara	**Ian Gooden** CEO igooden@solomonwater.com.sb
	Management Accounting Solomon Power	**Darwin R Maeriua** Manager Darwin.ririmae@solomonpower.com.sb
	Ministry of Environment, Climate Change and Disaster	**Debra Kereseka** Senior Environment Officer DKereseka@mecdm.gov.sb
Micronesia		
Kiribati	Ministry of Finance and Economic Development PO Box 67, Bairiki, Tarawa, Kiribati	**Benjamin Tokataake** Secretary for MFED secretary@mfep.gov.ki
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Country	Organization/Entity	Name and Position
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	Planning and Aid Division Department of Finance	**John Limen** Deputy Secretary of PAD jblimen@gmail.com
Palau	Bureau of Budget and Planning Ministry of Finance	**Casmir Remengesau** Director casmirer@gmail.com
	Bureau of Public Works	**Brian Melairei** Director melairei@gmail.com
	Bureau of Aviation	**Peter Polloi** Director saampalau@gmail.com
	Belau Transfer and Terminal Company Malakal Port	**Aric Nakamura**, CEO bttc@palaunet.com
	Palau Energy Administration	**Tutii Chilton** Executive Director tutiichilton@gmail.com
	Solid Waste Management	**Calvin Ikesiil** Chief of Division swm.bpw@gmail.com
Polynesia		
Cook Islands	Ministry of Finance and Economic Management PO Box 120, Rarotonga, Cook Islands	**Garth Henderson** Financial Secretary (682) 22878 garth.henderson@cookislands.gov.ck
Niue	Niue Government	**Peleni Talagi** Acting Secretary to Government Niue.Secgov@mail.gov.nu
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	Airfields	**Bill MacGregor** wkl.macgregor@gmail.com
	Department of Environment Ministry of Natural Resources	**Haden T Talagi** Director haden.talagi@mail.gov.nu
Samoa	Aid Coordination and Debt Management Division Ministry of Finance, Apia, Samoa	**Danielle Asenati Li'o – Tuiavii** Principal Economic Aid Coordination Officer (Grants)
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	Samoa Water Authority	**Silimana'i Ueta Solomona Jr** General Manager
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	Tonga Power Authority	**Nikolasi Fonua** Acting CEO nfonua@tongapower.to
Tuvalu	Planning, Budget and Aid Coordination	**Nuausala Nuausala** Director nuausala@gmail.com
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Country	Organization/Entity	Name and Position
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APPENDIX E

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