

From Nothing to Something ... Creating a Road Maintenance Culture for Tonga

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ABSTRACT

The Kingdom of Tonga is a small island country in the South Pacific, located some 1,500 km north-east of New Zealand. The road network, approximately 870 km consisting of about 640 km of public roads, is almost exclusively low volume roads, with only a few urban roads in the capital Nuku'alofa carrying over 1,000 vehicles per day. Over 90 % of the public roads are sealed. Due to a variety of structural and fiscal issues, road maintenance - both routine and periodic - effectively halted in the late 2000's. The Ministry of Works, nominally responsible for the maintenance of the road network, did not have the resources or equipment to maintain the roads so for about a decade there was effectively no routine or periodic maintenance.

In 2010 the Government of Australia provided funds to Tonga through the World Bank with the objective of establishing a routine and periodic maintenance program, with a secondary objective of stimulating the economy by creating employment through road works. This paper describes the success story of how Tonga went from having no regular road maintenance, indeed, not even contractors to undertake road maintenance, to having a competitive road maintenance industry undertaking routine and periodic maintenance across the country.

INTRODUCTION

This paper presents the success story of creating a road maintenance culture in a small and remote island state. Prior to the World Bank and Australian Aid funded Transport Sector Consolidation Project (TSCP), little to no road maintenance had been undertaken on the road network since 2003. The approach adopted and reported herein provides a methodology to follow for other small countries facing similar challenges – be they organizational, logistical, financial, or environmental. Through these efforts the Kingdom of Tonga has:

- Successfully created domestic capacity in road maintenance;
- Adapted and applied new periodic maintenance technologies suitable for Pacific Island Countries (PICs) with limited capacity contractors; and,
- Established the Ministry of Infrastructure to put maintenance at the center of its core business along with a focus on regulatory oversight functions.

Tonga, much like most of the PICs, is a small archipelago comprising of 176 islands with a surface area of about 750 km², yet is scattered over 700,000 km² of the South Pacific Ocean. Not only does this geographical constraint create logistical challenges for the road controlling authority, but financial ones as well, which have a negative impact on road maintenance.

In PICs, conventional economic analyses would not support major investments in road infrastructure on account of low traffic levels and high construction cost. But safe, secure and reliable transport infrastructure is critical for the development of small island states, to foster economic activity, create employment and provide access to education, health and social services, and in the process help to eradicate poverty. In response, the Government of Tonga with the support of its international development partners has started to address critical sustainability issues in the transport sector, while prioritizing sector investments to ensure the maintenance and preservation of the country's road infrastructure assets.

Road Maintenance Challenges in Tonga

Around 2003, due to fiscal challenges on the Government budget, periodic road maintenance effectively halted in Tonga. No routine maintenance was undertaken after 2008 except for limited brush removal and roadside grass cutting by communities and individual property owners. Despite this protracted neglect of maintenance, the road network remained serviceable on account of low traffic loadings, well-draining soils and good road building materials (coral aggregate), and initially well engineered road construction.

The then Ministry of Works was responsible for the maintenance of the road network. The road network of Tonga is approximately 870 km consisting of about 640 km of public roads, and of which 90% are sealed. Some 80 km of the network is classified as highways. The network size varies markedly between islands, with the roads on the main island Tongatapu constituting about 60% of the total road network. The roads in the outer islands are predominantly unsealed. Most of the investments were focused on the main island group of Tongatapu, despite the Ministry's mandate to maintain the network on all the island groups. The lack of resources and capacity in the Ministry, along with the logistical challenges and high in-house costs of accessing these island groups with heavy equipment, meant the road network was effectively not maintained. The level of service (LOS) of the network declined. Limited capacity and resources, however, is not specific to Tonga; many PICs have similar challenges.

The Government's limited financial capacity and the logistical challenges of servicing roads in the sparsely populated outer islands meant it was not viable to sustain domestic contractors for maintenance works. With no domestic contracting industry and limited resources and capacity within the Ministry of Works, the Government of Tonga relied heavily on foreign aid and foreign contractors intermittently to address its periodic road maintenance needs. However, almost no routine maintenance was carried out. Consequently, instead of the normative approach where a road asset is regularly maintained to preserve it, the opposite existed in Tonga where international contractors would mobilize and rehabilitate main roads periodically, with little or no on-going maintenance in the interim. This pattern of interventions may have addressed one part of road maintenance requirements in Tonga, but was unsustainable and costly and large portions of the secondary network suffered major deterioration.

A consequence of donor led activities was the absence of national technical standards in Tonga; foreign contractors would default to using standards which they were most familiar with, usually those from their own country's practice. As a result, different standards and types of construction were seen across the road network in Tonga.

The Ministry of Works was unsuccessful in establishing an Asset Management System (AMS), despite a number of attempts of different approaches funded by donors. Such a system would have easily provided the Ministry with the necessary information to manage the road network efficiently and effectively. This, in conjunction with key staff responsible for road maintenance operations leaving the Ministry, has led to a lack of knowledge about the history of the network, including the extent of public roads under the Ministry's jurisdiction, as well as a detailed road inventory of type and condition of pavements and traffic data. Without such a system in place, the prioritization of what maintenance was undertaken was sporadic and tended to be influenced by external pressures.

Supporting Reform: The Transport Sector Consolidation Project (TSCP)

Recognizing the critical role that the transport sector plays, economically and socially, in the development of the country, the Government of Tonga requested the assistance of the World Bank to review the country's transport sector with a view to improving efficiency within the sector, which at the time was managed across a number of different Ministries and agencies. Starting in 2008 the World Bank began assisting the Government to put in place strategic development plans, as well as options for sustainable funding and management of the road network.

In response to the global financial crisis in 2008, the Government of Australia provided additional funding to the Government of Tonga from their aid program through the World Bank with the specific objective of promoting private sector participation. The Government of Australia was particularly interested in road maintenance activities which could promote private sector participation and increase domestic employment in Tonga.

Because of the previous history, donors were cautious of investing in road maintenance activities, predominantly for two reasons: (i) the lack of a domestic contracting industry would mean international companies would likely be awarded the contracts and therefore donor funds would unlikely be injected into Tonga's economy, and (ii) the approach would be unsustainable, in terms of financing and implementing the works, with periods when no maintenance would occur, as had happened in the past.

The project addressed the above concerns by:

- (i) Supporting the creation of a road maintenance capacity with domestic contractors participating in the program as opposed to the previous approach where international contractors would undertake the large works contracts. To help build local capacity, the project offered domestic contractors an opportunity to bid on contracts of a size appropriate to their current equipment and financial capacity; introduced Otta seals, a new pavement technology which had never been trialed in Tonga or the Pacific; provided training opportunities to both the contractors and Ministry staff on various road maintenance activities; and helped update a number of key legislative pieces in the road sector which were either redundant, contradictory or non-existent; and,
- (ii) Assisting the new Ministry of Infrastructure and Government of Tonga establish a Road Maintenance Fund to secure funding for future road maintenance, once the backlog is addressed by donor funded projects. It is a common perception that aid support is unsustainable and when the funds from aid organizations are exhausted the environment reverts back to the original situation; this aspect was considered extensively in TSCP. To help establish a viable road maintenance capacity, the World Bank and Government of Australia were in agreement that the contractors would not be allowed to collapse, after the TSCP support ended. To meet this objective, the Government of Tonga with technical assistance provided through TSCP established a sustainable fund for future road maintenance activities.

The purpose of this paper is to demonstrate a successful model, using Tonga as a case study, of developing private sector capacity for road maintenance in a low income developing small country. The paper describes the different supporting initiatives such as the merger and restructuring of ministries, contractor training and maintenance capacity building, developing routine maintenance programmes, introducing new pavement technologies, and introducing necessary legislation and technical standards.

MODEL FRAMEWORK

It was well understood by the Government of Tonga that the time taken to develop effective road maintenance capacity would be lengthy. With the assistance of international consultants, the Government of Tonga was able to identify the weaknesses within the sector which were inhibiting the development of a sustainable maintenance contracting industry. The Government of Tonga adopted the following reform framework in the pursuit of establishing a sustainable road maintenance capacity:

- (i) Consolidate responsibility of the transport sector into one governing body, set out the roles and responsibilities of the agency, and establish the regulatory functions of each department under the agency's supervision. Develop capacity within the agency to manage and supervise road maintenance activities in the future.
- (ii) Develop a prioritized three year road investment program including assessing the current condition of the network.
- (iii) Adopt cost-efficient maintenance technologies commensurate with the available resources and local environment.
- (iv) Establish a domestic road maintenance industry, addressing the issues of low capacity and resources including training of local contractors in all aspects of road maintenance:
 - a. Road maintenance practices
 - b. Safety in and around the road environment
 - c. Competitive bidding and tender processes
 - d. Environmental compliance
- (v) Review, update, and draft legislation and technical standards to reflect international best practice and lessons learnt from previous experiences.
- (vi) Set up the functions for future maintenance, including putting in place an appropriate AMS and establishing funding mechanism(s) for future maintenance.

MERGER OF MINISTRIES

On July 1, 2012, the Ministry of Infrastructure was created from a merger of the Ministries of Works and Transport. With this came a central body for the regulation of the network with the Ministry of Infrastructure responsible for the entire transport sector.

The newly created Ministry of Infrastructure established its Mission Statement, outlined its roles and responsibilities, and established its core functions - essentially policy and regulatory oversight. As a result of the merger, the Ministry of Infrastructure identified a number of functions currently under its jurisdiction which were beyond their newly reformed responsibilities. An extensive program for the divestment of these non-core functions was developed. The non-core activities which were divested, along with the responsibilities retained by the Ministry of Infrastructure, are presented in Table 1 below.

TABLE 1 List of Divested and Retained Activities

Business Unit	New / Retained Responsibilities	Divested Activities
Marine and Ports Division	Maritime Safety and Security of all Ports (including Navigation Aids and Harbour Master) Maritime Standards and Planning Marine Environment Administrative support	Port Management Pilotage
Civil Aviation Division	Airline Operations Airworthiness	

	Aviation Security Aerodrome Air Navigation Systems/Aviation Traffic Management/Aviation Information Systems International/Regional Co-ordination	
Land Transport Division	Contract management Road services Traffic services (driving test administration and accident investigation) Safety compliance services	Materials Testing Laboratory Drivers' licensing Vehicle registrations Vehicle inspections Car mechanical repairs, panel beating, service station Quarry Heavy plant
Building Division	Asset Management Inspection Appraisal	Building design
Policy and Planning Division	Legal and Policy Economics and Planning Project Coordination Procurement	
Corporate Services Division	Finance HR Management Information Technology Administration Business Units	

An 'asset management' culture was established which was so successful, the Ministry of Infrastructure was recognized by the Institute of Asset Management (UK) as first runner up for their international Asset Management achievement award.

ESTABLISHING DOMESTIC ROAD MAINTENANCE CAPACITY

Step 1 – Contractor interest and training

Before trying to create a domestic contracting industry the project first undertook consultations through the Chamber of Commerce to gauge the potential private sector interest for undertaking road maintenance. Some 32 firms came to information sessions and many expressed an interest in working in road maintenance. Capacity reviews showed that these ranged from small operators with limited civil works experience, to larger firms who had undertaken major construction projects in the past. Many were staffed by former Ministry of Works staff who had gained some experience with road maintenance from the time when the Ministry undertook regular road maintenance.

From this, it was established that there would be a need for a series of training programs for the contractors to be conducted ranging from:

- Basic business operations, including accounting
- How to bid for civil works
- How to undertake civil works
- Environmental and traffic management
- Worker health and safety

Organizations such as the New Zealand Institute of Highway Technology (NZIHT) were hired by the project to undertake capacity building for potential contractors and these were run at no cost to the participants over an extended period of time. While monitoring the progress of TSCP, the contractors are proving to be quick learners in all aspects of road maintenance.

Step 2 – Road maintenance requirements

As noted earlier, several attempts had been attempted at creating an asset management system but with little success. Rather than embark on another major exercise, a simple condition survey was conducted which recorded the condition data and took GPS reference photographs of all intersections. The data were used to group defects into: crack repairs, pothole repairs, spot rehabilitation, edge repairs, shoulder reinstatement, side drainage reinstatement, verge reinstatement and spot reseals.

The data were analyzed and three classes of maintenance were identified (*I*):

- **General Routine Maintenance (GRM)** activities are those work items that need to be carried out at frequent intervals, generally more than once a year to preserve roads that are initially in a good or fair condition. At the onset there were relatively few roads in this condition as a result of inadequate maintenance allocations in recent years.
- **Heavy Routine Maintenance (HRM)** is being used to describe more extensive repairs that are required after a road has been neglected for a substantial length of time and where routine repairs have not been carried out in a timely manner. There was therefore a backlog of repair work to catch up on before the road is brought up to a condition where it is suitable for on-going general routine maintenance.
- **Periodic Maintenance (PM)** is an intervention that will preserve the road structure. Periodic maintenance of unpaved roads may consist of a complete re-gravelling to a specified thickness

A ranking index was established allowing roads to be prioritized based on weighted criteria for road class, traffic categories, and the level of current defects.

That analysis, coupled with estimated unit costs, showed that the road maintenance requirements were well in excess of the available funding—in fact 100% of funding could just be used for HRM. This was not considered appropriate as it was necessary to also implement regular GRM. So an initial budget allocation of US\$ 0.6 m was put towards HRM and US\$ 1.2 m for GRM.

As an indication of the maintenance needs, based on the cost estimates prepared from first principles a total of about US\$ 11.6 m was required to clear the initial backlog of defects, of which only some US\$ 4.4 million was addressed on the current project.

Step 3 – Routine Maintenance Contracts

The analysis of the network needs (*I*) suggested that a total of seven ‘area wide’ contracts for routine maintenance were appropriate, covering all of the islands groups in Tonga: three for each of Eua, Ha’apai, Vava’u and then four contracts for the main island of Tongatapu - Hahake, Hihifo, Nukualofa and Vahelote.

The condition data were used to estimate a minimum volume of works that would be undertaken for each contract, which included GRM and HRM. The bidders provided unit

prices against these volumes and were guaranteed that this would be the minimum contract value they would be paid for. For works that exceeded the minimum contract quantities, the contractors would be paid according to the priced rates. The condition of contract allowed the contract to be extended for a second year at the client's discretion.

The HRM work was restricted to Tongatapu because the cost of mobilizing heavy equipment for hot bitumen application to the outer islands was not justifiable, with these islands constituting on only 18% of total HRM requirements. The HRM work on Tongatapu was governed by the available funds and was selected using the prioritization ranking factor. In light of the backlog of works, the funding only allowed for some 1/3 of the road network to be under effective routine maintenance through the contracts.

A 'hybrid' performance based approach was used for the routine maintenance contracts. The contractor would be paid only for successfully executing a maintenance activity. A works supervisor would provide the contractor with a program of works for the next 2-4 weeks. The contractor would execute the works and, upon certification by the Ministry of Infrastructure's works supervisor, would be paid. Failure to successfully execute works would lead to retraining as well so that they could be more effective in the future.

The bidding of the routine maintenance contracts was successful. Three separate domestic contractors were awarded the first year PM contracts (a total value of approximately US\$ 1.3 million) and a further four local contractors were awarded the first year routine maintenance contracts (a total value of approximately US\$ 0.6 million). The second year program showed less diversity with the ten contracts on offer being awarded to four different contractors; three of which were awarded contracts in the first year. However, a total of 29 bidders were issued bidding documents for the activities under the second year road maintenance program and between four and seven local contractors submitted bids for each contract offered in the second year of the program. Competition within the market has now been established, and new contractors continue to emerge in Tonga.

APPROPRIATE PAVEMENT TECHNOLOGIES

Materials

In common with many PICs, Tonga had adopted a design specification from another country (namely Australia) for periodic maintenance. The only quarry capable of producing aggregate for chip sealing to the specification was the former Ministry of Works quarry ('Ahononou), and this had been closed for almost a decade prior to TSCP. During that time some donor funded projects had been undertaken using aggregate from a range of privately operated quarries within Tonga. However, visual observations of the performance of these chip seals showed that they usually suffered from early failure such as stripping or crushing of the aggregate.

The project supported an independent study (2) of seven quarries on Tongatapu to test properties and characteristics of the coral-based materials. The results of the testing indicated that material sourced from the 'Ahononou Quarry was the densest, strongest and most durable out of all materials tested. This was the quarry with material most appropriate for traditional surfacing, such as chip seals and asphalt concrete. Of the remaining six quarries tested, materials were at best marginal, with the Nishi and Malapo quarries having the highest quality.

The project supported the government to put in place a privately operated concession to reopen and manage the 'Ahononou Quarry. This concession was signed in late 2013 and

the concessionaire began operating in early 2014. This will provide an ongoing supply of appropriate aggregate for chip sealing and asphalt concrete works.

During the period between 2011 and 2014, the project still needed to undertake periodic maintenance, and appropriately this was done by introducing 'Otta Seal' technologies to Tonga, as described below.

Otta Seals

Otta Seals were adopted for the periodic maintenance contracts, and further described in (3). These had a number of specific advantages for Tonga:

- Otta Seals are designed to use a lower quality aggregate than chip seals, and two of the existing private quarries in Tongatapu had been tested and found to be able to supply the necessary materials.
- The way in which Otta Seals are constructed make them more 'forgiving' to construction quality variations than traditional chip seals. This makes them an ideal technology for new/emerging contractors, and therefore considered as a surfacing treatment in Tonga.
- Typically, Otta Seals have lower costs than chip seals which meant that given the significant backlog of road maintenance in Tonga more sections could be repaired.

Initially a minus 19 mm aggregate was trialed, but it was found that the coarse aggregate protruded above the matrix resulting in unwarranted noise levels in urban areas. As a result it was decided to use a minus 13 mm aggregate, shown in Figures 1 and 2, and this produced an excellent wearing surface. An experiment using minus 6 mm aggregate was not successful as the surface texture was very fine with the bitumen on the surfacing leading to a slippery surface when the road was wet. As a result of this work and experience, a minus 13 mm Otta Seal is now included and recommended in technical standards.



FIGURE 1 View after 9 months of Otta seal on Folaha Road constructed in August 2012.



FIGURE 2 Close-up of Otta seal surfacing on Folaha Road constructed in August 2012.

Interestingly the contractors encouraged the Ministry of Infrastructure to continue with the Otta Seals, because of the above advantages, even when the ‘Ahononou Quarry became operational.

Testing

The quality issues observed on a number of donor financed road projects suggested that the Government did not have the necessary capacity to undertake independent testing of civil works. A capacity assessment confirmed this and equipment was procured to establish the necessary testing capability for civil works, along with a full set of specifications and test procedures. An experienced laboratory manager assisted with training and implementation. Since the creation of the Ministry of Infrastructure, the Ministry is in the process of transferring the laboratory to the Tupou Tertiary Institute where it is used not only for testing of materials, but also training of students.

LEGISLATION AND TECHNICAL STANDARDS

TSCP provided funding for technical advisors to sit within the Ministry of Infrastructure to assist the staff with refocusing their efforts on the reformed responsibilities of the Ministry and regulatory functions of each division. Specifically for the Land Transport Division (LTD), with the help of the roads advisor, the Ministry of Infrastructure has drafted a new Roads Act, to supersede the existing Roads Act 1988, to set out the regulatory functions and

responsibilities of the LTD and the management of the newly established Road Maintenance Fund. While the Roads Act has been drafted, it has yet to be enacted.

The safety of the sector is governed by the existing Traffic Act (1988). Throughout the life of the project to date, two amendments have been drafted and enacted on this Act. Further recommendations to draft additional amendments to incorporate other safety clauses are yet to be considered.

One of the successes under the project was the Ministry of Infrastructure proactively developing technical standards based on experiences under the road maintenance program. Not only did this show an increase in capacity within the Ministry but also an increased understanding from the staff on the new technologies introduced to Tonga and the need for such materials to be available to both staff and contractors.

LESSONS LEARNED

Through the efforts of the project, a successful road maintenance industry has been established in Tonga. All of the contracts offered under the program have been awarded to local contractors. The works under the second year program were predominantly awarded to one contractor. Despite less diversity, competition between contractors has now been established and the total number of contractors participating in the bidding of the works remains high.

The bidding for the second year contracts were impressive. The improvement in their price – across all ten contracts, the total cost of the bids were approximately 11 percent below the Engineer’s Estimate – which is considered evidence that the contractors had utilized the training offered by the Ministry of Infrastructure and learnt during the first year on what areas of their operations they could potentially save on costs. The Ministry of Infrastructure is revising future contracts and the technical specifications in parallel to the operations based on lessons learnt in the previous year and findings from audits and missions.

Notably, through the efforts of the project, an estimated 200 domestic jobs, albeit predominantly part-time, have been created. This includes the employment generated by the road maintenance activities and the involvement of private sector in the divestment of non-core Ministry functions.

FUTURE MAINTENANCE NEEDS

A concern during the preparation of the project was the long-term sustainability of the domestic road maintenance industry created in Tonga. The project supported the Government of Tonga in establishing a Road Maintenance Fund which is expected to fund the maintenance needs of the network once the backlog of road maintenance is addressed (through donor projects). The Government has shown their commitment to ensuring a sound foundation for sustainable financing and management of the public road network by depositing TOP\$ 800,000 (approximately US\$ 430,000) into the fund in February 2014. Revenue generated from fuel excise tax, vehicle license fees, traffic fines, and other road user charges has yet to be deposited into the fund, although beginning FY 2015 it is expected funds from these sources will be deposited into the fund on a regular basis. The long-term sustainability of the Road Maintenance Fund will depend on the level of ownership by the Government of Tonga and especially the Ministry of Infrastructure, and one important monitoring indicator of the success of the fund will be the regular deposit of funds as well as

the utilization of the Road Maintenance Fund in financing routine and periodic maintenance activities of non-TSCP roads.

CONCLUSIONS

This paper has demonstrated a successful model, using Tonga as a case study, of developing private sector capacity for road maintenance in a low income developing small country. The Australian Government and World Bank funded project has supported the Government of Tonga with:

- Consolidating responsibility of the transport sector into one governing body and establishing appropriate roles and responsibilities of the Ministry of Infrastructure.
- Developing capacity within the Ministry of Infrastructure to manage and supervise road maintenance activities.
- Addressing a third of the network's maintenance immediate needs.
- Establishing an effective and sustainable domestic road maintenance industry capable of undertaking road maintenance activities in the future.
- Providing at least 200 domestic jobs for local people, moving away from the traditional approach of employing international firms to undertake road maintenance.
- Developing and adopting national technical standards for road maintenance activities.
- Setting up a fund specifically to address the maintenance needs of the road network.

Over the life of the project, to date, the domestic road maintenance industry has been established with an increase between the first and second year of the program in the number of contractors bidding on the works offered. The results of the bidding for the second year works has been impressive; not only have the contractors improved on their quality of bids, the savings from the second year have meant more of the backlog of maintenance identified could be addressed under the program. Competition between contractors has been established, and through the efforts of the project, the contractors have utilized the training offered by the Ministry of Infrastructure to improve their works.

The lessons learnt during the program have been incorporated into the technical standards and contracts. To ensure sustainability of the investments, and ensure the newly established contractors and industry would not collapse post TSCP, the Government of Tonga has established a Road Maintenance Fund for future road maintenance activities. The initial deposit and agreement on future revenues for the Fund is testament of the commitment the Government of Tonga has made to the domestic road maintenance industry and to ensuring sustainable road maintenance in the future.

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