ROAD INVESTMENT FOR SUSTAINABILITY OF NETWORK AND DOMESTIC CONTRACTORS

by Andreski, A

ABSTRACT

Many countries have recently created Roads Funds and Roads Agencies to improve the management of their road network. In many cases the investment strategies have not been optimal for a) the sustainability of the network, and b) the development of the domestic construction industry. Consideration is given to current road investment strategies together with other possible scenarios for Suriname, Tanzania and Zambia and how these strategies can effect the development of road asset value and the domestic construction industry. The main message in the paper is that giving sufficient priority to road maintenance at local level will enhance development of both national total road asset and the local construction industry.

The paper is in two parts. The first part proposes a simple spreadsheet model that can used as a tool for reviewing the impact of a country's road investment structure in terms of maintenance, backlog removal and development and projecting the resultant change in road asset value. The second part looks at the impact of strategies chosen in this way on the development of the domestic construction industry and provides a range of options that can be used to develop the domestic industry.

1. Introduction

Many countries have recently created Roads Funds and Roads Agencies to improve the management of their road network. In many cases the organisation structures chosen and investment strategies have not been optimal for a) the sustainability of the network, and b) the development of the domestic construction industry. Common features that contribute to this problem are that often capital works are given priority over maintenance, repeated rehabilitations of roads that have fallen apart due to lack of maintenance, and a persistent backlog that needs constant fire fighting attention. This situation does not favour small and medium domestic contractors who need regular work to prosper. In this environment, work contracts tend to be large, lumpy and erratic favouring large contractors that are in the main foreign firms that get their continuity of work between large contracts over several countries.

This paper looks at Suriname, Tanzania and Zambia as examples, where the status of the road sector is briefly outlined and the implications of their current road investment strategies examined. A simple model is applied that suggests other strategies that could lead to a more sustainable road networks. Road investment strategies can be geared towards developing the local construction industry and a range of options that could enhance this development are considered.

2. Case Studies

2.1 Suriname

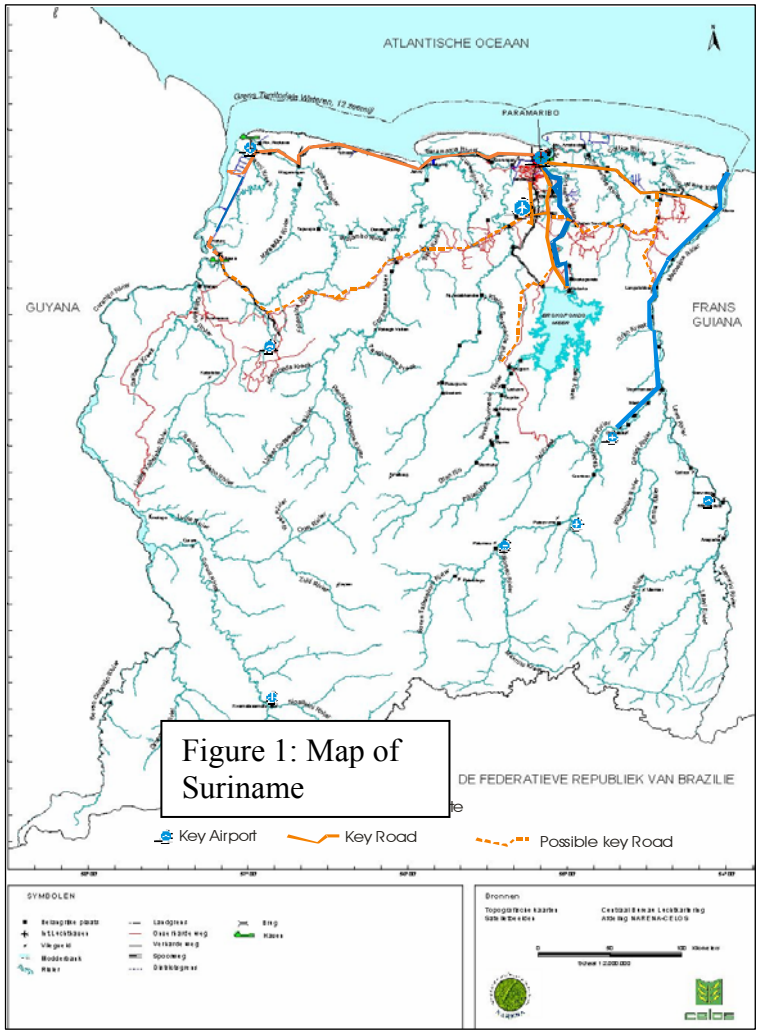

Figure 1: Map of Suriname

Suriname is a small country, with a land area of 163,300 sq.km, and a population of approximately 440,000, located on the Caribbean coast of the South American continent. Approximately 90% of the country is covered by forest, and the settled areas are all found in the north of the country within 50 to 100 km of the coast. More than half the population lives in Paramaribo and its suburbs. The GDP of the country is around $1.1b or per capita of around $2,500 that puts it close to a middle income country.

Traffic volumes are generally low and, outside Paramaribo, the flows rarely exceed 1,000 vehicles per day (vpd). The vehicle fleet has been growing at around 4% p.a. for the last decade, and there are now more than 115,000 vehicles in the country. Car ownership is approaching European levels. The road network consists of 4,570 km of roads, of which only 1,125 km, mainly in urban areas, are paved. The roads are, with the exception of those that have been recently rehabilitated, in poor condition as Suriname has fallen into a classic cycle of road failure, no maintenance and then repair.

At this moment performance of road maintenance is inadequate. Much of the road network is in poor condition and the extent of the network is insufficient for the country's overall development objectives. These problems are illustrated in the following problem tree with arrows showing causality:

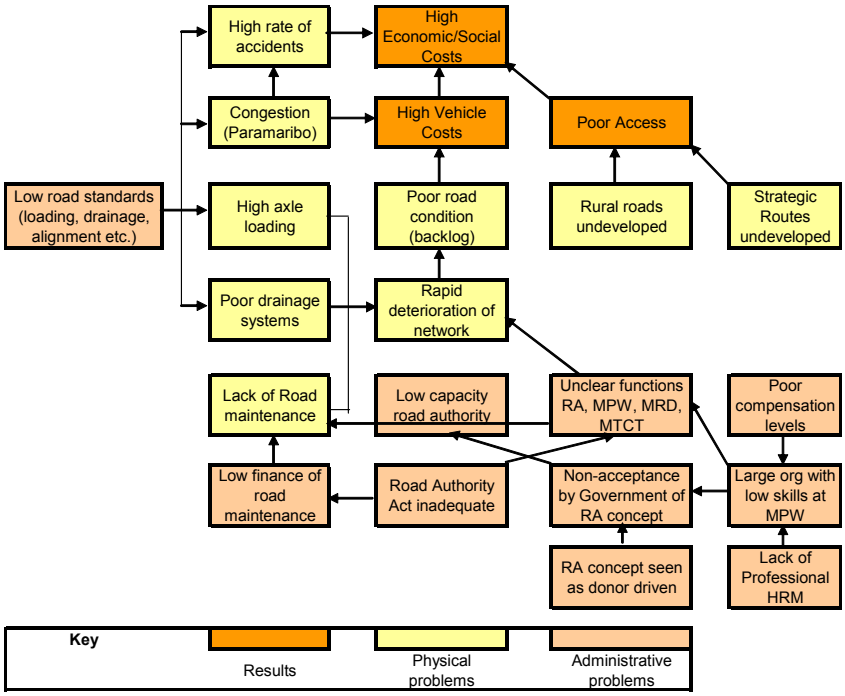

Figure 2: Suriname Road Sector Problem Tree

Figure 2 above shows that there are high economic and social costs associated with poor access and high vehicle operating costs. These are exacerbated by a high rate of accidents and congestion, particularly in Paramaribo that has 30 accidents a day. Like many developing countries there is poor access in terms of both the rural feeder roads and the strategic road network.

A lack of road maintenance is leading to a rapidly deteriorating road network that is only held at bay by repeated rehabilitations which is a very expensive way of managing the road network This deterioration is exacerbated by vehicle overloading and poor drainage systems, caused by low standards for vehicle overloading control, poor drains particularly in the city but also throughout the road network, respectively. Low road and street design standards in terms of alignment, width and traffic control contribute to this problem.

Under-funding of road maintenance makes a poor road network inevitable. Overall, the country is probably spending sufficient sums to develop the condition and extent of the road network in the order of US$30 million per year. Unfortunately most of this money is being spent on rehabilitation to remove some of the backlog caused by poor road maintenance. Only around US$3 million is spent on road maintenance, about $1 million each by the Roads Authority, Ministry of Public Works and Ministry of Regional Development. This has been identified as only 10-20% of the need in various studies such as the Feasibility Study for Institutional Strengthening of Suriname Transport[1]. Fortunately, the Government of Suriname agreed to increase the fuel levy from June 2006, effectively quadrupling the US$1m/y (or 1 cent per litre just on petrol) available for road maintenance from this source. However, the Ministry of Finance have voiced concerns about the ability of Road Authority to effectively manage these funds in its current status.

Institutional problems contribute significantly to the maintenance problem. The Road Authority (RA) has not taken off since its creation ten years ago, despite an EU funded

TA programme in the RA between 2002 and 2004. For over a year the RA had no Director or engineers although fortunately, from 2nd May 2006 a new Director has been appointed on a 1-year contract. The demarcation of functions between the Ministry of Public Works (MPW), Ministry of Regional Development (MRD), Ministry of Transport, Communications and Tourism and Road Authority is unclear with both duplication and omission. For example both MPW and RA authority maintain the primary road network, and both MPW and MRD maintain parts of the secondary and tertiary network. Some of this is due to inadequacies of the Road Authority Act but also non-acceptance of the concept by various quarters in Government.

The Road Authority Act does not mention a transition process for handover from Ministry of Public Works and what functions and responsibilities will remain with the Ministry once the handover has taken place. Final decision on the appointment of the Director of RA resides at very high level – Council of Ministers – and this means the process can take a very long time. The composition of the Board could be improved with majority private sector members, and it would be preferable if the Chairman of the Board was selected by Board members. Currently only two out of seven Board members are from the private sector. There are also potential conflicts of interest with some Board members also service providers.

A brief analysis of Suriname's investment strategy was carried out giving the following summary results.

Deferred maintenance cost factor	2.5
Maintenance cost as % of asset	3.0
% annual Increase in budget	1.0

		Year 10 Projection (2016)		
Initial Expenditure US$m	**2006**	**Strategy 1**	**Strategy 2**	**Strategy 3**
Asset Value	312	51	387	582
Maintenance Backlog	63	225	131	(50)
Initial Capital expenditure		20	10	16
Initial Rehabilitation expenditure		8	12	12
Initial Maintenance expenditure		2	6	12

Table 1: Suriname 10-Year Road Investment Scenarios

Note on Initial Factors:
Heggie and Vickers[2] state that deferred maintenance costs 2-3 times as much later. Due to the heavy rainfall in Suriname a factor of 2.5 is chosen on an annual basis. Metschies[3] recommends 1.5, 3, 5 and 4 per cent of the asset value of paved, gravel, earth and urban roads be spend on maintenance respectively and an average of 3% is chosen here. 1% is chosen as an annual increase in the initial investment. An explanation on how this model works is given in the annex.

Strategy 1 corresponded to its April 2006 capital focussed investment policy and this is predicted to result in a build up of road maintenance backlog of $225m and an asset value reduced to only $51m over a 10 year period.

Strategy 2 reduces capital expenditure by half, but increase expenditure on rehabilitation and maintenance by 80%. Total roads expenditure is actually reduced slightly. This projects asset value increasing modestly over 10 years but the backlog doubles.

Strategy 3 projects a significant increase in asset value and complete removal of backlog. Details of how this model works is given in the annex.

To conclude, Suriname's early 2006 strategy may lead to a large loss in road asset value and large accumulation of backlog. Should the planned increases in maintenance occur, then asset value is likely to increase although backlog would build up. If maintenance is fully funded then backlog can be removed. The current concentration on capital projects is inhibiting the development of local contractors and consultants.

2.2 Tanzania

Tanzania is an eastern African country with a population of around 34 million and a classified road network of about 80,000km. This covers a large surface area of close to a million square kilometres. The country has a GDP of about $10b corresponding to a per capita income of around $300 per annum which makes it one of the poorer countries in the world. Nevertheless, the country has considerable natural resources and a significant informal economy.

The management and financing of the road sector is maybe a decade or two ahead of Suriname. Since the turn of the century, a second generation Road Fund has been distributing maintenance funds on a regular basis to a new national road agency (Tanroads) and direct to over 100 district councils.

Tanzania had one of the first National Construction Councils in Africa, established 1979, and this institution pioneered a number of initiatives to develop the sector. This enabled the contracting industry to expand dramatically over the last 20 years. In 1986 there were 43 contractors in the country of which 23 were civil contractors and only 10 of these were local firms. By 1996 there were 600 road contractors and today these number well over 1,000. Several other institutions relevant to the sector are well established such as the Institution of Engineers Tanzania, Association of Consulting Engineers, Contractors Registration Board and Engineers Registration Board.

However, Tanzania has a number of similar problems to Suriname. Road conditions are often poor with a large backlog of road maintenance particularly in rural areas. Periodic maintenance of both paved and unpaved roads is generally neglected. The Tanzania Association of Civil Engineering Contractors is concerned that the bulk of road expenditure goes primarily to foreign firms. The main reason for this is structure of road financing in the country, where the bulk of investment goes in large scale capital works projects that can only be undertaken by large, usually international contractors.

The following table projects how the investment strategy affects the national road network maintenance backlog and total asset value over a 10 year period. In 2005 the total asset value is estimated to be $2.6b allowing for a backlog of $1.4b. It is assumed that investment increases at a modest 1% per annum in real terms, required maintenance cost is 3% of road asset value, and deferred maintenance cost is double that of normal maintenance cost.

Deferred maintenance cost factor	2.0
Maintenance cost as % of asset	3.0
% annual Increase in budget	1.0

		Year 10 Projection (2015)		
(US$m)	2005	Strategy 1	Strategy 2	Strategy 3
Asset Value	2,600	2,660	3,047	3,435
Maintenance backlog	1,400	1,766	908	49
Initial Capital expenditure		130	65	-
Initial Rehabilitation expenditure		65	130	180
Initial Maintenance expenditure		65	65	80

Table 2: Tanzania's 10-Year Road Investment Scenarios

Strategy 1 corresponds roughly to what is happening today where road expenditure totals $260m, of which half is spent on capital works, a quarter goes on rehabilitation and the remaining quarter goes on maintenance. The projection shows that the net asset value remains static and the backlog increases from $1.4b to almost $1.8b.

Strategy 2 switches half the capital expenditure (new works) to rehabilitation (backlog removal). The 10 year projection shows a modest reduction in backlog with the asset value increasing slightly from $2.6b to $3b.

Strategy 3 increases maintenance to necessary levels, cancels capital works (probably not politically acceptable) and concentrates investment on backlog removal (rehabilitation of existing network). This would remove the backlog altogether and increases the total asset to $3.4b over the 10-year period. For each strategy the total road investment is the same.

Similar to Suriname, the current structure of road investment in Tanzania does not favour the development of the local construction industry. Most of the investment goes on large scale construction and rehabilitation works that for which only large, mostly foreign contractors can compete. It is recommended that more works be switched from large scale centrally managed contracts to a much larger number of smaller scale sub-nationally managed contracts. This would have the dual benefit of developing local capacity and accelerating total road asset value.

2.3 Zambia

Zambia is a land locked southern African country with a population of around 12 million and a road network of around 67,000km. It has a GDP of around $4.6b that makes it one of the poorest countries in the world with a per capita GDP of $380. The country has a surface area of three quarters of a million square kilometres.

In 1998 the National Construction Council was created to act as a registrar, regulator, arbitrator and disciplinary body for the industry. It also trains contractors having recently absorbed the Roads Department Training School.

The Public Roads Act 2002 created the National Road Fund Agency Roads Development Agency (RDA) to be responsible for the 67,000km network. It become clear that 67,000km of road was too much to manage centrally and 40,000km were nominated as core. Unfortunately, this has resulted in the remaining 27,000km of non-

core feeder roads being ignored even if they were previously brought into good condition through other donor funded programmes.

In order to achieve results on the ground, RDA have recently awarded around 12, 3 year performance based improve and maintain contracts totalling around US$80m in value funded by Government and donors through budget support. The large scale nature of these contracts has resulted in most of them going to foreign contractors and there is concern that little of the road expenditure cake is going to local firms thus inhibiting their development.

The following table projects how the investment strategy affects the national road network maintenance backlog and total asset value over a 10 year period. In 2006 the total asset value is estimated to be $1.75b allowing for a backlog of $1.6b. As a relatively dry country, it is assumed that investment increases at a modest 1% per annum in real terms, required maintenance cost is 2.5% of road asset value, and deferred maintenance cost is 50% more than that of normal maintenance cost. The annex gives details of how this model works with Zambia as the example.

Deferred maintenance cost factor	1.5
Maintenance cost as % of asset	2.5
% annual Increase in budget	1.0

$millions		Year 10 Projection (2016)		
	2006	Strategy 1	Strategy 2	Strategy 3
Asset Value	1,750	1,734	1,861	3,014
Maintenance backlog	1,600	1,272	1,163	(9)
Initial Capital expenditure		20	20	-
Initial Rehabilitation expenditure		90	90	190
Initial Maintenance expenditure		35	45	50

Table 3: Zambia's 10-Year Road Investment Scenarios

Strategy 1 corresponds roughly to what is happening today where road expenditure totals $145m, of which the bulk goes on rehabilitation. The projection shows that the net asset value remains roughly static and the backlog reduces slightly from $1.6b to $1.3b. Strategy 2 adds $10m to the maintenance budget which is projected to add around $130m to the asset value over 10 years.

Strategy 3 increases maintenance to necessary levels, cancels capital works (probably not politically acceptable) and more than doubles investment on backlog removal (rehabilitation of existing network). This is projected to remove the backlog altogether and increase the total asset to $3b over the 10-year period.

Similar to Suriname and Tanzania, the current structure of road investment in Tanzania does not favour the development of the local construction industry. Most of the investment goes on large scale rehabilitation works that for which only large, mostly foreign contractors can compete. Currently the institutional framework inhibits switching from large scale centrally managed contracts to a larger number of smaller scale sub-nationally managed contracts. Fortunately, the Public Roads Act provides for the creation of Local Roads Authorities and it is recommended that these be set up as soon as possible to stimulate road asset growth and the local road construction industry.

3. Strategies to Develop Local Contractors

Adopting an appropriate financial strategy that gives emphasis to maintenance at sub-national level enables procuring entities to prepare contracts that are specifically geared towards developing the local industry. Andreski, Seth and Walker[4] identify the following options:

- Package contracts attractively vertically and horizontally
- Use simpler forms of contract and specifications geared to small contractor;
- The Development Team Model
- "Greenhouse contracts"
- Technical competitive tendering
- Labour based contracting
- Low cost equipment based contracting

Packaging of contracts is one of the best ways of providing a range work for the spectrum of the local construction industry and avoids the total value of the contract becoming too large for small and medium sized companies. This can be done vertically or horizontally. **Vertical packaging** is where projects are divided into several contracts each covering a short length of road. **Horizontal packaging** is where works are awarded within the same stretch of road according to particular activities, for example culvert contracts, drainage contracts, shoulder repairs or haulage. This method is particularly useful in that it enables some activities such as drainage to be low cost labour based and others such as providing compacted gravel would require high cost plant. It should be noted that road agency administration or supervision consultancy costs may increase but these could be offset by local firms providing lower rates.

Appropriate standard specifications should be included in the contract to suit the emerging local industry. They may include specifications allowing for local products. Specifications may also be simplified for the smaller contracts thus easing complexities for smaller firms and those that imply use of sophisticated imported equipment should be avoided. The size and complexity of contracts should be reduced so that they can be understood by emerging entrepreneurs.

The Development Team Model, pioneered in South Africa**,** packages works into the four basic functional components: construction management, materials management, materials supply, and the works. The work is contracted out to a small-scale contractor, materials management and supply is contracted out on a fee-basis to a materials manager, and construction management is contracted out on a fee-basis to a construction manager. The materials manager and construction manager may be either consulting firms or established contractors. They make up the development team and provide the necessary support to emerging contractors. The uniqueness of the model is that it combines contract packaging (unbundling); on the job hand holding; and provision of support in resource mobilization for the emerging contractors.

"Greenhouse contracts" are those set up for newly established contractors where much of the risk is removed. Consultants could be on call to provide advice. Easy contract terms may be available such as cost-plus or many of the equipment and materials provided by the client. Indicative rates may be provided or the total budget made known in advance. Another option may be to provide a bill of quantities with

rates and invite each contractor to bid a certain percentage above or below. The type of "greenhouse" should depend on the level of development of the local construction industry. Airtight greenhouse (windows closed) contracts with rates fully fixed could be provided at early stages and then gradually opened up to full financial competition once the industry approaches maturity.

Technical competitive tendering, similar to that used to procure consultants, is another option. Andreski & Byabato [5] present a method developed in Iringa Region, Tanzania in the early 1990s. Here all contractors or entrepreneurs interested in moving into the business in the region were requested to express interest in the Regional Engineers road maintenance program. Compulsory training was provided on how to carry out the works and prepare tenders. Short lists were then drawn up and contractors invited to submit technical proposals based on a priced bill of quantities. The technical proposals were then marked according to pre-published criteria and the technically best chosen. This had the advantage of ensuring contractors paid full attention to the training and prevented them from submitting unrealistically low bids.

There are a number of other strategies that can be used to develop a local construction industry that are not substantially affected by the road investment strategy. These may include:

- National Construction Council (NCC)
- Contractor registry
- Contractors associations
- Subsidised plant and equipment
- Contractor training
- Bulk of risk apportioned to client rather than contractor
- Enhanced credit availability
- Removal of tax exemption on donor funded projects
- Promotion of innovative local products

A National Construction Council (NCC) can be set up to develop contractors and **s**uch councils have been established in a number of countries. Tanzania created one in 1979 and Zambia in mid 1990s. Brushett & Seth [6] identify four main roles for these councils namely: regulatory, contractor development, advisory to Government, and information dissemination. Tanzania separated out the regulatory function in 1998 through the creation of the Contractors Registration Board. A number of NCCs have taken up the functions of the old Public Works Departments' Roads Training Centers. The NCC in Zambia has inherited the labour based training school for contractors, that was supported by NORAD and ILO. The Malawi NCC is actively training contractors but perhaps at the expense of the contractor registration function which is still rather weak.

Contractors can be regulated through a registration system. Many countries have set up a national system that classifies contractors according to financial and technical capability. Zambia and Malawi register contractors through their construction councils. Care needs to be taken that such systems do not become rent-seeking exercises where contractors just pay for the classification they want, so inspection and verification of contractors' resources is essential. Registration systems may be more effective at provincial level where the logistics of verification are much easier.

Andreski & Lusenge [7] describe such a scheme for Iringa Region, Tanzania where contractors were upgraded or downgraded depending on performance.

Facilitate creation and operation of contractors associations. These associations enable contractors to promote and defend their interests as a group and this has much more weight than individuals. They can agree contract conditions, payment procedures and regulations with Government or other major clients. They can provide advice, training, financial support and improved access to banking, insurance, materials and equipment to their members. Larcher and Miles [8] identify four issues that must be addressed when planning a contractors association: 1) It must be accepted by Government as representing their group, 2) Funding must be available through membership fees or grants, 3) There must be a good number of members, and 4) Like any other organization, it must have a good leadership and management. A good example of such an association is the Tanzania Civil Engineering Contractors Association.

Subsidised plant and equipment can give contractors a head start**.** Availability of equipment is often a major constraint to domestic contractors in developing countries. One option is to provide equipment at subsidized rates. However, this option will be difficult to sustain and is probably only viable as a kick starter.

New contractors need **training**. An emergent industry is likely to lack technical and business skills and training is a means of enabling new contractors to develop quickly. There is also likely to be a high turnover of both contracting companies and the staff within them so the training process needs to be continuous over a long period of time rather than a one-off exercise. Several types of training are available and these include, classroom training, "greenhouse contracts", technical competitive tendering after training seminars and mentoring on site.

Classroom training is also very useful and can take many forms. Typical technical aspects of labour and machine based road construction include: basic road engineering, identifying objectives, project planning using critical path analysis to develop bar charts and optimal use of resources, balancing plant and equipment, quality control, site supervision, work measurement and estimating, progress charts, contract monitoring and reporting. Business skills training may include cash flow management, contract conditions, tendering regulations and techniques, bonding and contract law. This training may last from one day to one month depending on the seniority of the staff concerned but should not be too long since contractors are very busy people needing to earn money to run the business.

Similar to the "greenhouse" concept is to allow **"high risk tendering"** and management of contracts. This may include reduced or no bonding, large advances with easy repayment terms, fast track payments, short listing of contractors thus reducing competition, price controlled or internet tendering. These types of contracts throw a lot of the risk on the client and even the individuals managing such tenders. Hence the client project managers will need the full support of their superiors and such techniques should be included in policy documents. For a well developed industry this may be expensive, but for an emerging industry it would accelerate its development and hence avoid many costly failed contracts.

Capital is a major constraint for newly emerging contractors. Banks in developing countries are notoriously risk averse and particularly reluctant to provide credit to what they perceive as high risk industries such as construction. **Enhanced credit availability** is one way around this problem. It may be necessary for the client or development partners to provide guarantees to local banks, thus removing or sharing the risk. They could also subsidize interest rates thus reducing them to levels affordable by contractors. Often collateral at high percentage rates is demanded and this could also be reduced if third parties are prepared to take some of the risk. If good cooperative local banks are difficult to find, other vehicles can be found such as Tanzania's Construction Industry Development Fund.

Some countries remove **subsidies to foreign firms or create advantages for local contractors**. Often Development Partners insist that local taxes such as import duties are not applied to their credits or grants. This means that large foreign companies can import new equipment without paying duty whereas the smaller local companies are offering to provide their services having already purchased duty paid equipment. This creates a big advantage to foreign companies particularly for the larger contracts. It would be better if the playing field was levelled by all parties paying the same level of tax. Alternatively, barriers can be placed on foreign firms. This could include high registrations fees or extra taxes on imported equipment. A domestic preference of around 5 to 15% can also be included in tender documents. Another advantage may be to require foreign contractors to subcontract a percentage of their contract to local firms.

Local entrepreneurs may produce **innovative local products**. These may include items such as wood stave culverts, bamboo reinforced concrete pavement or locally manufactured rollers and trailers. Local councils are frequently very conservative in regard to such innovations and prefer what they perceive as the "tried and tested" but more expensive foreign technology like Armco pipes. It is important that Government policies promote the local industry and also that these policies are fully disseminated at all levels.

References:

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Annex

Guide on Model to Assess Road Sector Financial Strategies

Objective

Improve Strategic Decision Making in the Allocation of Funds in the Road Sector

Primary Users

Policy makers in the road sector, Road Fund Board members, national, regional and district level agencies and/or local government institutions responsible for the planning and management of road networks in developing countries, multilateral and bilateral donors, and consultants.

Introduction

In many developing countries, national and sub-national road networks are in various states of repair. There are sections of good road requiring normal routine and periodic maintenance, and sections in fair to poor condition requiring backlog maintenance or rehabilitation. In some countries the extent of the network is insufficient generating a strong demand for new construction or upgrading. Often the levels and relative proportions of funding for new capital works, rehabilitation (or backlog removal) and maintenance are insufficient or sub-optimal. Funding levels tend to be based on historical precedent, political pressure or a fire-fighting strategy. There are a number of sophisticated computer models for assessing various strategic options such as HDM4, dTIMS, or RoadMentor. However, these tend to be "black boxes" that are not readily understood by the layman and require considerable volumes of data and expertise to operate.

Consequently, there is a need for a simple spreadsheet to assess financial options that can be understood and operated by planners and administrators with more general numeric skills. This tool is readily understandable by politicians and other senior decision makers through simple graphics and tables.

Zambia Example

The table below gives an example for Zambia. The cells coloured yellow in the spreadsheet are values to be entered by the user. The remaining figures are automatically calculated from formulae.

The first item to be entered is the deferred maintenance cost factor (b1). This parameter is the one that requires most engineering judgment. maintenance deferred costs 2-3 times more than that done in good time (Heggie and Vickers[2]). The parameter to be entered estimates how much more that maintenance will cost if deferred to the following year and would depend on terrain and rainfall.

The next parameter (b2) to be entered is the maintenance cost as a percentage of asset value. Metschies[3] estimates that this percentage is 5% for earth roads, 3% for gravel roads and 1.5% for paved roads. So the figure entered here depends on the relative proportions of the network that are paved, gravel or earth.

The next factor (b3) is the average percentage in real terms that the budget is expected to increase over the next 10 years.

Three different strategies are analysed in the following tables. Strategy 1 corresponds roughly to the current financial strategy. The asset value of the network (b6) is entered in millions of US dollars. This corresponds to the total replacement value of the network less the maintenance backlog (b7). These two figures are estimated from inventory, condition and unit rates data.

The annual maintenance requirement (b8) is automatically calculated from the network asset value (b6) times the maintenance cost factor (b2).

The annual loss of asset due to backlog (b9) is automatically calculated from the value of the backlog (b7) times the maintenance cost factor (b2) times the deferred maintenance cost factor (b1).

The capital expenditure (b10), rehabilitation expenditure (b11) and maintenance expenditure (b12) are taken from the country's budget forecasts.

The rest of the spreadsheet is automatically calculated.

The new asset value (c6) = old asset value (b6) plus capital expenditure (b10) less backlog cost (b9) plus reduction in backlog [(b7-c7].

The new backlog (c7) = old backlog (b7) less rehabilitation expenditure (b11) plus annual cost of backlog (b9) plus the difference between required maintenance expenditure (b8) and actual maintenance expenditure (b12).

The new maintenance requirement (c8) is the same proportion (b2) for the asset value (c1). The new loss due to backlog (c9) is automatically calculated from the value of the backlog (c7) times the maintenance cost factor (b2) times the deferred maintenance cost factor (b1).

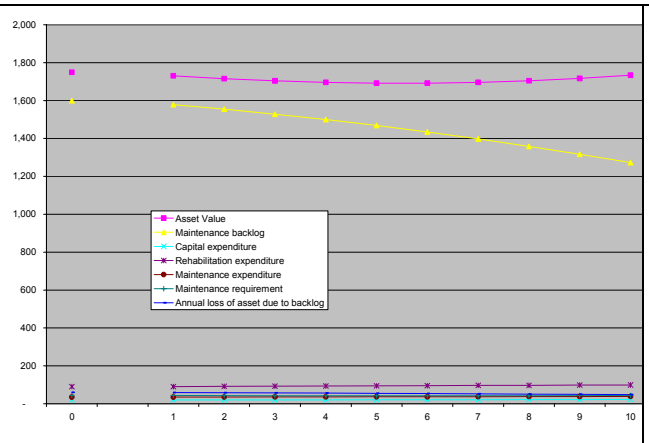
The new annual expenditures on capital works (c10), rehabilitation (c11) and maintenance (c12) are simply inflated by the annual increase in the budget (b3).

Each subsequent year is treated in the same manner although projected expenditures could be entered manually rather than adjusted by an inflation factor.

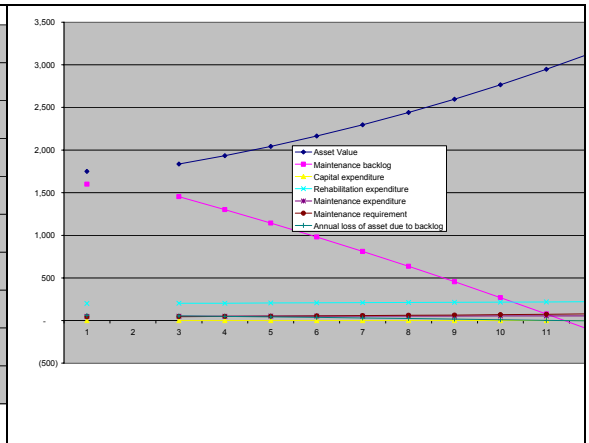
The formulae for strategies 2 and 3 are identical but with different initial values for capital, rehabilitation and maintenance expenditure.

Zambia Example

	a	b	c	d	e	f	g	h	i	j	k	l
1	Deferred maintenance cost factor	1.5		Entered data								
2	Maintenance cost as % of asset	2.5	New asset value=old asset value+capital exp.-backlog cost+reduction in backlog									
3	% annual Increase in budget	1.0	New backlog=old backlog-rehab exp+annual cost of backlog+req maint-maint exp									
4	**Strategy 1 (Current)**	$millions										
5	**Year**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
6	Asset Value	1,750	1,731	1,716	1,704	1,697	1,693	1,692	1,697	1,705	1,717	1,734
7	Maintenance backlog	1,600	1,579	1,555	1,529	1,500	1,468	1,434	1,398	1,359	1,317	1,272
8	Maintenance requirement	44	43	43	43	42	42	42	42	43	43	43
9	Annual loss of asset due to backlog	60	59	58	57	56	55	54	52	51	49	48
10	Capital expenditure	20	20	20	21	21	21	21	21	22	22	22
11	Rehabilitation expenditure	90	91	92	93	94	95	96	96	97	98	99
12	Maintenance expenditure	35	35	36	36	36	37	37	38	38	38	39
13	**Strategy 2 (Fully fund maintenance)**											
14	Asset Value	1,750	1,741	1,737	1,736	1,740	1,749	1,762	1,779	1,802	1,829	1,861
15	Maintenance backlog	1,600	1,569	1,535	1,498	1,459	1,416	1,371	1,323	1,273	1,219	1,163
16	Maintenance requirement	44	44	43	43	44	44	44	44	45	46	47
17	Annual loss of asset due to backlog	60	59	58	56	55	53	51	50	48	46	44
18	new roads	20	20	20	21	21	21	21	21	22	22	22
19	Rehabilitation expenditure	90	91	92	93	94	95	96	96	97	98	99
20	Maintenance expenditure	45	45	46	46	47	47	48	48	49	49	50
21	**Strategy 3 (remove backlog in 10 years)**											
22	Asset Value	1,750	1,836	1,934	2,043	2,164	2,296	2,441	2,597	2,766	2,948	3,142
23	Maintenance backlog	1,600	1,454	1,302	1,144	980	811	636	455	269	78	(119)
24	Maintenance requirement	44	46	48	51	54	57	61	65	69	74	79
25	Annual loss of asset due to backlog	60	55	49	43	37	30	24	17	10	3	(4)
26	Capital expenditure	-	-	-	-	-	-	-	-	-	-	-
27	Rehabilitation expenditure	200	202	204	206	208	210	212	214	217	219	221
28	Maintenance expenditure	50	51	51	52	52	53	53	54	54	55	55



Scenario 1: Current



Scenario 3: Remove Backlog in 10 years