ARE DEVELOPING COUNTRIES PAYING FOR THEIR ROADS? – MATCHING ROAD COSTS AND AVAILABLE FUNDS

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ABSTRACT

Financing road network life-cycle costs on sustainable basis is one of the most crucial challenges facing many developing countries, as it requires a thorough awareness of road network costs and available sector funds. This paper presents a pragmatic cost-revenue model for estimating road network life-cycle costs and expected road revenues. Drawing on examples from Ghana and Namibia, the model calculates performance indicators for measuring the extent to which road users are contributing to the financing of road network life cycle costs. The findings indicate that road user contributions in Ghana are sufficient to cover only the expected maintenance costs and about three-quarters of the estimated network life cycle costs. User contributions cover only one-half of the total costs when the costs of clearing existing maintenance backlogs are included. By comparing user contributions and actual allocated domestic funds, the model shows that only about 50% of what users contribute is actually allocated to the road sector. This disparity between road network life cycle costs and available funds for road financing is a major development constraint, as needed road improvement projects cannot be undertaken due to lack of funds or under-allocation of available funds. With existing network conditions, it is estimated that 1.5-3.0% and 4.5-6.0% of GDP allocation would be required for annual maintenance and network life cycle costs respectively in both countries.

1. INTRODUCTION

Road transport continues to play an indispensable role in the movement of over 90% passenger and freight traffic in most developing countries. Roads serve as the circulation system in the promotion of commerce, communication, and socio-economic development. The provision of road infrastructure gives both the rural and urban poor access to health, education, employment and other needed social services [7]. This means that without efficient transport infrastructure in place, economic and social development would be severely hindered.

Despite the importance of roads in the promotion of overall economic development and improvement in living conditions, efficiency of road transport systems in many developing countries is often constrained by high vehicle operation and maintenance costs due to poor road conditions. Though demand for transport infrastructure continue to grow - a result of high population growth rates, urbanisation and growth in economic activities - resources for road maintenance and asset replacement continue to be a burden.

The problem of inadequate road financing can be viewed from two perspectives. First, low-income countries with oversize network will obviously not have sufficient financial resources for maintaining it. The second problem is the perceived low priority for road maintenance by many governments in developing countries. Again, road maintenance is financed from the general budget and hence competes with other sectors for often very limited funds.

The negative impacts of inadequate road maintenance are clear. Allowing roads to deteriorate, say within less than half their life span, only to spend additional scarce resources to rebuild them is economically unjustifiable. Poor road network condition also translates into poor and often expensive transport services. This is a serious development constraint, especially in countries, where transport cost is a major determinant of prices of basic goods and services.

Sustainable financing of the road network requires a comprehensive awareness of road life cycle costs and available road sector funds. Often the road administration is limited in its ability to determine these network funding needs due, in part, to constraints in obtaining road network information and tools for calculating road costs and expected revenues or funds.

Domestic funding is generally not sufficient to cover expected road costs. The road sector continues to rely heavily on donor support for funding. For example in Ghana, between 1996 and 2003, donor funds constituted roughly 40% of annual road sector budgets [1]. The question here is not about the necessity of donor supports, but rather the extent to which current levels of reliance on foreign assistance are sustainable. Even though donor funds might appear indispensable, it is safe - from road financing sustainability perspective - to focus on available domestic funds when assessing developing countries' efforts at preserving their road assets.

As a starting point, sustainable road financing requires a thorough awareness of both the expected network life cycle costs on one hand and corresponding available domestic funds on the other hand. The sustainability of any road-financing plan is therefore measured by the extent to which these available domestic funds cover the expected life-cycle costs of the road network. How do we assess the balance between road network costs and available domestic funds? This paper presents a pragmatic cost-revenue model for identifying and estimating in a systematic, transparent and logical manner, all road costs and user contributions.

The cost-revenue model, developed in MS Excel, is applied to a case study on Ghana and Namibia - two Sub-Sahara African (SSA) countries, which have embarked on very ambitious road sector development programmes.

2. THE COST - REVENUE MODEL

The cost-revenue model is designed to assist road administrators and policymakers to estimate, in a simplified, transparent and logical manner all road life cycle costs, revenues from user charges and actual domestic funds allocated for road financing. The results of the model are used later used to calculate performance indicators.

The objectives of the cost-revenue models are basically to provide answers to the following questions:

- are sufficient funds allocated to cover expected road network life-cycle costs (i.e. maintenance and reconstruction costs)
- to what extent do road users contribute to the financing of these life-cycle costs? and
- how can road sector financing performance be measured?

By estimating both the funding needs of the entire road network of the country and also revenues from user charges, the model assesses the extent to which these domestic funds and revenues from user charges cover the expected life cycle costs of the road network.

2.1. Network life cycle costs

As a first step to estimating funding needs, the national road network has to be classified. This is important since different unit costs can be associated with different road types. In most countries each road class is administered by a separate road agency. Classifying the network, and placing them under different road agencies, is also essential for budget allocation purposes. Typical road classes that can be found in many countries are

- *Trunk (or national) roads*: These roads link regional (and district) capitals and form the main frame of the national road network. Trunk roads are of national strategic and economic importance. They could be further classified as national, inter-regional or regional roads. A national roads agency or a highway authority usually manages trunks roads.
- *Provincial roads*: these roads provide mobility for both passenger and freight in the regional or provincial context. They serve as connectors between towns not situated along national roads. Provincial roads are usually under the responsibility of the provincial government.
- *Urban roads*: these consist of roads within major town and cities. Urban roads are usually under the control of municipal governments in some countries.
- *Feeder (rural) roads*: These roads are classified as inter-district, connectors or access roads. Inter-district roads cross more than one district. Connectors are feeder roads that link a trunk road to either another trunk road or feeder road. Finally, an access feeder road provides a link between a trunk road and a (farming) community. Most feeder roads have earth surfacing.

The next step is to identify all road activities and estimate the financial requirements for the road sector. Typical road activities are routine maintenance, periodic maintenance and reconstruction or asset replacement. The classification of these cost items is based on the required frequency for the road improvement activity and the costs involved. Estimation of unit cost figures for road construction and maintenance depends very much on how road projects are contracted. Where contracts are awarded on fixed price basis, the unit cost could be taken as the average per km cost of current road projects. There are additional costs to cover road administration overheads and cost of capital.

2.1.1. Routine maintenance costs

Routine maintenance are maintenance measures aimed at enhancing the *functional integrity* of the road by ensuring a conducive road environment and riding surface. It is required, for example, to keep “good” roads in “good” condition. Routine maintenance can be classified into two categories, namely; pavement and non-pavement related. Pavement related maintenance activities are required at intervals during the year with a frequency depending on the condition of the pavement and traffic volume or traffic composition. One example is pothole patching.

Non-pavement related routine maintenance on the other hand is required on all roads (paved or unpaved) during the year irrespective of traffic or pavement conditions. Activities include bush clearing, drain clearing, ditch cleaning, culvert cleaning, road sign cleaning, repairs of minor damage to side slopes, levelling of shoulders and verges. Routine maintenance interval used in this model is one year.

2.1.2. Periodic maintenance costs

This maintenance type is required at intervals of several years. The interval depends on the type of activity and the road surface type. The aim of periodic maintenance is to preserve the *structural integrity* of the road. Periodic maintenance is needed, for example, to bring “fair” roads to “good” condition. Some periodic maintenance activities include resealing, regravelling, pavement overlay, spot improvement, asphalt concrete resurfacing (or partial reconstruction), walkway repairs, reconstruction of drainage structures (including culverts and bridges), roadway markings, installation of traffic signals and speed rumps [3]. Periodic maintenance interval can range from three years for regravelling to 12 years for asphalt overlay.

2.1.3. Asset replacement costs

Road infrastructure is designed to have a specific life span. At the end of this design life, the bearing capacities of the road sub-layers reduce to the point where they are unable to carry the expected traffic loads. At such a point it will not be economically worthwhile to continue with just maintenance works. The entire infrastructure (both sub- and super-structure) has to be replaced. Road asset replacement involves the reconstruction of the whole pavement structure including provision of new subbase, gravel base and a surfacing. Since road asset replacement involves a complete reconstruction, such a reconstruction cost could be as high as the cost of a new construction. The construction cost of a road is therefore assumed to be equivalent to the asset replacement cost. The unit cost of construction/reconstruction (measured in $/km) is the average per km cost of a newly constructed or reconstructed road. The unit construction cost should be estimated for each road class and surface type.

2.1.4. Administrative costs

Administrative costs include all other costs not directly related to specific road projects but which are required for the efficient functioning of the institutions and agencies responsible for road management and planning in the country. Typical administrative costs include traffic management and road safety, environment and social management, consultancy and technical support, training and institutional support. The administrative cost is taken as the proportion of total costs required to cover road agency overheads. It is expressed as a percentage of the total road budget. This benchmark is derived from past road administration overheads.

2.1.5. Cost of capital

The cost of debt, which is simply the expected interest payments, depends on the source of road funds. It can range from 0% (in the case of interest free-loans from some development banks) to say 15% (for many commercial banks). A sensitivity analysis may be performed on total road costs, and hence performance indicators, using different costs-of-debt.

The choice of appropriate interest rate to use in the model is based on the following interpretations:

- That government expects some minimum returns on investment when building transport infrastructure (otherwise it invests the money elsewhere)
- In order to improve transport infrastructure the government takes a loan that has to be serviced
- The transport sector is perceived as a business that must generate returns on investment

2.2. Network costing scenarios

The model examines two road network-costing scenarios. These are the “Base” and “Extended” scenarios. What constitute road network life-cycle costs? Which road cost items must be borne by road users?

2.2.1. The base scenario

The base scenario for network life cycle costing considers the case of “theoretically” new roads or a network in good condition. By assuming that the road network is already in good condition, the base scenario estimates the annual financial requirement for maintenance and future road asset replacement. The idea is that, supposing donors were to help a country to construct new roads or to rehabilitate its existing network, would the country be able to generate and allocate sufficient funds to meet:

- required routine and periodic road maintenance costs and
- annual asset replacement costs? That is, will the country be able to make necessary monetary savings to replace the network at the end of it economic or design life?

The base scenario aims at assessing the sustainability of donor-funded reconstruction and rehabilitation projects. Many donor-funded road projects have failed in the past because counterpart local funds required for routine or periodic maintenance are often not provided. This model will therefore assist policymakers and the road administration to estimate how much funds will be needed annually for road maintenance and replacement and also to determine if existing user contributions and allocated funds are adequate to cover the expected road life-cycle costs.

In the base scenario, the life cycle costs therefore consist of annual routine maintenance, annualised future periodic maintenance and asset replacement costs. There is also provision for administrative overhead and cost of capital. The model assumes an administrative cost of 5% of net total road costs and a cost of capital of 0%. With cost of capital of 0%, we are considering the case where road costs are financed from say interest-free loans. Though this may represent a rare scenario, by excluding any possible interest payment, the results of the model presents the least costs the road administration must bear irrespective of the sources of funding available to it. *Table 1* presents the road network life cycle costs for Ghana. The unit cost figures are obtained from unconstrained road budgets for year 2003 to 2005 [1].

Table 1 - Annual network life cycle costs in Ghana (base scenario)

Road class	Network size	Asset replacement costs				Routine maint. costs		Periodic maintenance costs			Total maint	Annual life-cycle costs	
Surface type	km	US$ /km	US$m	years	US$m /year	US$/km/ year	US$m	US$/km	years	US$m /year	US$m /year	US$m /year	%Asset cost
Trunk roads	12 690		3 493		137.6		13.3			61.8	75.0	212.7	6.1%
Asphalt	1 600	500 000	802	30	26.7	1 150	1.8	110 000	12	14.7	16.5	43.3	5.4%
Bituminous	4 730	300 000	1 420	30	47.3	1 040	4.9	23 000	9	12.1	17.0	64.4	4.5%
Gravel	6 360	200 000	1 271	20	63.6	1 020	6.5	22 000	4	35.0	41.5	105.0	8.3%
Urban roads	4 060		796		31.3		7.3			15.2	22.5	53.8	6.8%
Asphalt	410	404 400	167	30	5.6	1 900	0.8	83 550	12	2.9	3.7	9.2	5.5%
Bituminous	1 520	227 300	346	30	11.5	1 900	2.9	27 580	9	4.7	7.6	19.1	5.5%
Gravel	2 130	133 000	283	20	14.2	1 700	3.6	14 400	4	7.7	11.3	25.5	9.0%
Feeder roads	32 610		873		43.5		13.0			38.8	51.8	95.4	10.9%
Bituminous	1 210	141 300	172	30	5.7	470	0.6	16 200	9	2.2	2.8	8.5	4.9%
Gravel	17 770	30 000	533	20	26.6	470	8.4	6 300	4	28.1	36.4	63.1	11.8%
Earth	13 630	12 300	168	15	11.2	300	4.1	1 250	2	8.5	12.6	23.8	14.2%
Total	49 370		5 162		212.5		33.6			115.8	149.4	361.8	7.0%
Overheads					10.6		1.7			5.8	7.5	18.1	
Grand total			5 162		223.1		35.3			121.6	156.8	379.9	7.4%

2.2.2. *Extended Scenario*

The extended scenario estimates the financial requirements of the network in its current condition. By classifying the national road network under "good", "fair" and "poor" conditions, the extended scenario estimates both the cost of bringing the entire network to good condition and the recurrent costs of maintenance and asset replacement. The assumption here is that, as a first step, if a country's network is in a poor condition, it would require funds to bring it to a good condition and then maintain it as the need arises.

Consideration of this scenario is particularly important where a government must finance from its own resources the rehabilitation, maintenance and asset replacement costs. In estimating the additional cost of network rehabilitation, the entire road network is reclassified based on road class, surface type and surface condition as shown in *Table 2*. For each surface type in poor or fair condition, the appropriate maintenance intervention is recommended. Each intervention has an associated unit cost and a time interval for repeating that activity.

Table 2 - Cost of clearing existing backlog

Road class / Surface type	Network condition	Required intervention	Network length	Cost of clearing backlog		Over 10 years
			km	US$/km	US$m	US$m/year
Trunk roads			8 911		1 271	127.1
Asphalt			412		86	8.6
	Poor	Reconstruct	104	500 000	52	5.2
	Fair	Overlay	308	110 000	34	3.4
Bituminous			2 650		336	33.6
	Poor	Reconstruct	994	300 000	298	29.8
	Fair	Reseal	1 657	23 000	38	3.8
Gravel			5 848		848	84.8
	Poor	Reconstruct	4 043	200 000	809	80.9
	Fair	Regravel	1 805	22 000	40	4.0
Urban roads			2 889		396	39.6
Asphalt			240		62	6.2
	Poor	Reconstruct	132	404 400	53	5.3
	Fair	Overlay	107	83 600	9	0.9
Bituminous			883		122	12.2
	Poor	Reconstruct	487	227 400	111	11.1
	Fair	Reseal	396	27 600	11	1.1
Gravel			1 767		212	21.2
	Poor	Reconstruct	1 575	133 000	210	20.9
	Fair	Regravel	192	14 400	3	0.3
Feeder roads			26 267		448	44.8
Bituminous			522		45	4.5
	Poor	Reconstruct	291	141 300	41	4.1
	Fair	Reseal	231	45 300	4	0.4
Gravel			14 568		311	31.1
	Poor	Reconstruct	9 239	30 000	277	27.7
	Fair	Regravel	5 330	6 300	34	3.4
Earth			11 177		93	9.3
	Poor	Reconstruct	7 088	12 300	87	8.7
	Fair	Reshape	4 089	1 300	5	0.5
Total			38 068		2 115	211.5
Overheads					110	11.0
Grand total					2 221	222.1

Approximately US$2.2 billion is needed to clear existing maintenance backlog and bring the entire network to good condition. A national road development objective could, for example, involve a programme that aims at clearing all road maintenance and reconstruction backlogs within a defined time frame. In this case study, a 10-year network rehabilitation programme is assumed. This implies that the initial cost of network rehabilitation could be financed within a 10-year period at an annual cost of US$222 million, excluding interest on invested capital.

Additional funds are then needed for routine and periodic maintenance as well as asset replacement at the end of the network life. From the base scenario, annual maintenance and asset replacement costs are US$156.8 million and US$223 million respectively. The annual life cycle cost of the national road network therefore amounts to US$602 million. This is what is required, at least for the next 10 years, to finance current network improvement and maintenance and future network replacement costs. Summary of the expected network financing plan is shown in *Table 3* below.

Table 3 - Annual network life cycle costs in Ghana (extended scenario)

Road class/ surface type	Cost of clearing backlog		Annual maintenance costs	Annual asset replacement costs	Annual life cycle costs
	US$m	US$m/year*	US$m/year	US$m/year	US$m/year
Trunk roads	1 271	127.1	75.0	137.6	339.7
Asphalt	86	8.6	16.5	26.7	51.8
Bituminous	336	33.6	17.0	47.3	97.9
Gravel	848	84.8	41.5	63.6	189.9
Urban roads	396	39.6	22.5	31.3	93.4
Asphalt	62	6.2	3.7	5.6	11.8
Bituminous	122	12.2	7.6	11.5	31.3
Gravel	212	21.2	11.3	14.2	46.7
Feeder roads	448	44.8	51.8	43.6	140.2
Bituminous	45	4.5	2.8	5.7	13
Gravel	311	31.1	36.4	26.6	94.1
Earth	93	9.3	12.8	11.2	33.3
Total	2 115	211.5	149.4	212.5	573.4
Overheads	106	10.6	7.5	10.6	28.7
Grand total	2 221	222.1	156.8	223.1	602.0

Notes: *Cost of clearing backlog is spread over 10years. Interest rate used is 0%.

2.3. Road revenues

On the revenue side, the model distinguishes between what road users are paying into the system and what is actually allocated to the road sector. User contributions look at all revenues generated directly or indirectly from road users without regards to where or how these funds are allocated. Domestic funds consider all funds from domestic sources that are allocated exclusively for road financing. They include allocated user revenues and other general budgetary allocations to the road sector. Since the goal is to measure the extent to which road users are “paying their way”, the model ignore contributions from donors.

For countries like Ghana with a road fund system, domestic funds will basically be the sum of road funds and road sector share of the consolidated funds.

2.3.1. *User contributions and domestic funds*

The major sources of road user contributions in Ghana are the (1) fuel levy (2) vehicle registration fees (3) vehicle inspection fees (4) international transit fees and (5) road/bridge/ferry tolls. The objective of the government is to ensure that allocated user charges cover at least annual maintenance costs [1]. This objective has been constrained by low political support for review of user charges. These user charges are legislated and always require parliamentary approval for review, but this political consensus is often difficult to reach. The setting of user charges also takes into account the damaging effect of the vehicle types on the road network. They are base on axle loading and vehicle configuration, with heavier vehicles paying relatively higher fees. Apart from fuel revenue, all other revenues from road user charges are channelled directly into the road fund.

In the case of revenues from fuel related charges, which is currently the most important source of road funds, it is important to examine the difference between what users contribute and what is actually channelled to the road fund (see *Table 4*).

User contributions from fuel levies are the amount of fuel tax in excess of normal sales taxes. The analogy here is that, if fuel should be sold under normal market conditions just like “mineral water”, that is with no specific additional fuel related taxes added, then any tax payments in excess of normal sales taxes could be considered as road users “extra” contribution to the economy. The essence of this distinction is that, by just looking at the road fund fuel levy to assess the extent to which users are “paying their way”, we could be underestimating road users’ actual contribution to road funding in the country. In other words, road users may be paying more for using the road network than what the legislated road fund fuel levy is telling us. Table 4 illustrates the fuel pricing mechanism being used in Ghana and how user contributions from fuel levies are estimated [2] [6].

Table 4 - User contributions from fuel levies

Fuel tax /margins	Gasoline US$ cents/ litre	Diesel US$ cents/ litre
Ex-Refinery Current Price (1)	46.65	55.21
Excise Duty Specific	7.85	9.95
Cross-Subsidy Levy	5.47	(3.00)
Primary Distribution Margin	0.48	0.48
BOST Margin	0.96	0.96
UPPF Margin	3.06	3.06
Gross Margin	7.11	7.11
Total “Normal” taxes & margins (2)	*24.93*	*18.57*
Debt Recovery Fund Levy	5.47	5.47
Road Fund Levy	6.56	6.56
Energy Fund Levy	0.05	0.05
Exploration Levy	0.11	0.11
Deregulation Mitigating Levy	4.84	0.00
“Extra” taxes (3)	*17.03*	*12.19*
Ex-pump price (4) = (1)+(2)+(3)	88.61	86.01
User contribution = (3)	17.03	12.19

From *Table 4,* the total user contributions from fuel are US$ 17 cents for gasoline and US$ 12 cents for diesel, which is equivalent to the ex-pump price less ex-refinery price and "normal" taxes and margins. Road fund fuel levy is US$7 cents per litre. This means that only about one-half of what Ghanaian road users contribute, in terms of extra fuel taxes, actually goes to fund roads.

Table 5 shows the calculation of annual road user contributions from vehicle population and existing road user charges [3].

Table 5 - Annual total road user contributions for Ghana

Vehicle population		Vehicle registration revenue			Vehicle inspection revenues			User contributions through fuel levies			International transit revenues			Toll revenues			Road fund
Vehicle type	No. of vehicles	Reg. veh.	Fee	Rev.	Vehicles inspected	Fee	Rev.	Fuel levy	Consumption	Rev.	No. int. transits	Fee	Rev.	No. of trips	Toll rate	Rev	Total
	[2005]		US$	US$m		US$	US$m	US$/litre	Metric Tonnes	US$m		US$	US$m		US$	US$m	US$m
Motor cycles	112 400	15 150	5.6	0.08	89 900	2.2	0.20	0.17	633 400	148.8				3 237 400	0.02	0.07	151.7
Cars	427 300	29 600	22.0	0.65	341 800	2.2	0.75				179 500	2.2	0.39	12 308 700	0.05	0.68	
Pickup /Light bus	48 800	8 700	33.0	0.29	39 000	3.3	0.13	0.12	928 500	134.4	76 900	2.4	0.19	1 405 300	0.09	0.12	137.8
Heavy bus	107 400	5 600	43.9	0.25	85 900	3.8	0.33				59 700	4.4	0.26	3 094 500	0.14	0.44	
Light trucks	37 500	2 500	55.6	0.14	30 000	3.3	0.10				20 500	2.6	0.05	1 079 200	0.20	0.21	
Medium trucks	16 600	960	72.2	0.07	13 300	4.4	0.06				9 200	4.4	0.04	479 300	0.20	0.09	
Heavy trucks	13 700	1 380	131.8	0.18	11 000	11.0	0.12				7 200	5.5	0.04	395 600	0.44	0.17	
Total	763 700	63 870		1.66	610 900		1.69			283.3	353 000		0.98	22 000 000		1.80	289.4

Notes Assumptions (1) cars, motorcycles consume premium and pick-ups, buses and trucks consume diesel. (2) Approximately all refined premium and diesel oils are consumed by vehicles. Exchange rate US$ 1= GHC 9000

Total user contribution is about US$290 million but domestic fund allocated to roads is only US$185 million. In assessing the extent to which users are contributing to road financing, policymakers must be aware of the fact that over 45% of what users are actual paying (mostly coming from extra fuel taxes) are not allocated to roads.

Table 6 - User contributions and total domestic funds for Ghana

Sources	Domestic funds	User contribution
Fuel	129.60	283.30
Vehicle registration	1.66	1.66
Vehicle inspection	1.69	1.69
International transits	0.98	0.98
Tolls	1.80	1.80
Consolidated funds	49.40	-
Total	185.13	289.43

3. PERFORMANCE INDICATORS

How do we assess the extent to which sector objectives have been realised? How do we measure the performance of the road administration? To ensure that results of the model are useful to policymakers and the road administration, performance indicators that are measurable, comprehensive and holistic are developed. The indicators are tools for measuring the road sector performance in terms of revenue generation and allocation and the extent to which these funds cover road costs. To be objective and relevant, performance indicators ought to be broad enough to capture the essential concerns of the government and road administration [5]. They should also be flexible enough for use across different country contexts, and specific enough to be measured.

To summarise, the performance indicators should assist the road administration to

- evaluate the degree to which sector programmes have achieved their intended objectives,
- assess the efficiency of the road administration in implementing sector financing policies,
- develop alternative means of achieving financial objectives. For example by considering alternative sources of user revenues or cost minimisation strategies, and
- benchmarking and providing opportunity for sharing experiences.

3.1. Key performance indicators

These indicators measure the extent to which existing user contributions and allocated domestic funds cover estimated life cycle costs of the road network.

Table 7 - Key performance indicators for Ghana and Namibia

Performance indicator	Ghana	Namibia
User contributions in relation to		
(a) routine maintenance costs	862%	604%
(b) total maintenance costs	194%	93%
(c) total costs (base scenario)	76%	43%
(d) total costs (extended scenario)	48%	32%
Domestic funds as in relation to		
(a) routine maintenance costs	551%	786%
(b) total maintenance costs	124%	122%
(c) total costs (base scenario)	49%	56%
(c) total costs (extended scenario)	31%	42%
Domestic funds as share of user	54%	130%

User contribution
In Ghana, existing user contributions are able to cover all expected maintenance costs but can fund only up to 76% of the estimated total costs. This implies that if government decides to allocate all revenues from road user charges to the road sector, these user contributions are sufficient to finance up to 76% of expected road costs. User contribution as share of road costs is 43% in Namibia. Moreover, if the cost of initial network rehabilitation is included, then user contributions can cover only up to 48% of the total life cycle costs in Ghana compared with only 32% for Namibia.

Domestic funding
On domestic funds as share of user contributions, only 54% of what road users in Ghana contribute is eventually allocated for road financing compared to 130% in Namibia. This means that 46% of what road users in Ghana are contributing actually goes to subsidize other sectors of the economy, and in Namibia the road sector is receiving subsidies. Again, existing allocated domestic funds are sufficient to fund road maintenance in both countries, but are only able to finance 49% and 56% of the total costs in Ghana and Namibia respectively. If the costs of clearing existing maintenance backlogs are included, domestic funds are only able to cover 30% total road costs in Ghana and 42% in Namibia.

3.2. Secondary performance indicators

The secondary indicators measure indirect impacts of road sector under funding and also assist in explaining the differences in the key indicator figures.

Table 8 - Secondary performance indicators for Ghana and Namibia

Performance indicator	Ghana	Namibia	Unit
Road density	0.21	0.05	km/km2
User contributions per vehicle	379	801	US$/year
User contributions as share of GDP	3.3	2.7	%
User contributions per capita	13.8	72.9	US$/year
Domestic funds as share of GDP	2.1	3.5	%
Road maintenance costs in relation to total road costs	39.3	46.4	%
Road maintenance costs as share of GDP	1.7	2.9	%
Total road costs as share of GDP	4.3	6.2	%
Affordable network (with domestic funds)	35.7	56.4	%
Affordable network (with user contributions)	76.2	43.3	%

User contributions: User contribution per vehicle in Namibia is about twice that of Ghana. But Ghana's low user charges appear to be compensated by its relatively high motorisation. With roughly the same network size, motorisation in Ghana is over 700,000 vehicles compared with less than 200,000 vehicle population in Namibia. Higher motorisation offers benefits of economy of scale. If a government policy requires that road costs be solely financed from user charges, then with the same network size and comparable costs, countries with higher levels of motorisation can expect to have relatively lower user charges. To what extent should users contribute to financing an oversized network? Will it be economically justifiable for road user to pay for roads, which have been oversupplied?

Road maintenance costs: Road maintenance is an important component of a road-financing plan. The cost-revenue model indicates that to ensure that maintenance is not under funded, road maintenance funds should be 39% (Ghana) and 46% (Namibia) of total road budget. In other words, for maintenance to be fully carried out in Ghana on an annually basis, government must allocate 1.7% of annual GDP for road maintenance. The total road cost as share of GDP is 4.3%. This figure will be higher if the costs of clearing existing maintenance backlogs are included. Currently Ghana Government annual allocation from domestic sources to the road sector stands at 2.1% of GDP – which is less than 50% of what is required.

Affordable network size: Supposing domestic funds are the only source of financing the road sector, then based on existing level of domestic funding, only 36% of Ghana's road network is maintainable, which is low when compared with Namibia's 56% maintainable road network. On the other hand, if user contributions is the sole source of sector financing and if all will be allocated to the road sector, then 76% of Ghana's road network and 43% that of Namibia are maintainable with current user contributions. Another indicator, which measures the burden of road costs on a country, is road density. As can be expected, countries with higher road densities (measured in km/km2) will spend more on roads than those with lower road densities. Ghana's road density is about four-folds that of Namibia. Higher road density means greater accessibility, but it also implies higher required road investment and maintenance costs. It is therefore important for a country to strike an appropriate balance between the need to increase accessibility - by building more roads – and reducing road life cycle costs by keeping to an affordable (or a maintainable) network size. There are various options available to developing countries to finance the road network on a sustainable basis.

Increasing user chargers: considering the fact that users actually pay more for using poor roads, it is economically justifiable to increase user charges provided the funds generated will be allocated for road financing. With existing network conditions in both countries, fuel levies of US$ 0.14 (Ghana) and US$ 0.23 (Namibia) are required to cover network life cycle costs.

Focusing on core network: the most trafficked roads should receive priority when it comes to maintenance. Key rural roads leading to major market, health and education centres (which are mostly used occasionally) should have just sufficient seasonal improvements.

Road concessioning: the third option is to commercialise highways, through say road tolling, and to use the limited available road funds to finance feeder and urban roads, which because of their low motorisation levels cannot be self-financing. Highways are costly but are mostly only used by the car owners who are usually the well off in society. In the Ghana example, trunk roads constitute only 26% of the total network size but represents 60% of network life-cycle costs. Part of the road funds could also be used to subsidize public transport, which is mostly used by the urban and rural poor.

4. COMPARISON WITH OTHER ROAD MODELS

The cost-revenue model presented in this paper does not compete, but rather complement s other road investment models, which have been developed by other road investment institutions. In particular, this model is very useful where extensive road network data is not available. It only presents a rough estimate, as a starting point, of the financing requirement of the entire road network and available funds. It also serves as a useful guide in the allocation of funds to the different road sub-sectors. It does not prioritise road projects and therefore leaves the investment decision to the road authority.

Table 9: Comparison of road financing models

Model	Objective	Data requirements	Limitations
Roads Economic Decision (RED) Model	Performs economic evaluation of road investment options using the consumer surplus approach and is customized to the characteristics of low-volume roads	Road length, condition on the dry and wet seasons, geometry, surface type, and accident rates, social benefits etc.	Extensive network information is required
Highway Development and Management Model (HDM4)	Investigates choices in investing in road transport infrastructure. It prioritises projects based on budget constraints	Vehicle fleet, road network, road works, projects, programmes, strategies	Useful as a long-term planning tool only, as extensive network and vehicle fleet data, as well as calibration is needed.
Road User Charges (RUCS) Model	Estimates road user charges required to ensure that the costs of operating and maintaining all roads are fully-funded, and that each vehicle class covers its variable costs	Road geometry, condition, driver and vehicle fleet data (e.g. vehicle utilisation), road unit costs, road user charges,	Detailed data requirement on vehicle fleet.
Road Cost-Revenue Model	Assesses the extent to which existing domestic funds and user contributions cover road network life cycle costs	Network length and condition, road unit costs and user charges, vehicle population by class	Estimates network but not project costs Does not prioritise road investments.

5. CONCLUSION

Despite the important functions of roads, the road sector in many developing countries still remains grossly under funded. This has resulted in a large share of road networks in poor conditions. Under funding or deferred maintenance have severe future cost implications. Failing to provide maintenance when they are needed leads to higher future maintenance and reconstruction costs. These additional costs are estimated to be 25% (Namibia) and 37% (Ghana) of network life cycle costs. Although user contributions form a significant source of road budgets, they are not sufficient to cover the estimated life cycle costs of the road network. In Ghana, only one-half of what road users contribute, in the form of road user related charges, are actually allocated to road financing with the rest going to cross subsidize other sectors of the economy. These disparities between user contributions and allocated domestic funds underestimate the extent to which road users are contributing to the road sector or the national economy. Efficient allocation of existing road revenues should therefore be the first step to addressing the problem of road sector under funding.

With current levels of maintenance backlog, about 4.5-6.0% of GDP would be required to finance the life cycle cost of the network. The required cost of maintenance is 1.5-3.0% of GDP. How can developing countries ensure adequate funding for the road sector? The obvious solution is to increase existing user charges. But how much of road costs are road users able or willing to bear? It is recommended that where a government is unable to increase user charges to bridge financing gaps, due to say political or economic reasons, the road network could be reduced to an affordable size. This can be done by focussing on the core network with high motorisation and providing minimum improvement for less trafficked rural and urban roads. It is justifiable to have a core network size which existing resources can adequately fund rather than an oversized network, which is left to deteriorate due to lack of adequate funding.

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