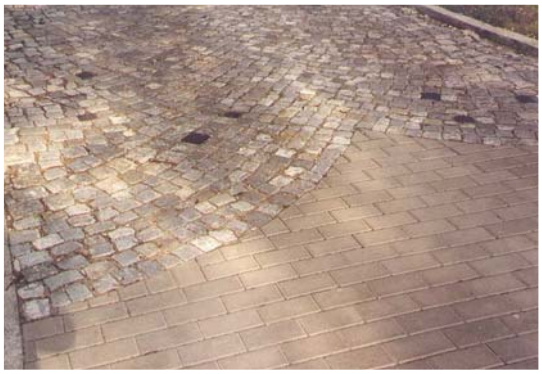

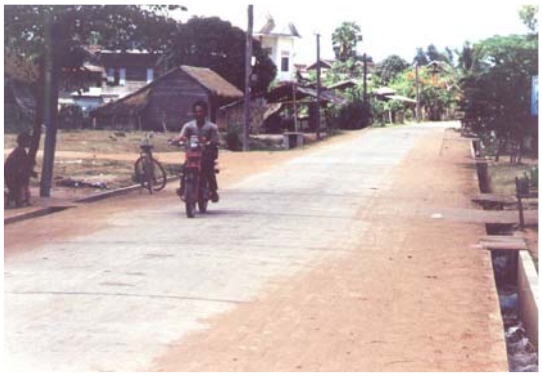

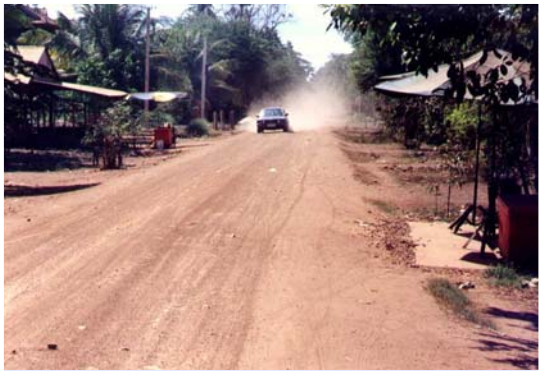

# LOW COST ROAD SURFACING (LCS) PROJECT

LCS WORKING PAPER No 3

## COSTING OF ROADWORKS

by
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Intech Associates
CONSULTING ENGINEERS

May 2002

***THE LOW COST ROAD SURFACING INITIATIVE***

The Low Cost Road Surfacing (LCS) initiative aims to provide documentation and international guidelines on the provision and maintenance of low cost road surfaces and basic access for rural communities in economically emerging and developing countries (EDCs). It is based on a research project funded principally by the British Department For International Development (DFID) under its Knowledge and Research (KaR) programme. The initiative is led by UK-based specialist consultants Intech Associates. Collaboration is being established with a number of organisations with interests or experience in the sector, including TRL Ltd, ILO/ASIST Africa and Asia-Pacific, the ILO-SIDA funded Upstream Project and Ministry of Rural Development Cambodia, WSP International, Ministry of Transport Vietnam, Greater Mekong Subregion Academic Research Network, University of the Witwatersrand RSA, The Institute of Technology of Cambodia, Chieng Mai University Thailand, and the Committee C20 (Appropriate Development) of PIARC (World Road Association). The LCS programme is being implemented over a 3 year period from 2001 to 2003.

The LCS programme is concerned with supporting sustainable improvements in low cost, road surfacing and basic access to support poverty reduction initiatives in rural communities. This implies the effective use of local resources, particularly human resources, locally available and alternative materials, and readily available and low cost intermediate equipment wherever possible. In the situation of scarce financial resources, it also requires the application of affordable and appropriate standards and adoption of techniques suitable for use by the indigenous private sector (particularly small domestic construction enterprises) and local communities. The application of good management practices coupled with adequate technical inputs are also encouraged.

It is intended that dissemination of the guidelines will be through electronic media as well as more traditional publication routes.

This Working Paper is intended to inform and provoke discussion, contributions and dissemination. The LCS Project welcomes dialogue with engineers, managers, organizations, communities and individuals active or interested in the rural transport sector with the objective of the promotion of a sustainable rural access approach for EDCs.

This document is an output from a project funded by the UK Department for International Development (DFID) for the benefit of developing countries. The views expressed are not necessarily those of the DFID.

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Abbreviations

EDC - economically Emerging and Developing Country
IFRTD - International Forum for Rural Transport and Development
ILO/ASIST - International Labour Office/Advisory Support Information Services & Training programme
ITC – Institute of Technology of Cambodia
KIHBT – Kenya Institute of Highway and Building Technology
KTC – Kisii Training Centre
LCS - Low Cost (Road) Surfacing
TRL - Transport Research Laboratory

COSTING OF ROADWORKS

*Note: This is a draft document for consultation and comment. Extracts may be copied provided the source is acknowledged.*

By Robert Petts, B Sc, C Eng, MICE, MIHT, MIAgrE., Principal Intech Associates.

## 1. INTRODUCTION

This paper discusses important issues relating to costing of roadworks in developing countries.

Various types of costing are required in the roads sector to meet the objectives of the developing country organisations involved in construction and maintenance operations, for example:-

**Figure 1 - Types of Costing for Roadworks**

| Organisation | Costing Purpose | Remarks |
|---|---|---|
| Road Planning Authority | Network maintenance & development planning, benefit-cost analysis. | Desirable accuracy - moderate. Usually based on typical cost per km of category of road and surface type and cost per m² of structure. Based on historical data with allowances for inflation. To include consultation, works costs, plus design, preparation, supervision and audit costs. May also require additional socio-economic and environmental cost considerations. |
| Force Account Road Department | Internal cost analysis of operations, plant fleet replacement planning, forward budgets, annual budgets for each account. | Desirable accuracy - moderate to accurate. The various inputs may be procured on different accounts and possibly through separate departments (e.g. finance and equipment capital expenditures). Identification of all costs is often difficult with the accounting systems used. |
| Road Authority Contracts Department | Forward budgets, contract estimates, tender evaluation and contract monitoring. | Desirable accuracy - moderate to accurate. Inflation, risks, contingencies and cash flow predictions/analyses are important aspects. |
| Contractors & Sub-contractors | Internal cost analysis, pricing for tenders. Ensure profitability. | Requires accurate and up-to-date knowledge of all costs and productivities. |
| Equipment Hire Organisations | Cost recovery and adequate return on investment. Ensure profitability. | Requires realistic and detailed knowledge of true ownership costs (including finance and depreciation), operating costs and overheads which must be recovered through the charge rates. |

In economically developed countries, quantity surveying experts and organisations closely monitor actual contract costs and provide comprehensive costing services to the road sector. Costing manuals are available and updated on a regular basis (e.g. Reference 2). Unfortunately, in developing countries these services are not commonly available and individual organisations generally do not have the in-house resources and information to carry out the costing properly. The cost basis and operating environment are also usually very different in developing countries.

Accurate costing depends on the realistic assessment of a wide range of factors affecting

the input costs of an operation, and the productivity or efficiency of the operation. Unfortunately the task is made more difficult in developing countries by a number of influential issues such as finance and physical resource shortages, variable workload, imperfect markets, exchange rate fluctuations, inflation etc.

This paper is not a comprehensive guide to the costing of roadworks for each organisation and each level and cost function. However it does discuss some of the important issues relating to costing which have often been neglected in the past. This situation has unfortunately lead to unsupported and incorrect decision making at policy, investment and operational level and the inefficient or inappropriate use of the resources available.

By consideration and application of some of the principles discussed in this paper, it should be possible to improve the efficiency of the use of the limited road sector resources available by developing and applying better costing systems within each sector organisation.

## 2. General

Actual costs are affected by method of implementation. For a force account operation, finance and depreciation components for equipment, operational overheads may not be documented or appreciated. However they will be incurred somewhere in the system. Contractors will naturally have to include all of these costs in their contract prices, plus allowances for profit, late payment and other risks. To make a valid comparison between force account and contractor implementation, a full costing should be carried out of both systems to include all of the components discussed in this paper.

It is possible for a contractor to make savings on many cost items due to the pressures of competition and efficiency, to make a profit and still complete work cheaper than a force account operation if ALL cost components are fully and realistically priced. This is particularly relevant for construction operations. It can also apply to some road maintenance operations.

## 3. Outline Costing

For efficient management of a road network it is necessary to keep careful historical and current records of works costs. This will be necessary for planning and budgeting purposes, and also for evaluation of tenders from contractors.

It will probably be necessary to adjust figures for inflation, as this may be significant. This can sometimes be achieved with reference to statistics collected and presented by the Government statistical office. Where these are not reliable, or are non-existent, then costing and inflation adjustment becomes more problematic and resource consuming.

Historical costs can be inflated approximately using knowledge of the percentage components affected by key items such as labour, new plant costs, diesel, transport haulage, and applying inflation factors to these components. Significant movements in currency exchange rates will also affect imported items/components and overall construction and maintenance costs.

## 4. Detailed Costing

It will usually be necessary to prepare a detailed costing of a road construction scheme or maintenance operations, either for internal budgeting and funding purposes, or for

contracting out the work. This will normally be achieved through preparation of a *Bill of Quantities* (BoQ) which can be priced internally, or on behalf of the client, and by a contractor.

The BoQ will normally contain an item for each construction or maintenance activity with a description. The tenderer will insert a unit rate and carry out the price computations.

Bills of quantities in a national standardised format and activity related items will assist clients and contractors in pricing works and assessing value-for-money. It will also assist both clients and contractors to build up a database of costs for every construction and maintenance activity.

Each BoQ item description and method of measurement should be described in detail in the contract documents to avoid misunderstandings during the estimating and measurement for payment of the work. Where there is a technology choice, or a policy of encouragement of a particular technology, then this should be clearly stated in the contract and measurement documents.

The usual approach is to calculate all of the direct site costs, such as materials, equipment hire and labour costs for each BoQ item. All other costs such as preliminaries, mobilisation, overheads and profit, are then calculated for the contract/project. These 'on-costs' may be assigned to specific bill items provided for this purpose or spread across all of the BoQ items.

Contractors, their estimators/quantity surveyors or contractors' associations should keep detailed cost and performance records for each BoQ item. If these are not available, then it is necessary to calculate every bill item from first principles and without the benefit of experience. This is very laborious and would undoubtedly involve increased estimating risks.

In a cost database, BoQ items can be divided into their components of labour, materials and equipment. These can be factored by increases in their prices to facilitate estimating in an environment of cost inflation.

The checklist in Figure 2 indicates the components which should be included in any complete costing and contract.

Actual costs or the contractor's perception of them can vary according to a range of 'operating environment' factors. This will influence tender prices. These factors may include:-

- size of project (economies of scale)
- location (mobilisation & demobilisation costs) & type of project
- contractor's experience and expertise
- financial arrangements and health of the contracting enterprise
- availability of resources
- market conditions (scarcity or surplus of work)
- nature of the competition
- general reputation of the client and client's advisers
- specifications and quality standards and how strictly they will be adhered to
- client's reputation and ability to ensure timeliness of due payments
- labour relations and government attitude/directives regarding labour issues
- local inflation, loan interest rates and currency exchange rate stability
- quality and adequateness of the contract documents and arrangements
- actual or perceived risks.

**Figure 2 - Checklist of Items for Contractor's Costing for Roadworks**

| Direct Site Costs | Overheads & Profit |
|---|---|
| ❑ Materials (including losses)<br>❑ Quarry royalties/fees<br>❑ Bought in components (e.g. culvert rings)<br>❑ Unskilled labour<br>❑ Skilled labour<br>❑ Equipment operating costs<br>❑ Equipment hire<br>❑ Hand tools & survey equipment<br>❑ Temporary works (e.g. shuttering, shoring, de-watering etc.)<br>❑ Services hired in (e.g. site surveyors) | ❑ Equipment purchase/depreciation<br>❑ Equipment finance or opportunity costs<br>❑ Finance of other capital expenditure, purchases, stores, parts, cash flow or retention monies<br>❑ Other banking charges<br>❑ Insurances, bonds, guarantees<br>❑ Depreciation/write-off of non-equipment assets<br>❑ Site Camp, main office, workshop, field/mobile workshop, stores, accommodation establishment & operating costs<br>❑ Supervision and support vehicles<br>❑ Mobilisation and demobilisation costs<br>❑ Ongoing transport to and from site and freight<br>❑ Supervisory, technical and clerical staff recruitment and payroll costs<br>❑ Security measures, facilities or services<br>❑ Services (water, electricity, sanitary)<br>❑ Communications (telephone, mail, radio)<br>❑ Training<br>❑ Services hired in (e.g. estimators, temporary works design, accountants, auditors, legal)<br>❑ Travel, meetings with client<br>❑ Investigations & tender preparation costs<br>❑ Protective clothing and safety arrangements<br>❑ First aid and injury costs<br>❑ Traffic control/signs/diversions access and service roads<br>❑ Testing of materials<br>❑ Personnel allowances, welfare, pensions, health, social costs<br>❑ Marketing, public relations, catering/entertainment<br>❑ Contingency/Risks (e.g. unforeseen additional unpaid work, poor materials, remedials, late payment, weather/seasonal, late completion and other delays, dispute resolution)<br>❑ Inflation/cost adjustment arrangements/allowances<br>❑ Taxation, duties, licences, permits, levies etc<br><br>❑ Profit |

*Note: some costs may be treated as either Direct Costs or Overheads*

Care must be taken by clients in using historical contract BoQ items for assessing new tenders. Contractors can be adept at distributing costs on a particular contract with weighting to certain items to facilitate cashflow early in a contract, or where they anticipate that quantities of a particular item will increase.

Lump Sum, Cost Plus and Target Price forms of contract are not commonly used in the roadworks sector in developing countries. These alternatives require careful individual cost and risk assessment as they are inherently more risky for either client or contractor. These types of contract arrangement are not discussed in this document.

## 5. Equipment Costing

Equipment costing probably poses the greatest problem for both force account organisations, contractors or plant hire organisations in developing countries. To realistically cost equipment and ensure that equipment can be replaced when worn out or obsolete, comprehensive and realistic costing must be carried out on an ongoing basis. Although operating costs are reasonably easy to assess, major problems exist with calculating ownership costs which consist primarily of finance and depreciation components.

Calculation of these costs involves making assumptions far into the future regarding the economic life, annual utilisation and residual value of the equipment. This involves considerable risks in a developing country environment. Ownership costs can be a very high proportion of the total overall costs of ownership and operation of a piece of equipment. Failure to appreciate the real costs of owning and operating equipment has contributed to the failure of many developing country contractors.

### *Equipment Cost Components*

There are a number of components to equipment costing which must be fully appreciated and accommodated in any full and realistic costing of a piece of equipment.

**Figure 3 - The cost components to be considered:**

**OWNERSHIP**

- **Finance/Opportunity cost of capital**
- **Depreciation/Replacement/Amortisation**

**OPERATING**

- **Spares and consumables**
- **Workshop costs**
- **Fuel and lubricants**
- **Operators' payments, allowances & other costs**

**OTHER**

- **Overheads**
- **Risk (e.g. late payment)**
- **Profit**

Some of these components are discussed in detail in the following text.

## *Equipment Costing Issues*

This section considers factors which can have a significant effect on real equipment costs, losses or profits for a contractor, or performance of a road authority.

Accurate equipment costing depends on a large range of factors as indicated in Figure 4. Many of these factors vary over time and a number of the influences can be outside the control of the equipment owner, e.g. finance costs, inflation, foreign exchange rate fluctuation, fuel costs, imported spares costs, etc.

Furthermore predictions have to be made up to 15 or more years ahead on issues such as expected equipment life, availability or cost of funding (interest rates), market for disposal of the equipment, and probably most importantly; Utilisation.

**Figure 4 - Costing of Equipment - Factors to Consider**

| Input Costs | Output / Productivity |
|---|---|
| ❑ Economic Life<br>❑ Depreciation: Capital Investment /Replacement<br>❑ Obsolescence<br>❑ Salvage value/demand for used equipment<br>❑ Interest: Investment Costs<br>❑ Spare Parts and Consumables<br>❑ Workshop (inc. mechanics, equipment, tools, manuals, stores, etc.)<br>❑ Mobile mechanical & logistical support<br>❑ Workshop Management<br>❑ Skill/motivation of mechanical support<br>❑ Mobilisation (Low loader)<br>❑ Manufacturer's local agent support<br>❑ Insurances and taxes<br>❑ Fuels, lubricants and greases (& their quality)<br>❑ Operator and assistant(s)<br>❑ Accommodation/transport/payroll costs<br>❑ Training (initial & ongoing)<br>❑ Environmental (e.g. dusty air)<br>❑ Standardisation of equipment (effects on spares/skills/training)<br>❑ Security arrangements, stock losses<br>❑ Equipment abuse/inappropriate use<br>❑ Forex premium<br>❑ Risks and cashflow on long term investment<br>❑ Contractor cashflow: time lag between incurring costs and payment | ❑ Standing time (breakdowns, awaiting spares/fuel, etc.)<br>❑ Unproductive time (awaiting instructions, travel to/from/between work sites etc.)<br>❑ Productive time per year<br>❑ Type & size of machine (appropriate? flexible?)<br>❑ Ground conditions<br>❑ Climate - weather, seasonal factors<br>❑ Altitude (on engine performance)<br>❑ Nature of the work<br>❑ Skill/motivation of Operator/assistant(s)<br>❑ Condition of Machine<br>❑ Work Planning and Organisation<br>❑ Adjustments from manufacturer's performance guidelines |

*These factors will affect the cost of ownership and operation of equipment, and its profitability.*

An investment in equipment certainly carries considerable risk.

Further guidance on costing of equipment and a simple cost model can be found in

Reference 3.

### *Ownership Costs*

There are two important, and potentially large, components in the ownership costs of a piece of equipment, these are:-

- **Depreciation/replacement/amortisation,** and
- **Finance or Opportunity Cost**

In the past public authorities have tended to ignore these important cost components (with very unfortunate consequences). Many contractors have also not evaluated these costs realistically. Some reasons for this can be cited as:

- equipment being provided by international agencies with (low interest) loans or as gifts,
- equipment inherited from other organisations (such as aid projects),
- no capital or interest charges to the user,
- equipment procurement, management and user organisations being separate,
- very low inflation,
- equipment considered as 'written off' and therefore 'free of charge'
- considerable work involved in calculating and updating costs,
- long expected equipment life so that replacement will be "somebody else's problem".

Furthermore by ignoring these costs it has not been possible to make fair comparisons between force account (internal) and contractor operations options.

However in a future sustainable system, this approach will not be possible and commercial and responsible asset management practices will have to be adopted by contractors, public fleet owners and users alike, taking account of all costs.

There are different approaches for viewing and treating these ownership costs. However these guidelines recommend the following method.

### *Depreciation/replacement/amortisation*

A piece of equipment is a substantial capital investment and should be viewed as an asset (although invariably declining in real value or depreciating).

Depreciation is the charge which should be made for using up the life of the equipment. For example when new, a piece of heavy equipment may have an expected economic life of 10,000 engine hours. The difference between the cost new and the residual/scrap value should be spread over the anticipated 10,000 hour working life and charged to the user for each hour used. The economic life or asset value of the piece of equipment is being ***consumed*** and should be paid for.

Naturally if the economic life is assessed to be only 5,000 hours in the working environment for various reasons then the depreciation charges should be adjusted accordingly, i.e. double in the example given. It is therefore very important that the owner is realistic in his/her assessment of the economic life. The factors indicated in Figure 4. are influential in the determination of this. Economic life can vary by a factor of more than 10 under the range of influences in practice in developing countries.

It is important to appreciate that even with inflation the residual value is always tending towards zero or a very small value (unlike say, an investment in some property).

**Figure 5. Example - Effect of Equipment Life on Depreciation Charges**

A piece of equipment costs 150,000 Local Currency Units (LCU). It is assumed that at the end of its life it has no residual or scrap value.

If the equipment works for its total design life of 10,000 hours, the depreciation cost would be **15 LCU/hour**.

If it works only half its design life (5,000 hours) before being scrapped, the depreciation cost would be **30 LCU/hour**.

If it works only 1,000 hours before being scrapped, the depreciation cost would be **150 LCU/hour**.

If there is significant inflation, as is experienced in many developing countries, then it is important to regularly revise depreciation charge rates to reflect **current replacement costs** of the equipment. Otherwise the value of asset being used up will be undervalued and insufficient funds will be raised to replace the asset or repay the capital investment. Continuing with the example above, each hour of an expected 10,000 hour life should be charged at 1/10,000$^{th}$ of the **current** difference between cost new and scrap to avoid loss of asset value.

**Figure 6. Example - Effect of Inflation**

A piece of equipment cost 150,000 Local Currency Units (LCU) when purchased new 5 years ago. However, with inflation a replacement of the same model would now cost 250,000 LCU. The current scrap value for a similar machine is 25,000 LCU.

Assuming the machine will have a working life of 10,000 hours, the current depreciation charge should be:-
(250,000 - 25,000) / 10,000 = **22.5 LCU/hour**

*IF THE OWNER MAKES INSUFFICIENT CHARGES FOR DEPRECIATION/ REPLACEMENT THEN HE/SHE IS EFFECTIVELY WASTING THE ASSET.*

A contractor risks bankruptcy and a public fleet manager risks ending up with a fleet of scrap with insufficient funds to replace it. Unfortunately it can take many years for this to become apparent when equipment life cycles are typically 10 - 20 years.

For normal accounting purposes a writing-down or depreciation allowance is usually made for equipment investments. This is for accounting or taxation purposes and should not be confused with the economic management of the equipment asset and charge rates to be recovered from the user or client.

### *Finance or Opportunity Cost*

This is a more difficult concept to appreciate. This is the *cost of the capital* tied up in the piece of equipment. There are two ways of looking at this cost.

Firstly, if an individual, contractor or organisation procures a piece of equipment and needs to borrow the money to buy it, he/she will be charged interest on the capital amount (as well as having to repay the total capital amount borrowed - the principal). The cost of this interest should be recovered from the use of the equipment. Sometimes this charge is actually included in the overall overhead of the organisation, however it is likely to be a substantial component and should certainly be part of the equipment charge rate.

Alternatively, if the owner already has the financial resources to buy the equipment for cash, he/she could choose to invest that money elsewhere, e.g. deposit at a bank, purchase government securities bearing interest, loan it to another business or friend. In every case the owner could expect a *return* or *interest* on the capital deployed, as well as getting the capital back after a period of time.

Whichever view is taken there is a cost or value on the availability of the capital or *opportunity cost* - the interest charged for or foregone by investing in the equipment.

**Figure 7. Example - Finance Cost**

A contractor buys a piece of equipment which costs 150,000 Local Currency Units (LCU) new. The purchase is financed completely by a bank loan with security provided by some property that he owns. The fixed interest rate and other charges relating to the loan (excluding capital repayment) are equivalent to an interest rate of 20% per annum. The contractor expects to work the machine for 10,000 hours over a 5 year period (i.e. 2,000 hours/year) over which time he will repay the loan.

The costs of finance can be calculated as follows:-

$$\text{Finance cost} = \frac{((N + 1) / 2N) \times \text{Purchase Price} \times \text{interest rate expressed as a decimal}}{\text{Hours per year}}$$

*Where N = number of years of the loan.*

In this case the finance charge should be **9 LCU/hour**

Lower utilisation or extended repayment periods would increase this figure significantly. For example, an 8 year equipment life and loan repayment period, and 1,200 hours per year, utilisation would raise the finance charge to **14 LCU/hour**.

The problem is to determine what value should be used for costing this component. For a piece of equipment procured on a loan, it is fairly straightforward. The cost should be the actual cost of the finance, i.e. the interest charges plus any other (non-capital repayment) charges that the financing institution includes in the loan arrangement.

Extreme care should be taken regarding the evaluation of finance arrangements, as lending institutions have different (and often to them lucrative) ways of calculating interest charges.

The same quoted interest rate can result in widely varying interest charges due to different calculation methods. It is important to obtain detailed information on the actual interest repayments, whether they are fixed or will vary throughout the period of the loan.

If the equipment is purchased with cash, or has already been 'written off', more flexibility can be used to assess the value of the capital. This is one cost component where a contractor can adjust his/her price to gain competitive advantage after considering the prevailing market rates. Consideration of current and likely future interest rates, the risks associated with alternative investments, and inflation rate should also come into the decision making process.

Ultimately an equipment owner will have to work within the constraints of the local market and will not be able to charge significantly more than the prevailing market rate. However it is essential that the owner appreciates whether, by hiring out at the market or particular rate, he/she would be making an actual loss or a profit. Operating for extended periods at a loss inevitably leads to insolvency.

### *Intermediate equipment*

Intermediate equipment, which is often fabricated locally within a country, usually involves low cost and capital outlays for a contractor. The output may be limited, however this is often suited to intermittent or small scale works. The low cost may mean that the investment can be recovered by the contractor within a short period of time, thus reducing the risks compared to the long investment recovery periods typical of heavy plant.

### *Second Hand Equipment*

In some countries there is an established practice of importing second hand (used) equipment from developed countries. This involves much lower capital outlays for contractors. Provided that the skills are available locally to repair the particular equipment models, and possibly to refurbish or manufacture spares, then the cost of ownership and operation of such equipment can be much lower than in economically developed countries. Such local capacity can considerably extend the working life of equipment.

**Figure 8 - COSTING OF LABOUR - FACTORS TO CONSIDER**

| Input Costs | Output / Productivity |
|---|---|
| ❑ Wages<br>❑ Availability/competition from other sectors<br>❑ Allowances<br>❑ Labour Accommodation/transport & payroll costs (avoided when using casual labour)<br>❑ Medical support<br>❑ Water provision<br>❑ Recruitment<br>❑ Protective Clothing<br>❑ Pension, insurance, other payroll costs<br>❑ Training<br>❑ Handtools (approx 5% of wages?)<br>❑ Labour paid after work carried out<br>❑ Contractor cashflow: time lag between incurring costs and payment | ❑ Task rates/productivity targets<br>❑ Supervision<br>❑ Ground conditions<br>❑ Climate - weather, seasonal factors<br>❑ Motivation/incentive schemes<br>❑ Skill/motivation of supervisors<br>❑ Cultural and social traditions<br>❑ Quality of/availability of/appropriate Handtools<br>❑ Health and nutrition<br>❑ Labour availability<br>❑ Seasonal availability (e.g. harvest time competition)<br>❑ Other work opportunities<br>❑ Work planning and organisation |

## 6. Costing of Labour Operations

The costing of labour operations is somewhat simpler than equipment as most of the input costs can be identified and predictions far into the future are not required. The risks involved with costing of labour based operations are therefore reduced compared to equipment. The factors influencing the costing of labour operations are set out in Figure 8.

## 7. Strategies for Effective Costing

Due to the complexity of accurate costing and the enormous amount of ongoing data collection and analysis required, this is often too much of a burden on the limited resources of individual small local contractors. The following arrangements could substantially reduce this burden. Suitable arrangements would have to be developed to fund and resource (and possibly charge for) these services on a sustainable basis. It would be essential to develop users' confidence in the service and ensure that pricing would be equitable and comprehensive.

### *Client fixes Contract rates for Common Operations*

The Client carries out, or arranges for, costing of commonly used operations such as provision & haulage of gravel, installation of culverts or grading/reshaping. This requires the provision of good quantity surveying services, either internally or contracted in, on a regular basis. Rates usually have to be approved by a government tender board. Unit rates have to be fully inclusive of all finance, depreciation, mobilisation, overheads, risk and profit etc. Such a system has been used in Uganda. Where there is a local shortage of contracting capacity, individual registered contractors can be appointed to carry out the roadworks using the standard unit rates. Where the market is effective then contractors can be asked to submit bids based on the standard unit rates (percentage discount or premium).

### *Client Guideline Costing Service*

The client will organise detailed costing of all standard BoQ items and the details of the cost breakdown and assumptions would be provided with the tender documents. The first step towards this approach has been made by a programme in Namibia whereby the client's estimate for each operation is inserted alongside the item in the tender BoQ. With an accompanying detailed cost analysis, tenderers would be able to make their own assumptions and adjust each bill item cost accordingly.

### *Contractor's Association Estimating Service*

A contractor's association would be well placed and motivated to provide baseline costing services to its members for a fee. Non-members or clients could also be encouraged to use the system for a (probably higher) fee.

### *Local Quantity Surveying Services*

Local quantity surveying companies could provide costing services for a fee. Clients and contractors would need to be convinced of the need for and value of such services. Confidentiality would be a major issue and have to be safeguarded for each contractor using the services.

**Figure 9. What should it cost?**

Unfortunately many authoritative documents quote single values for the cost of individual roadworks operations. This is grossly misleading. Hopefully this paper has demonstrated the wide range of factors that will influence the cost of an operation. The same activity can have a real cost differing by a factor of 10 or more in different locations, for different standards and quantities, using different technologies, different implementation arrangements and operational environment conditions.

Real cost awareness can significantly improve the decision making process and achieve much better use of the limited resources available.

As a 'rule of thumb' guideline ***only,*** the following ***can*** be achieved using labour and intermediate equipment technology in a low labour wage environment. Costs include finance and depreciation and, where appropriate, profit.

- Rehabilitation of unpaved road - camber & drainage system only - from US$ 2,000/km
- Construction/rehabilitation of a gravel rural road - from US$ 7,000/km
- Construction of a dressed stone paved road - from US$ 8,000/km
- Construction of a bitumen seal surfaced road - from US$ 10,000/km
- Routine maintenance (only) of a gravel rural road - from US$ 250/km/year
- Periodic maintenance of a gravel rural road - US$ 400 to 2,000/km/year

***There is no shortcut - roadworks must be properly costed in all situations.***

## References


1. **Thagesen B.** *editor,* Highway and Traffic Engineering in Developing Countries, E & FN Spon, 1996.
2. **Davis Langdon & Everest,** Chartered Quantity Surveyors, *editor,* Spon's Civil Engineering & Highway Works Price Book, 11th edition, E & FN Spon, (Annual).
3. **Petts. R.**, Handbook of Intermediate Equipment for Roadworks in Developing Countries, MART, draft January 1999.
4. **Associated General Contractors of America**, Contractors' Equipment Cost Guide.
5. **Gongera K. & Petts R.,** A Tractor and Labour Based Routine Maintenance System for Rural Roads, 2000.
6. **Andersson C., Beusch A. & Miles D.,** Road Maintenance and Regravelling (ROMAR) using Labour-based Methods, Handbook & Workbook, I T Publications, 1996.
7. **Intech Associates & Sesani Projects (Pvt) Ltd,** Equipment and Rural Road Maintenance Cost Study, for Department of Roads, Association of Rural District Councils, Zimbabwe, ILO & Sida, Final Report, 1998.

## Appendix – Example Assessment of Real Direct and Overhead Costs

### Description of the Zimbabwe Rural Road Maintenance System

The maintenance system is operated under a parastatal organisation with responsibility for all management of a core district road network of approximately 25,000 km.

The rationale behind of Routine Road Maintenance System in Zimbabwe, is based on the segmentation of districts into a number of unit areas, where individual unit areas typically contain some 120 - 160 km of road under maintenance. These unit areas are each the responsibility of a Maintenance Unit, which is based in a Maintenance Base Camp located centrally within the Unit Area. This base camp accommodates the personnel, equipment and tools required to execute the road maintenance activities.

The main purpose of the Road Maintenance Unit is to ensure that, through proper execution of planned routine maintenance activities, the rural road network is kept in good trafficable condition throughout the year and that the useful life of the road surface is extended until periodic maintenance (regravelling) is required.

The Routine Road Maintenance mainly comprises activities that have to be performed regularly throughout the year. These maintenance work activities are straightforward ***routine*** activities which, once mastered, are repeated throughout the year according to seasonal requirements. The most effective way to ensure that these activities are properly carried out is to prepare detailed individual work programmes tailored for each Maintenance Unit Area taking account of each road's specific needs. The smaller sizes of the maintenance unit areas make the management of the maintenance easier (less roads to plan, easier organisation for the execution of activities and better control of activities) and reduce the need for highly qualified technical staff. A small number of engineers are based at Headquarters, all field management is by trained and experienced technician and artisan personnel.

The Road Maintenance Unit Set-up

The Road Maintenance Unit (RMU) is the core element of the maintenance system. The RMU comprises a team of trained staff (Maintenance Supervisor, Unit Clerk, Tractor Driver, Towed Grader Operator, and Mechanical Aid), who along with the necessary equipment and material resources operate from a centrally located base camp within the Maintenance Unit Area.

These Area Based Units are completely self-contained regarding their day to day operation and look after all rural roads within their specified influence area. The maintainable length of road is dictated by what can be handled using 1 agricultural tractor, which is the key item of equipment required for towed grading, tyre dragging and transporting the labour and materials. This length is between 120 and 160 km of road, principally depending on traffic quantities and terrain.

## Zimbabwe Routine Maintenance System for District Roads

Costs have been calculated for two extreme cases of the road network under the responsibility of a standard maintenance camp. i.e. 100 km and 200 km (network average = 150 km). Excludes Erosion Control and Bridge repair works.

| | | | | | | | ANNUAL COSTS (Z$) | |
|---|---|---|---|---|---|---|---|---|
| ***Prices are mid 1997.*** | | US$1=Z$ | 12 | | | **Network km** | **100** | **200** |
| **1.** | **DIRECT COSTS - ANNUAL** | | | | | | | |
| 1.1 | **Labour** | | | | | | | |
| | Monthly wage rate | | 608 | Z$/month | | | | |
| | Average monthly casual labour force - 100 km | | | | | 7 | | |
| | Average monthly casual labour force - 200 km | | | | | 14 | | |
| | Annual casual labour costs | | | | | | 51,072 | 102,144 |
| 1.2 | **Handtools @ 5% of labour costs** | | | | | | 2,554 | 5,107 |
| 1.3 | **Equipment** | | | | | | | |
| | Finance/opportunity cost on capital | | | 15 | % | | | |
| | FINANCE/OPPORTUNITY | | cost new | life years | | residual% | | |
| | MF 275 Tractor (70 hp) | | 240,000 | 10 | | 15 | 19,800 | 19,800 |
| | AG 4000 Towed Grader | | 85,000 | 10 | | 20 | 7,013 | 7,013 |
| | 5 tonne Trailer | | 60,000 | 10 | | 10 | 4,950 | 4,950 |
| | 4,500 litre Bowser | | 60,000 | 10 | | 10 | 4,950 | 4,950 |
| | Tyre drag/20 km | | 500 | 10 | | 0 | 206 | 413 |
| | DEPRECIATION | | | | | | | |
| | MF 275 Tractor (70 hp) | | | using | | | 20,400 | 20,400 |
| | AG 4000 Towed Grader | | | the | | | 6,800 | 6,800 |
| | 5 tonne Trailer | | | above | | | 5,400 | 5,400 |
| | 4,500 litre Bowser | | | assumptions | | | 5,400 | 5,400 |
| | Tyre drag/20 km | | | | | | 250 | 500 |
| | Towed gradings/year (average) | | | 4 | | | | |
| | Tyre draggings/year (average) | | | 12 | | | | |
| | Tractor hours/road km/year | | | 4.4 | | | | |
| | SPARES & SERVICE PARTS | @ | | 3 | % of cost | | 5,874 | 11,748 |
| | including tyres and consumables | | | | new per 1,000 hours | | | |
| | FUEL | @ | | 6 | litres/hour | | 10,560 | 21,120 |
| | | @ | | 4 | Z$/litre | | | |
| | LUBRICANTS | @ | | 5 | % of fuel costs | | 528 | 1,056 |
| | INSURANCES | @ | | 2 | % of equipt cap. | | 8,900 | 8,900 |
| 1.4 | **Materials** | @ | | 200 | per km/year | | 20,000 | 40,000 |
| 1.5 | Contingencies | @ | | 5 | % | | 8,733 | 13,285 |
| | | | | | **TOTAL - DIRECT COSTS Z$** | | **183,389** | **278,985** |
| | | | | | **COST Z$ PER KM** | | **1,834** | **1,395** |

***1.***

## 2. UNIT OVERHEADS

| | | | | | | |
|---|---|---|---|---|---|---|
| Facilities and Buildings | Capital Cost (Z$) | | 250,000 | Including Pull-in camps | | |
| Finance | | | | | 19,375 | 19,375 |
| Depreciation | over | 30 | years | | 8,333 | 8,333 |
| Maintenance & Repair | @ | 0.4 | % asset v. | | 1,000 | 1,000 |
| Finance for store stockholding | | 20,000 | Z$ value | | 3,000 | 3,000 |
| Unit Supervisor | | 32,400 | inc. allow. | | 32,400 | 32,400 |
| Clerk | | 25,200 | Inc. allow. | | 25,200 | 25,200 |
| Tractor Driver | | 22,800 | Inc. allow. | | 22,800 | 22,800 |
| Towed Grader Operator | | 12,000 | Inc. allow. | | 12,000 | 12,000 |
| Mechanical Assistant | | 25,000 | Inc. allow. | | 25,000 | 25,000 |
| Administration/telephone etc. | | | | | 1,500 | 1,500 |
| | | | **UNIT OVERHEADS** | | **150,608** | **150,608** |
| | | | **COST Z$ PER KM** | | **1,506** | **753** *2.* |

## 3. HQ & PROVINCIAL OVERHEADS

| | | | | | | |
|---|---|---|---|---|---|---|
| (8 Provincial offices) | divided by | 190 | Units | | | |
| Salaries (HQ & Provinces) | | | 3,500,000 | | | |
| Personnel Allowances & expenses | | | 1,000,000 | | | |
| Supervision Vehicles | | | 3,000,000 | | | |
| Equivalent office rental cost | | | 300,000 | | | |
| Administration/Stationery costs | | | 100,000 | | | |
| Telephone and Communications | | | 60,000 | | | |
| Insurances | | | 50,000 | | | |
| Training & Evaluation Costs | | | 750,000 | | | |
| | | | 8,760,000 | | 46,105 | 46,105 |
| | | | **HQ & PROVINCIAL OVERHEADS** | | **46,105** | **46,105** |
| | | | **COST Z$ PER KM** | | **461** | **231** *3.* |

## 4. TOTAL REAL COST Z$ / KM, DIRECT COSTS & OVERHEADS

| | | | |
|---|---|---|---|
| *(1 + 2 + 3)* | **3,801** | **2,378** | *4.* |
| ***US$/km Equivalent*** | ***317*** | ***198*** | |
| | *for 100 km* | *for 200 km* | |