International Labour Organisation

Jobs or Machines

Comparative Analysis of Rural Road Work in Cambodia

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Photography by Bjørn Johannessen and Douk Narin

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Executive Summary

Rural road projects have been an important delivery mechanism for reinstating community access in Cambodia over the past decade. The works are acknowledged as being of high quality, and the labour productivity rates and costs are in line with international norms. Infrastructure programmes are now in a stage of rapid expansion in Cambodia. A major effort is being made to rehabilitate and upgrade the state, provincial and rural road networks. Many different approaches are being applied: equipment and labour-based, force account and contracting.

This study has been undertaken to compare the costs and potential benefits of the various approaches to assist and inform the Government of Cambodia in their policy setting for current and future operations related to rural infrastructure provision.

A number of projects have been studied, through analysis of summary reports and data, interviews with project staff, and site inspections. Labour-based projects were represented by the ILO managed Labour-based Rural Infrastructure Works Programme and the ADB funded Rural Infrastructure Improvement Project. Equipment-based projects have included some NGO funded rural roads but have relied mainly on national roads undergoing rehabilitation by force account equipment-based teams, under the direction of the Department of Roads in the Ministry of Public Works and Transport (MPWT), and urban works carried out by contractors in Phnom Penh.

In general, labour-based methods for constructing rural gravel surfaced roads in Cambodia were found to be less expensive than works carried out using equipment-based methods.

The employment potential for labour-based techniques is very high. There is a considerable long term potential for the approach. It is estimated that using labour-based methods to carry out a programme of rural road upgrading, combined with labour-based maintenance of the existing

maintainable road network could generate between 3.7 and 6.7 million days of work per year, depending on the extent of the programme. Taking the maximum figure, this is equivalent to 33,000 full time jobs, and would create opportunities for 100 rehabilitation contracts and 270 maintenance contracts per year.

Labour-based methods could also have an application for the primary and secondary road restoration programme, particularly where these roads are being restored to a gravel surface, or where alternative more durable surfaces can be adapted to a labour-based approach.

Labour-based work methods, as currently developed in Cambodia, should be adopted as the standard approach for all rural road rehabilitation and maintenance, if the government wish to maximise the employment impact in the rural areas. This will have no negative implications for the efficiency, cost effectiveness, or quality of the business of managing the rural road sector. Significant employment can be generated by the adoption of an appropriate policy without the necessity to allocate any additional funding other than that already earmarked for the restoration of the national road network.

This model of infrastructure provision provides the optimum mix of benefits, being both cost effective and employment creating. However, the approach is not being adopted by all agencies and is incorrectly viewed in some circles as being more expensive, lower in quality or more time consuming than conventional equipment-based techniques.

The study was initiated by the Employment Intensive Investment Programme of the ILO and supervised by EIIP's regional programme for Asia and the Pacific, ASIST-AP. The authors wish to thank all project staff, ministry officials, consultants, contractors and NGO's who gave up their time for detailed questioning and cross examination, and were often extremely helpful in sourcing key documents.

Chapter 1

Introduction

1.1 Background

During the last decade, many rural infrastructure projects have been implemented and contributed to the rehabilitation of the rural road network of Cambodia. These projects have been an important delivery mechanism for reinstating community access, which was largely destroyed through war and neglect during the preceding thirty years of civil strife.

To be more precise, since 1992, over 1,500 km of rural roads, around 100 km of irrigation canals and a large amount of civil work including markets, wells, sanitation and flood protection work have been rehabilitated. Although differences exist in modalities of execution in these projects, most of this work is generally acknowledged as being of high quality while the labour productivity rates and costs are in line with international norms. It is estimated that several million days of employment have been created for, in particular rural, unskilled workers during this period.

Infrastructure programmes are now in a stage of an even more rapid expansion in Cambodia, and as part of this, a continued effort is being made to rehabilitate and upgrade the national, provincial and rural road networks. A number of different approaches are being applied, viz. equipment-based operations carried out directly by the departments of the Ministry of Public Works and Transport, large scale equipment-based international contractors, small and medium size local equipment-based contractors, through food for work operations, and labour-based force account operations managed directly by the Ministry of Rural Development or donor agencies.

1.2 Justification

While it is deemed necessary to mobilise more resources for rural infrastructure provision, it is also increasingly recognised by the government

that the need for rationalising and optimising works execution has become important. This complies an analysis and comparison of the past experiences of various projects and formulate recommendations on the applicability of various modalities and their advantages and restraints. On the one hand, this requires a thorough examination and breakdown of the cost structure of the projects down to the level of unit costs. On the other hand, one also has to look at a wider context than just costs, and assess the direct and indirect social benefits that often are manifest in non-monetary terms, such as capacity building effects, skills development, employment creation and sustainability.

This study has been conducted with this intention. It compares the costs and benefits of the various projects, and is intended to assist and inform the Government of Cambodia in their policy setting for current and future operations related to rural infrastructure provision.

1.3 Methodology

Initially, it was envisaged that a purely financial analysis of selected projects could be carried out, which in the turn would be complemented and then expanded on with additional data to arrive at an economic analysis of the costs and benefits of the various projects.

This would have been a straightforward exercise if all relevant data was available and one could relate to one standard. In reality, the sample group of projects was limited, due to a general lack of concise information on actual costs and their breakdown into skilled labour, unskilled labour, equipment, materials and overhead costs. Furthermore, considerable differences were found in the design specifications, construction methods and implementation modalities.

As a result, (besides collecting the correct financial data,) this study had to investigate the types of implementation and work organisation, the labour and equipment content, and the operational and financial factors that had been considered by the agencies and organisations in establishing their cost calculations. Only with this breadth of data was it possible to draw some conclusions as to the economic costs and potential employment and capacity building benefits. To arrive at this, the following framework in seven steps was followed.

(i) Pre-assessment of Data Availability

During the inception of the study, an overall assessment was carried out to determine data availability. Not only the availability of information on actual costs, but more importantly information on the breakdown of cost into skilled labour, unskilled labour, equipment, materials and overhead

cost was examined. A stringent criteria was applied to only accept actual data, because pre-construction cost estimates might not reflect the true cost of the actual works. In addition, the focus thus had to be limited to completed roads only, to avoid distortions as gravel, earthworks and drainage will not be exactly in phase during the entire construction period.

The disadvantage of this approach is that the available data was severely reduced, as not all projects kept exact records in sufficient detail of all needed data. The advantage, however, was that the data collected would be more reliable and valid, as this was actually measured during construction and not estimated. During this stage, data was also collected on economic time series that would be needed for the financial cost adjustment.

(ii) Selection of Sample Group

A sample group was established on the basis of the pre-assessment. It was attempted to obtain a sample group that would be balanced in terms of technology choice (labour-based or equipment based) and in terms of implementation modalities (force account or contracted out works). Strict adherence to this balanced approach would have had severe repercussions

Table 1: Sample group of selected projects

	Agency	Project Name	Modality	Size
Labour-bsed	Ministry of Rural Development	Rural Infrastructure Improvement Project	Contract	77 km
	Ministry of Rural Development	Rural Infrastructure Improvement Project	Force Account	525 km
	International Labour Organisation	Labour-based Rural Infrastructure Works Programme	Force Account	36 km
	International Labour Organisation	Labour-based Rural Infrastructure Works Programme	Contract	7 km
Equipment-based	Department of Public Works and Transport	Urban Road Restoration Project	Contract	12 km
	Ministry of Public Works and Transport	Primary Road Restoration Project	Contract	438 km
	Ministry of Public Works and Transport	Rehabilitation Emergency project	Force Account	438 km
	Norwegian Peoples Aid and Action Nord Sud	combined records	Contract	48 km

***Note**: Labour-based works are also being carried out under the auspices of WFP, KfW and various NGOs. These works were not considered by this study, primarily because the extensive use of food for work and voluntary labour would be problematic. Also the USAID, Cambodia Emergency Roads Repair Project has been excluded from the analysis, as it was implemented in 1992 during a hyperinflation period. The limited data available was considered unreliable for the purpose of this comparison, although it supports the general conclusions of the study.*

on the sample size for the reasons mentioned above. For this reason, it was decided to accept over- and under-representation of certain categories, but to refrain from generalist conclusions regarding these categories without explicit comments to substantiate the arguments presented.

(iii) Data Collection

Financial data was collected for each project. During the collection of project data information on contracting practices was also collected. Most of this data related to the type of equipment used during the implementation, methods of cost-calculation, hiring rates of equipment, and accounting and other financial problems encountered during the implementation. This best captures the hidden costs in any operation, which may include equipment breakage, management failures during planning, delays caused by weather, mistakes that had to be rectified, and unanticipated site conditions (although this should be minimal for this type of work). Also, a large portion of the roads was visually inspected in order to assess the quality of the work delivered.

(iv) Cost Analysis and Breakdown

The collected data was broken down into unit cost rates and average volumes of work required per kilometre. In particular, the Ministry of Rural Development (MRD) kept excellent and up to date records of the performance of the Rural Infrastructure Improvement Project (RIIP). This information was already compiled and categorised into skilled labour, unskilled labour, equipment, materials and overhead costs. For this reason, the RIIP data set was accepted as the benchmark to which the other projects would be compared and normalised (ref. Step (v)).

It, however, proved necessary to adopt somewhat different approaches to analysing the data of other projects in order to come up with a meaningful comparison. While all projects kept records of their overall costs, some have very limited data on the actual quantities of work involved, other than the length of the road, leave alone a breakdown into equipment, labour, materials, etc. Therefore for some projects, estimations and conversions were made for the missing information on the basis of what could reasonably be expected in comparison with the data available from the RIIP.

Originally, it was also intended to capture the overhead costs for client supervision. This would allow a comparison between the consultancy costs necessitated by contract management as opposed to the force account costs attributable to head office supervision. In practice, no accurate data could be obtained from the ILO or MPWT to represent their input. RIIP overhead costs was approximated to 7% on the basis of the funds the project allocated to MRD to cover their counterpart costs at central and provincial level, but this did not cover technical assistance, which played a large role

in the training and overall control. Similarly, most consultants estimated 7% as their design and supervision costs over and above the contract costs.

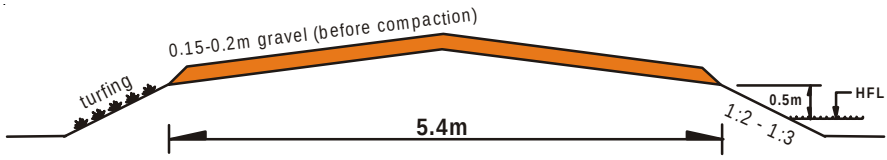
However, there would still be a client cost which is not covered by this estimate. It was therefore decided to omit the client supervision costs from this exercise. The on-site supervision costs, however, are captured throughout.

(v) Normalisation

Besides the fact that MRD had the information readily available on the RIIP, and the considerable size of their works implemented, the technical specifications that were used have been accepted as the official rural road specifications, endorsed in 1999 by the Government of Cambodia (see Figure 1). Accepting these specifications as the research standard thus has a double advantage. It not only avoids recalculation of the largest part of the data available into a different standard, but also leaves the data in its original form, in accordance with the design specifications of Cambodia and thus the research results can easily be referred to.

For this reason, all data collected on the volumes of work in other road projects was adjusted to comply to this standard, if they did not already. Further, on the basis of the RIIP project data, an average number of culverts and bridges per kilometre was estimated. Together with the technical specifications, this is referred to as the "1 km benchmark". Normalising the other projects to these specifications allowed comparison on equal grounds.

Figure 1: Cross section of the 1 km benchmark



Notes: The above technical specifications for a typical rural road are assumed to include the construction of 1.6 culverts and 0.2 bridges and are considered appropriate for the terrain type that applies to much of Cambodia's agricultural productive areas.
Source: *Technical Manual, Labour-based Road Construction Methods, Ministry of Rural Development, Phnom Penh 1999*

(vi) Inflation Correction (omitted)

After adjusting the data to meet the technical benchmark, the data was originally corrected to 1999 prices. Adjustment for inflation during the construction period would normally be carried out using a dedicated Construction Price Index that follows the variation in key supplies (cement,

diesel, steel, labour costs, etc). This index is not yet established in Cambodia. The alternative, the Consumer Price Index, does not properly reflect the situation in the construction industry.

Table 2: Consumer Price Index movements 1993 - 2000

Basic CPI movements	1993	1994	1995	1996	1997	1998	1999	2000
Exchange Rate	2689	2545	2451	2624	2938	3750	3900	4000
Index	109.7	103.8	100	107.1	119.9	153	159.1	163.2
CPI US$ growth	3.0%	2.6%	2.8%	2.9%	2.3%	1.6%	2.2%	2.5%
CPI US$ index	86.1	88.6	91.0	93.5	96.2	98.4	100.0	102.2
CPI Riel growth	114%	-0.5%	7.7%	6.8%	8.0%	14.8%	4.0%	0.0%
CPI Riel index	32.9	70.5	70.1	75.5	80.7	87.1	100.0	104.0

As set out in Table 2 and Table 3, it is apparent that in US Dollar terms there has actually been a decrease in the costs of some key construction items up to 1999. Given the fact that labour payments have remained constant around 4000 Riel a day, indexing of construction costs to increase by 2 to 3 % each year in line with the CPI would therefore seem unwarranted.

Apart from two ILO Labour-based Rural Infrastructure Rehabilitation Project roads built in Seam Reap between 1995 and 1997, all works reviewed in this study have been carried out between 1998 and 2000. In addition, all costs have been recorded in US Dollars. It was therefore decided that adjusting for 1999 prices is an unnecessary complication in this case, and the omission would not significantly detract from the veracity of the comparison.

Culvert works by local contractor, Svay Rieng Province, RIIP 1999.

Table 3: Construction Price Index movements 1993 - 2000

Prices including tax	1993	1994	1995	1996	1997	1998	1999	2000
Cement[1] in Riel	na	na	12,839	15,293	16,033	17,368	16,616	16,208
Cement Index Riel	na	na	77.3	92.0	96.5	104.5	100.0	97.5
Cement in US$	na	na	5.2	5.8	5.5	4.6	4.3	4.1
Cement Index US$	**na**	**na**	**122.9**	**136.8**	**128.1**	**108.7**	**100.0**	**95.1**
Aggregate[2] in Riel			36,666	39,300	41,158	45,853	47,256	47,525
Aggregate Index Riel			78	83.2	87.1	97.0	100.0	100.6
Aggregate in US$			14.96	14.98	14.01	12.23	12.12	11.88
Aggregate Index US$			**123.5**	**123.6**	**115.6**	**100.9**	**100.0**	**98.1**
Diesel in Riel	560	650	719	770	857	1,065	1,113	1,360
Diesel Index Riel	50.3	58.4	64.6	69.2	77.0	95.7	100.0	122.2
Diesel in US$	0.21	0.26	0.29	0.29	0.29	0.28	0.29	0.34
Diesel Index US$	**73.0**	**89.5**	**102.8**	**102.8**	**102.2**	**99.5**	**100.0**	**119.1**
Tax on Diesel	20%	20%	20%	20%	20%	20%	30%	30%

Casual LabourReported as 4000 Riel a day equivalent for ILO & RIIP projects, throughout this period

Notes:

[1] price per 25kg bag

[2] price per cubic metre

(vii) Comparison

After the appropriate adjustments and normalisations had been made, an overview was prepared, presenting the various costs and cost breakdowns of the projects covered by this study. These projects were grouped into technology type and implementation method. Weighted averages of these cost and their breakdown of the various sub-groups were reviewed and discussed before drawing up the final conclusions and recommendations.

Earthworks by manual labour supported by light compaction equipment, RIIP 2001.

1.4 The Research Team

The study was carried out over a period of two years. The initial assessment was carried out in August 2000 by David Stiedl, Paul Munters and Chandra Shrestha. The first data collection and analysis were carried out by Chandra Shrestha and Paul Munters between August 2000 and February 2001. Further data collection, analysis and quality assessment were subsequently carried out by Douk Narin and Paul Munters between September 2001 and February 2002. A first draft report was compiled by David Stiedl on the basis of the provided inputs in the middle of 2002. Towards the end of the 2002, additional field data was collected by Pen Sonath. This final report was prepared by Paul Munters and edited by BjØrn Johannessen from ASIST AP.

1.5 Structure of Report

For convenience, the projects are grouped by implementation type and discussed in separate sections, describing the assumptions made. Detailed tables used in the analysis are contained in the annexes.

Urban road works, Monivong Boulevard, Phnom Penh 2002.

Chapter 2

The Rural Infrastructure Improvement Project

This chapter analyses the labour-based Rural Infrastructure Improvement Project (RIIP), and derives the quantities and unit costs of rehabilitating a typical one km section of rural road. This analysis forms the baseline for all further comparisons. This section covers works carried out by both force account and local contractors.

2.1 Force Account Operations

This ADB funded project was designed to implement a set of rural infrastructure interventions in the six provinces of Prey Veng, Svay Rieng, Takeo, Kampot, Kandal, and Kampong Cham in south-eastern Cambodia. The RIIP was instituted to improve and maintain 600 km of rural roads, 20 market sites and other key rural infrastructure. Road works were carried out through the Provincial Departments of Rural Development using labour-based methods. The project commenced in December 1997 with force account operations and was gradually transferred to contracted works as contractor training was completed. A parallel objective was to develop the capacity in the Ministry of Rural Development (MRD) and its provincial departments to effectively plan, design, manage and implement rural infrastructure.

This study is only concerned with the rehabilitation of laterite surfaced (often referred to as gravel) rural roads. Excluded are the works on the construction of rural markets and other civil works such as wells, primary schools, office buildings, irrigation structures and flood control works. Also not included is the large element of capacity building and general training, together with a mandate to introduce a sustainable maintenance system on the roads rehabilitated by the project.

Initially, the road works were largely carried out as a force account operation, employing local labour supervised by staff from the provincial departments of the MRD, with training and overall management support from a

technical assistance team. As the project progressed, local contractors were trained to gradually take over from the force account operations.

It should be noted that local contractors and builders were used extensively from the start for the construction of all structures. In addition, conventional contractors were engaged to source and transport all gravel materials (sometimes for distances of up to 50 km, but more commonly 10 to 15 km). Laterite costs average some 20% of total costs. In some countries, labour-based operations commonly use labour to supply gravel, which has not happened in this case and needs to be borne in mind when comparing with equipment-based operations. However, this approach is the most cost effective way to deal with gravel supply in Cambodia, given the well established local industry and the comparatively long hauling distances.

Road works effectively commenced in January 1998, and as of June 2001, 61 roads totalling 525 km were completed by force account and 9 roads totalling 77 km by local contractors. Record keeping was exemplary in this project, and the required data is clearly set out in the semi-annual reports. Where specific information was not available, it was possible to extract necessary data from job reports held in the MRD reporting system. The only exception was equipment inputs, not the running costs which are clearly recorded, but the actual presence of units on site, which is an important indicator in order to establish correct equipment depreciation charges.

Two sets of data have been analysed, of which a summary can be found in Annex 1.

A sample of 39 roads was analysed in dept to elaborate details of earthworks quantities, structures, and typical equipment fleet inputs. This facilitated the abstraction of typical quantities of work for an RIIP road, as summarised in Table 4 below.

The extended sample, which covers all 61 roads allowed us to estimated financial details more precisely. This was carried out as a quick check to analyse financial trends, and did not include the physical details as carried out for the limited sample.

As can be seen in Table 4, the average total costs in the two sample groups differ by 16%, but the pattern of expenditure and the average worker inputs are almost the same.

Table 4: Costs and quantities of force account operations in the Rural Infrastructure Improvement Project

data period	Projects with concise records of typical quantities (limited sample)	All Projects (extended sample)
number of roads	39	61
total km	333.31	524.70
Typical quantities per km (weighted average)[1]		
worker days/km	4,849	4,946
clearing m^2/km	10,029	-
earthworks m^3/km	3,246	-
laterite m^3/km (compacted)[2]	780	780
culverts/km	1.5	1.6
small bridges/km[3]	0.1	0.2
Cost breakdown(weighted average)[4]		
% labour[5]	40%	39%
% skilled labour[6]	11%	12%
% materials[7]	35%	33%
% equipment O&M[8]	8%	9%
% miscellaneous	6%	7%
Average cost/km US$	**12,132**	**14,098**

Notes:
[1] *Derived from total quantities for all roads divided by km.*
[2] *A 1.2 compaction factor is assumed where loose quantities were given.*
[3] *Less than 10 meter spans.*
[4] *Derived from total cost for all roads divided by total km.*
[5] *Casual labour, unskilled and locally recruited.*
[6] *Skilled labour includes salaries of operators, drivers, supervisors and travel allowances*
[7] *Structures and laterite costs combined*
[8] *Equipment covers plant hire as well as operation and maintenance of project equipment. Depreciation costs are not included.*

Considerable variations were found in the average costs per km, ranging from US$ 6,000 to over US$ 21,000. This is due to a number of factors including varying laterite haulage costs, amount of earthworks and frequency of cross-drainage structures. Given the fact that the data covered a large geographic area and included many different project settings, whilst comprising detailed records of over 500 km of roads, it can be safely assumed that 14,098 US$/km is a reliable indication of the average project cost for the RIIP, built to typical rural road standards with good supervision and consistent quality.

This average, however, does not include equipment depreciation costs, which are discussed in the following section.

2.2 Equipment Depreciation

The RIIP programme purchased a considerable amount of light equipment appropriate for labour-based work methods. The current equipment fleet has an estimated new value of approximately 2 million US$, and includes 76 pedestrian operated vibrating rollers, and 94 light trucks (including etans, a small locally fabricated truck).

It is necessary to depreciate some of this investment across the project works to reflect the real charge. The situation is complicated by the fact that in the early stages the programme had to hire some equipment because of the lengthy procurement process for some key items.

Project records were not sufficiently detailed to allow the researcher to abstract the equipment clock times, or to determine the exact items of plant allocated to a particular project. However, from discussions with project staff it was possible to determine a typical fleet. This fleet included 2 pedestrian rollers, 1 etan, 1 light truck, 1 plate compactor and 1 motorcycle (water bowsers are mounted on etans or light trucks, and therefore not counted separately for this exercise).

It was first roughly estimated that this typical fleet could construct around 14 km a year. A more detailed analysis revealed that a single pedestrian roller on a 6 hour day and an annual utilisation rate of 1200 hours would be capable of compacting 7.4 km of laterite a year to the required thickness of between 15 and 20 cm. Further verification of the amount of equipment showed a gradually increasing capacity with the number of project sites under construction, and revealed that an average output of 14 km would be line with the overall project output.

Compaction of earthworks, RIIP 2001.

Assuming this typical fleet as a minimum requirement, it was then concluded that the average equipment cost per km would be 565 US$ against an interest rate of 12%. This figure is in line with the international lending rates. From the project data, the following information was deducted to arrive at the conclusions presented in Table 5.

Table 5: Equipment depreciation costs in force account operations in the Rural Infrastructure Improvement Project

	pedestrian roller	plate compactor	etan	light truck	motor cycle
purchase cost, US$	4,272[1]	1,079[2]	5,813[2]	14,827[2]	1,262[2]
estimated total no. per work site	2	1	1	1	1
estimated life in years	6	6	6	6	6
annual hours of utilisation	1,200	1,200	1,200	1,200	1,200
annual depreciation					
12% interest	1,039	262	1,414	3,606	307
cost/km at 12%	77	19	104	266	23
Fleet cost/km			**565**		

Note:
[1] *Cost of rollers supplied from South Korea*
[2] *Average of RIIP project inventory*

The average depreciation cost for a typical fleet of light equipment was calculated at US$ 565 per km, which was added to the total cost to provide a complete picture of the direct costs of the road works. This amount is also applied in the analysis of the costs of ILO labour-based infrastructure rehabilitation works described in Chapter 3.

Average costs per km for force account operations and percentage distribution of costs can therefore be summarised as follows for the extended sample:

Table 6: Adjusted force account costs Rural Infrastructure Improvement Project

Cost breakdown					Total cost US$/km
% labour	% skilled labour	% materials	% equipment	% miscellaneous	
37	12	32	12	7	**14,663**

2.3 Contracted Works

An important part of the RIIP was the development of local contractors to take over from the force account units. Nine projects, totalling 77.34 km, were completed by local contracting firms. The results are summarised below. Full details of these projects are included in Annex 1.

Table 7: Adjusted small scale contracts costs Rural Infrastructure Improvement Project

Number of roads	total km	workdays/km	costs per km (weighted average)		
			% works	% materials	**Total US$/km**
9	77.34	3,767	65%	35%	**11,116**

For this work, the equipment costs are included in the contracts. Total costs per km, averaging at 11,116 US$, are 24% lower than force account operations. The percentage of material costs (i.e. structures and gravel) is the same order as the force account operations (35% compared with 32%). Therefore, this variation cannot necessarily be accounted for by favourable laterite rates or low structure content.

However, the average labour input per km is substantially lower (3,767 workdays as opposed to 4,946 wd for the force account works), so it is possible that the contractors are achieving greater productivity rates from their workforce.

Stump removal by manual labour, Svay Rieng Province, RIIP 1998.

Chapter 3

The Labour-based Rural Infrastructure Works Programme

This programme, later termed the Upstream Programme, represented the final phase of the ILO's involvement in developing and implementing labour-based procedures for infrastructure rehabilitation in the Cambodia since 1992. Although this final phase of the programme was primarily involved in studies and advice to the government on labour-based approaches, it conducted some limited road rehabilitation and maintenance work. It also represented the repository of information for the 550 km of rural roads and 96 km of secondary irrigation canals constructed under the prior ILO Labour-based Rural Infrastructure Rehabilitation Project.

3.1 Force Account Operations

At the time of this study, the ILO programme had taken on the role of advising the government on policy and developing new techniques and planning procedures. Recent implementation projects were therefore limited to contractor training trials and piloting road maintenance.

Records were available for past projects in summary reports for the provinces of Seam Reap and Battambang, but these were somewhat lacking in detail, mainly providing overall costs and labour inputs.

Detailed information was no longer available. It was, however, possible to analyse the data for a number of completed projects in Seam Reap, and extract values for costs of structures, gravel haulage, labour wages, but not for equipment which appears to have been recorded on a programme basis, rather than on the individual projects. See details in Annex 2.

Table 8: Force account costs and quantities of work in the Labour-based Rural Infrastructure Works Programme

number of roads	5
total km	35.6
Quantities per km (weighted average)[1]	
workdays/km	4,909
clearing m^2/km	not recorded
earthworks m^3/km	not recorded
laterite m^3/km (compacted)[2]	1,000
culverts/km	2.6
small bridges/km^3	0.2
Cost per km (weighted average)[4]	13,194

Notes:
[1] derived from total quantities for all roads divided by total km
[2] 1.2 compaction factor assumed where loose quantities given
[3] less than 10m span
[4] derived from total cost for all roads divided by total km

Although these works are very similar to the road works of the RIIP, some adjustments still need to be made before it is possible compare these costs to the average of the RIIP.

The information available from the ILO does not include equipment cost. As the only estimate available, the value of 1,753US$ /km for equipment operation, maintenance and depreciation based on the RIIP data, was added to compensate for this lacuna.

It was also necessary to make adjustments for varying design standards as the ILO project applied a 20 cm compacted gravel surface, 5.0 metres wide, compared to the RIIP project which used a 15cm compacted layer, 5.4 metres wide. This had an impact on several cost elements and involved two more complex estimations.

(i) The average labour input of the ILO project was 4909 wd/km. At a daily task rate of 4 m^3/wd for spreading and compaction of laterite, it was calculated that 250 WD was required for a one kilometre section, assuming a 5 meter width. Of the remainder of 4659 wd/km, it is assumed that 90% or 4193 wd/km relate to earthworks, while 10% or 466 wd/km relate to bush-clearing. These wd/km rates are important for calculations that follow.

(ii) In addition to the above, the difference in quantities of work of the two design specifications was caclulated as -19% for gravelling works, and +8% for the earth works.

The resulting correction factors for the number of workdays for gravel spreading and compaction required is thus -55 wd/km, while for the earthworks an additional 335 wd/km would be required. Also, the laterite quantities need to be adjusted to the RIIP standard. It was estimated on the basis of material use in the RIIP projects, that of the total materials cost, only 4322 US$/km was related to laterite, hence the reduction of 19% would result in -811 US$/km in monetary terms.

No correction was made to equipment use in laterite compaction, as the RIIP requirement data was applied.

To compensate for the difference in the average number of culverts per kilometre (1.6 per kilometre in RIIP as opposed to 2.6 per kilometre in the ILO project), the equivalent RIIP cost of 643 US$/culvert was deducted from the total cost. As the number of small bridges per kilometre showed no difference from the RIIP average, no compensation was needed for this.

Table 9: Normalisation of force account Labour-based Rural Infrastructure Works Programme Operations

Laterite compaction and spreading (-19%)	- 55 wd/km
Laterite use (-19%)	- 811 US$/km
Earthworks (+8%)	+335 wd/km
Equipment O&M and depreciation	+ 1,753 US$/km
Subtraction of 1 culvert per kilometre	- 643 US$/km
Cost adjustment per km	**+ 579 US$/km**

Notes:
- assuming unskilled labour wage of 1 US$ per work day
- 1.2 compaction factor assumed where loose quantities given
- less than 10m span
- derived from total cost for all roads divided by total km

Based on the adjustments above, the overall breakdown of the cost changed slightly, and deviates only 6% from the RIIP average that was firmly backed by its sample size and concise recording.

Table 10: Normalised costs of force account works in Labour-based Rural Infrastructure Works Programme

Cost breakdown					total cost US$/km
% labour	% skilled labour	% materials	% equipment	% miscellaneous	
36	2	50	12	0	**13,773**

3.2 Contracted Works

The ILO carried out training of small-scale contractors in road construction in Seam Reap Province. This training included trial contracts consisting of rehabilitation works on short (approximately 1 km) rural road sections. As part of these contracts, the project provided the contractors with an equipment hire scheme at negotiated rates. An overview of the collected data can be found in Annex 2. The average cost before corrections was estimated to 15,461 US$/km. As part of the normalisation, adjustments were made for gravel spreading and compaction, gravel materials and for reduced gravel surface thickness as indicated in the Table 11.

Table 11: Normalisation of contracted works in the Labour-based Rural Infrastructure Works Programme

Laterite compaction and spreading (+4%)	+ 34 wd/km
Earthworks (+8%)	+ 401 wd/km
Addition of 1.3 culverts per kilometre	+ 836 US$/km
Cost adjustment per km	**+ 1,271 US$/km**

Notes:
- assuming 1 US$ per workday
- 1.2 compaction factor assumed where loose quantities given
- derived from total cost for all roads divided by total km

The result of the normalisation is a total cost per kilometre of 16,732 US$.

Table 12: Total costs for contracted works-Labour-based Rural Infrastructure Works Programme

			Cost breakdown				
number of contracts	**total km**	**Workdays /km**	% labour	% other	% materials	% equipment	**total US$ /km**
7	6.6	4,966	29%	11%	30%	30%	**16,732**

The relatively high costs compared with the force account operations, could be attributed to the organisation of the work, which was divided into short sections, and making it difficult to develop the momentum necessary to achieve a well organised labour force and streamlined working procedures. Further, the works were contracted out to pre-selected contractors, which limited the competition element and therefore may have increased the price of the works.

Chapter 4

Other Rural Road Rehabilitation Projects

A considerable amount of rural road rehabilitation has been carried out by various agencies and NGOs involved in local government support and general rural development projects. The work has been carried out applying a number of different implementation strategies, including labour-based work methods and self help inputs from beneficiary communities. Design standards varied considerably in these projects, and in some cases works were limited to spot improvement works. Due to the limited suitable information available on these projects, the review sample was restricted to only include the works of the following two NGOs:

Action Nord Sud

This NGO was involved in upgrading rural roads in several provinces and has established a management model in collaboration with the provincial authorities, whereby it assists with award and supervision of equipment-based road rehabilitation contracts, utilising the Provincial Departments of Rural Development for supervision. Bidding documents were obtained for one road of 19.7 km in Seam Reap, which was completed within the quoted costs and up to the standards achieved by similar labour-based road works projects in the province.

Typical Bill of Quantities are included in Annex 3.

Norwegian Peoples Aid

Very limited information was available from these projects. The data available was obtained from the rehabilitation of three rural roads, carried out using equipment-based work methods by contract in Bantey Meanchey Province in 1999.

SEILA

Although the SEILA project has carried out a considerable amount of road works, some very limited data was found in this project. This information was under-specified and therefore excluded from the study.

During field inspections, some of these roads showed to be of a lower construction standard than found in the RIIP and ILO works. The reason for this was often blamed on the lack of construction supervision.

A summary of all the data analysed is provided in Table 13, with the costs as originally quoted.

Table 13: Equipment-based projects by contract

Organisation	Location	Cost/km	Comments
ANS	Soth Ni Kum District, Seam Reap	5,054	Detailed BoQ and specifications
NPA	Road 1, Bantey Meanchey Province	11,588	Detailed BoQ and specifications
NPA	Road 2, Bantey Meanchey Province	8,389	Detailed BoQ and specification, no drainage structures
NPA	Road 3, Bantey Meanchey Province	7,003	Detailed BoQ, no specifications

Notes: as per original data, unadjusted for specification differences compared to RIIP standard.

Of the above projects, the information in Table 14 was extracted from one contract let by Action Nord Sud. This work was administered by the provincial staff of the Ministry of Public Works and Transport with support from the NGO technical staff and an engineer. The road has similar characteristics as the RIIP roads, except it has a slightly narrower gravel surface (4 metres) and includes a substantial 40 metre span bridge. The bridge cost was excluded from the comparison and the costs pro-rated up for an equivalent width to the RIIP standard. Note that the earthworks quantities are somewhat higher.

One other anomaly was that the contract was eventually awarded to two contractors, i.e. split into one for the contact for the earthworks, and one contract for the laterite delivery and structures. The lowest bid for laterite delivery was substantially cheaper than normal market rates at 0.75 US$ per m^3, compared with the average of US$ 2. The contractor may have been able to offset the costs by surplus haulage equipment to offer this price.

Therefore, an average was taken of all the eight full bids to obtain a more representative costing. Unfortunately, no data was available on the distribution of costs on equipment, materials and labour content, and thus no cost-breakdown could be established.

Table 14: ANS equipment-based costs and quantities

Number of roads	1
Total km	16.7
Workdays/km	not known
Clearing m^2/km	not itemised
Earthworks m^3/km	5,837
Laterite m^3/km (compacted)	600
Culverts/km	2.0
Small bridges/km	none
cost/km	**10,173**

Notes: Based on the averages of 8 contract bids

As the width of the laterite layer is only 4 meters wide, corrections was required not only to normalise the volumes of laterite, but also to the volumes of earthworks. Also, a correction for the number of culverts/km was included in the calculations.

Table 15: ANS equipment-based normalisation

Earthworks (+35%)	+ 2,237 US$/km
Laterite (+30%)	+ 561 US$/km
Subtraction of 0.4 culverts per kilometre (@ 643 US$ per culvert)	- 257 US$/km
Cost adjustment per km	+ 2,541 US$/km

As a result, the adjustments total up to above 2,541 US$/km or 25% of the original value. Given the small sample size, the validity of the data cannot be considered very high, and can merely be used as illustrative example to confirm other data-sets.

Table 16: ANS normalised equipment-based costs and quantities

Cost breakdown					total cost US$/km
% labour	% skilled labour	% materials	% equipment	% miscellaneous	
not recorded	not recorded	not recorded	not recorded	not recorded	**12,714**

The other data set available related to a project implemented by Norwegian Peoples Aid, which was associated with community resettlement programmes supervised by the provincial staff of the Ministry of Public Works and Transport. Unfortunately, no data was available on the distribution of costs on equipment, materials and labour content.

Table 17: NPA equipment-based costs

	Road 1	Road 2	Road 3
Size	19.8 km	5.9 km	5.8 km
Workdays/km	Not known	Not known	Not known
Clearing/km	8,989	Not itemised	9,000
Earthworks/km	3,250	6,283	5,170
Laterite/km (compacted)	1,000	675	1,000
Culverts/km	0.76	none	0.85
Small bridges/km	0.15 [1]	none	none
cost/km	**12,399**	**8,390**	**6,654**

Note: *four bridges exceeding 10 metre span excluded from the calculation*

The specifications for these roads varied considerably in width and thickness of gravel surfacing and drainage provision. Also, corrections for the number of culverts/km needed to be made. The following adjustments were deemed necessary to bring them in line with RIIP standards.

Table 18: NPA equipment-based normalisation

	Road 1	Road 2	Road 3
Earthworks	+ 208 US$/km [1]	+ 1021 US$/km [2]	+ 228 US$/km [1]
Watering Laterite	+ 60 US$/km [1]		
Delivery Laterite	- 607 US$/km [3]	+ 332 US$/km [4]	- 396 US$/km [5]
Laterite Compaction	+ 110 US$/km [1]	+ 149 US$/km [2]	+ 40 US$/km [1]
Correction for number of culverts per kilometre (@ 643 US$ per culvert)	+ 514 US$/km [6]	+ 1029 US$/km [7]	+ 482 US$/km [8]
Cost adjustment per km road 1	**+ 276 US$/km**	**+ 2,531 US$/km**	**+ 354 US$/km**

Notes:
[1] from 5.0 to 5.4 meter width (+8%)
[2] from 4.5 to 5.4 meter width (+20%)
[3] from 0.20 to 0.15 thickness and from 5.0 to 5.4 meter width (-22%)
[4] from 4.5 to 5.4 meter width (+20%)
[5] from 0.20 to 0.15 thickness and from 5.0 to 5.4 meter width (-22%)
[6] 0.8 culvert
[7] 1.6 culvert
[8] 0.75 culvert

As a result of the adjustments to both the projects of Action Nord Sud and Norwegian Peoples Aid, the average increased considerably as shown in Table 19. As mentioned before, it should be taken into account that the limited sample size reduces the validity of the data, and thus this sample can merely be used as illustrative example to be compared with other more sound data.

Table 19: Normalised costs, small scale equipment-based contracts

NPA Road 1 (19.8 km adjusted from 5.0 m width to 5.4 m and from 0.20 m laterite thickness to 0.15 m)	12,675 US$/km
NPA Road 2 (5.9 km adjusted from 4.5 m width to 5.4 m)	10,912 US$/km
NPA Road 3 (5.8 km adjusted from 5.0 m width to 5.4 m and from 0.20 m laterite thickness to 0.15 m)	7,008 US$/km
Weighted Average NPA	**11,301 US$/km**
ANS Soth Ni Kum District, Seam Reap (16.7 km) from Table 16	12,714 US$/km
Overall Weighted Average	**11,790 US$/km**

It does, however, clearly indicate that overall per km figures need to be carefully scrutinised, as many (hidden) factors can distort the cost to a very large extent. Cost calculations not only need to be based on firm and structured information. Due to the variations in design and work methods, extensive normalisations are needed in order to arrive at comparable data sets. These normalisations need to be explicitly mentioned in order to make a convincing comparison.

Single Span Bridge constructed by local contractor in Kampot Province, RIIP 2001.

Culvert construction by local builder, Svay Rieng Province, RIIP 1998.

Chapter 5

The Road Emergency Rehabilitation Project

The National Road Emergency Rehabilitation Project (NRERP), was implemented by the Department of Road Infrastructure (DRI), and the Department of Heavy Equipment (DHE) in the Ministry of Public Works and Transport (MPWT). A selection of eleven completed projects from eight provinces was analysed in this study.

MPWT has a number of force account units based at provincial and central level. These units utilise equipment, owned and operated by the ministry, paying directly for fuel, labour and materials. The ministry applies standard hire rates for its equipment, which are supposed to reflect the costs of ownership in terms of maintenance, repairs and eventual replacement.

Urban Road No. 271, Urban Road Restoration Project, Phnom Penh 2002.

A number of these units has been utilised in the National Road Emergency Rehabilitation Project to carry out immediate repairs to the country's main roads. Some of this work consists of ripping up the existing degraded bitumen pavement, and importing laterite to form a gravel road. Work may also include the re-establishment of a bitumen surface.

From eleven of these operations, unit rates have been established for works similar to rural roads. The study obtained data on direct costs for these projects together with equipment details. These roads, which forms part of the national road network, have a width of 6 to 7 meters and a laterite surface thickness from 15 to 20 cm. On the basis of the quantities involved and conversions to the typical rural road specifications as given in Chapter 1, the data as summarised in Table 20 and Table 21 was compiled.

Table 20: Project costs (with earthworks), Road Emergency Rehabilitation Project

Description	Total Cost US$	Road Length km	Cost per km, US$					
			Owner cost of Equipm.	Main.& Oper. of Equipm.	Labour	Materials	Misc.	Total
National Road No. 7, Stung Treng								
Grubbing (Scarifying of exist. pavement) [1]			1,216					1,216
Earthworks [1]	11,616	3.8	6,490	2,596	220		151	9,456
Laterite works [2]	61,529	22.3	1,688	2,328	198	202	135	4,550
Total	73,145		9,394	4,923	418	202	286	15,223
National Road No. 6, Kampong Thom								
Grubbing (Scarifying of exist. pavement) [1]	20,655	23.8	1,216	585	163		32	1,997
Earthworks [1]	46,939	19.3	6,490	1,639	457		84	8,677
Laterite works [2]	35,011	34.6	1,688	683	190	417	37	3,016
Total	102,605		9,394	2,908	810	417	161	13,690
Average			**8,758**	**3,915**	**614**	**309**	**223**	**14,456**

Notes: *[1] Earthwork and grubbing volumes are adjusted.*
[2] Laterite volumes are adjusted to 5.4 m width and 15 cm layer thickness (780 m^3/km).

It should be noted that only two of the projects had significant earthworks operations and these have been used to estimate the overall costs.

Table 21: Project costs (without earthworks), Road Emergency Rehabilitation Project

Description	Road Length km	Cost per km, US$					
		Owner cost of Equipm.	Main. & Oper. of Equipm.	Labour	Materials	Misc.	Total
Stung Treng Town	19.2	2,859	3,193	305	295	197	6,848
National Road No. 7, Kampong Cham	33.5	2,859	1,486	199	295	83	4,922
National Road No. 68, Siem Reap	75.0	2,859	1,990	296	120	209	5,474
National Road No. 6, Bantey Meanchey	75.4	2,859	1,181	206	316	146	4,708
National Road No 157, Thmorkol to Borvel,							
Battambang National Road No 3,	28.8	2,107	1,441	202	3,314	432	8,248
Takeo	69.2	2,859	2,265	304	320	252	6,000
National Road No 51	26.0	2,859	1,201	296	802	200	5,358
National Road No 57	73.8	2,859	1,336	282	1,804	297	6,579
National Road No 76	36.9	2,859	1,251	296	599	186	5,192
Average		**2,776**	**1,705**	**265**	**874**	**223**	**5,842**
Earthwork averages [1]		6,490	1,416	581	0	174	8,661
Adjusted Average Cost per Km		**9,265**	**3,120**	**846**	**874**	**396**	**14,502**

Notes *[1] The estimated average earthworks is based on an extensive analysis by Douk Narin in March 2002, and adjusted to a road width of 5.4 metres.*

From Table 20, the averages for earthworks were calculated and then added to the cost estimation of the works without earthworks data. This way, an overall average could be established for a fictive 438 km of gravel roads.

The above data have been further normalised to bring it in line with the analysis of other components of the study. In particular, no drainage costs were available from the MPWT data, so a typical unit cost (1,950 US$/km) has been added in, based on the contractor rates from Chapter 6. These rates are not substantially different from the RIIP rates and should not distort the comparison.

After re-distribution of skilled and unskilled labour (unskilled labour averages 15% of total labour), the adjusted average costs and cost break-down are set out below in Table 22.

Table 22: Adjusted average cost per km, Road Emergency Rehabilitation Project

	Cost breakdown					total cost US$/km
	Unskilled labour	skilled labour	materials	equipment	misc.	
Overall average	127	719	874	12,385	396	14,502
Adjust for structures	10	60	1,693	187	0	1,950
Adjusted average	**137**	**779**	**2,567**	**12,572**	**396**	**16,452**
	%	**1%**	**5%**	**16%**	**76%**	**2%**

Four wheel drive etan delivering construction materials for bridge works in Takeo Province, RIIP 2001.

Chapter 6

The Primary Road Restoration Project

In addition to the work being carried out directly by the Ministry of Public Works and Transport, a number of donors and international development banks have been funding the reconstruction and rehabilitation of the major strategic road links. The work consists essentially of repairing or reinstating the drainage and sub-base before adding a new base and bitumen surface, although sometimes the works also included the widening of the carriageway and adding additional drainage structures.

The work is designed by international consultants working together with the Department of Transport staff in MPWT, and is being let as international contracts under FIDIC conditions. From the Road Restoration Project, funded by ADB, data were obtained for unit rates on all activities compatible with rural roads (clearing, earthworks, laterite sub-base, etc.), and used to synthesise the costs for a typical rural road.

Six contract packages, awarded to four contractors, representing a total of 438 km were inspected. The details of the contract are set out below in Table 23.

Table 23: Overview of the contract packages analysed from the Primary Road Restoration Project

Contractor	package	Length km	Value for all works [1] US$	Value of analysed bill items US$
Nawarat Patanakarn Public Company Ltd.	National Road No 5, (5B & C)	130	19 million	12.8 million
Muhibbah Engineering	National Road 6, (6B) and & 7, (7A)	143	16.3 million	9.3 million
China Jilin International	National Road 7, (7E)	65	8.5 million	6.1 million
CEC - Nopawang J.V.	National Road 1	100	Not available	9 million

[1] *less contingencies and VAT*

The applied rates for activities similar to rural roads, i.e. clearing, earthworks, small drainage works, and construction of laterite sub-base were identified. These rates were then applied to the typical specifications of a rural road to estimate comparable costs. The data available was not broken down into constituents of labour, equipment and materials, although, the study was given access to several estimates of breakdowns that had been submitted from contractors to justify their rates. However, by using the unit rate justifications, it was possible to synthesise a breakdown of costs, which are included in the summary of overall costs in Table 24. Details of the individual packages are summarised in Annex 4.

Table 24: Adjusted costs Primary Road Restoration Project

Contractor	Cost breakdown				total cost US$/km
	% labour	% skilled labour	% materials	% equipment	
Nawarat Patanakarn (130 km)	3	15	13	69	26.634
Muhibbah Engineering (143 km)	1	0	27	72	12.507
China Jilin (65 km)	2	7	18	72	18,688
CEC - Nopawang (100 km)	1	7	24	68	19,079
Weighted Average	**2**	**9**	**19**	**70**	**19,121**

Earthworks by locally recruited labour, Labour-based Rural Infrastructure Works Programme.

The difference in materials and equipment compared with Chapter 5, can be partially accounted for by the cost of laterite delivery. The private sector is generally paying commercial rates, whereas with the exception of Road 157, the Ministry is extracting and transporting their own laterite, with some royalty payments of 0.2 to 0.3 US$/m^3 when extracted from private sources.

It should also be noted that the combined skilled and unskilled labour costs are a considerably higher percentage of the total costs than pertains in the force account MPWT works. This can partially be explained by the relative wages, which appear to be more than twice the public sector rate, as illustrated Table 25.

Table 25: Comparison of MPWT and private sector wages

Work Description	MPWT force account rates per day	Contractor rates per day [2]
Supervisor	2.56	7.69
Operator	1.80[3]	5.76
Skilled labour	1.80	4.00
Unskilled labour	1.30	3.00

Notes:
[2] *assumed 26 work days per month*
[3] *assumed same rate as skilled labour*

Levelling works by manual labour employed by local contractor, RIIP 2001.

Kampot Province.

Chapter 7

Urban Road Restoration Project

The Urban Road Restoration Project in Phnom Penh was carried out by international and local contractors under the supervision of the Department of Public Works and Transport of Phnom Penh (DPWT). Five urban roads were analysed, funded by government grants.

The work consists of breaking up the existing pavement, reinstating the sub-base and base and applying an asphalt surface. In some cases, it has been necessary to widen and raise the carriageway which involves a significant amount of earthworks.

Table 26: Analysed Urban Road Restoration Projects

Road Name & Location	Length	Dimensions Shoulders	Carriage Way	AC Surface	Thickness Base Course	Sub-base
Urban Road No. 271, Phnom Penh	2.1km	2 m	17 m	50 mm	mix stone M30 20 cm M40 25 cm	Laterite 25 cm
Urban Road No. 70-273-516, Phnom Penh	2.8 km	2 m	12 m	50 mm	mix stone M30 20 cm M40 25 cm	Laterite 20 cm
Urban Road Monivong Blvd, Phnom Penh	6.7 km	5.7 m	18 m	50 mm	mix stone M30 20 cm	Laterite 30 cm Sand 50cm

The study analysed the bills of quantities for five roads, extracting the relevant items similar to that required for an RIIP gravel road. Basically, the analysis follows the procedures adopted in Chapter 4 to establish a unit cost for a typical km of equivalent rural road, and is broken down into the constituent parts of labour, materials and equipment costs.

Further, a sum of 1,950 US$ per km has been added to reflect drainage structure costs, derived from the contractors estimates in Chapter 6. An overview of the cost breakdown is summarised in Table 27.

Table 27: Adjusted costs Urban Road Restoration Project

	Cost breakdown					US$/km
	% labour	% skilled labour	% materials	% equipment	% miscellaneous	
Urban Road No. 271, Phnom Penh	1	4	13	73	9	19,219
Urban Road No. 70-273-516, Phnom Penh	1	4	13	73	14	19,187
Urban Road MONIVONG Blvd., Phnom Penh	1	4	12	64	19	21,757
Weighted Average	**1**	**4**	**12**	**68**	**16**	**20,678**

The costs are higher than the international contractor rates established in Chapter 5 from the Primary Road Restoration Project. This is partly due to the necessity to transport ordinary fill material from outside the city boundaries. For most of the other projects in this study, fill materials were obtained adjacent to the required location.

Rehabilitation Works, Monivong Boulevard Urban Road Restoration Project, Phnom Penh 2002.

8 Chapter

Analysis and Conclusion

8.1 Overview

In the preceding sections, various projects were discussed. In Chapter 2, the technical specifications of the ADB Rural Infrastructure Improvement Project, implemented through the Ministry of Rural Development, were discussed and selected as the benchmark. Consequently, all other project data was normalised in the consecutive sections to allow comparison with this benchmark. The result of this exercise is summarised in Table 28.

Urban Restoration Project, Phnom Penh 2002.

Table 28: Overview of costs and cost breakdown of road works

Construction Method	Project Description	sample size	US$/km	cost breakdown: unskilled labour	skilled labour	materials	equipment	miscellaneous
labour-based	ADB Rural Infrastructure Improvement Project, Force Account (Chapter 2)	525.0 km	14,663	37%	12%	32%	12%	7%
	ILO Rural Infrastructure Works Programme, Force Account (Chapter 3)	35.6 km	13,773	36%	2%	50%	12%	0%
	ADB Rural Infrastructure Improvement Project, Contracts (Chapter 2)	77.0 km	11,116	na	na	na	na	na
	ILO Rural Infrastructure Works Programme, Contracts (Chapter 3)	6.6 km	16,732	29%	11%	30%	30%	0%
	Weighted Average Total	**644.2 km**	**14,211**	**37%**	**11%**	**33%**	**12%**	**6%**
	Weighted Average Force Account	**560.6 km**	**14,606**	**37%**	**11%**	**33%**	**12%**	**7%**
	Weighted Average Contracts	**83.6 km**	**11,559**	**29%**	**11%**	**30%**	**30%**	**0%**
equipment-based	MPWT Primary Road Restoration Project, Contracts (Chapter 6)	438.0 km	19,121	2%	9%	19%	70%	0%
	MPWT National Road Emergency Rehabilitation Project, Force Account (Chapter 5)	438.0 km	16,452	1%	5%	16%	76%	2%
	DPWT Urban Road Restoration Medium Scale Contracts (Chapter 7)	11.6 km	20,678	1%	4%	12%	68%	16%
	NPA and ANS Small Scale Contracts (Chapter 4)	48.2 km	11,790	na	na	na	na	na
	Weighted Average Total	**935.8 km**	**17,513**	**1%**	**7%**	**17%**	**73%**	**1%**
	Weighted Average Force Account	**438.0 km**	**16,452**	**1%**	**5%**	**16%**	**76%**	**2%**
	Weighted Average Contracts	**497.8 km**	**18,447**	**2%**	**9%**	**19%**	**70%**	**0%**
Overall Weighted Average (Total)		**1,580.0 km**	**16,167**	**15%**	**9%**	**24%**	**49%**	**3%**
Overall Weighted Average (Force Account)		**998.6 km**	**15,416**	**21%**	**9%**	**26%**	**40%**	**5%**
Overall Weighted Average (Contracts)		**581.4 km**	**17,456**	**2%**	**9%**	**19%**	**69%**	**0%**

Note: *Cost breakdown averages have been calculated on reduced sample sizes for those subsets that contain na indicators in their cells. Costs have been normalised to meet the RIIP standards as specified in Figure 2.*

Weighted average cost of gravel roads in Cambodia

Average Labour Based

- Force Account 14,606 US$/km
- Total 14,211 US$/km
- contracted 11,559 US$/km

- Asian Development Bank
  Rural Infrastructure Improvement Project (contracts)
  77 Km @ 11,116 US$/km
- International Labour Organisation
  Upstream Project (force account)
  36 Km @ 13,773 US$/km
- Asian Development Bank
  Rural Infrastructure Improvement Project (force account)
  525 Km @ 14,663 US$/km
- International Labour Organisation
  Upstream Project (contracts)
  7 Km @ 16,732 US$/km

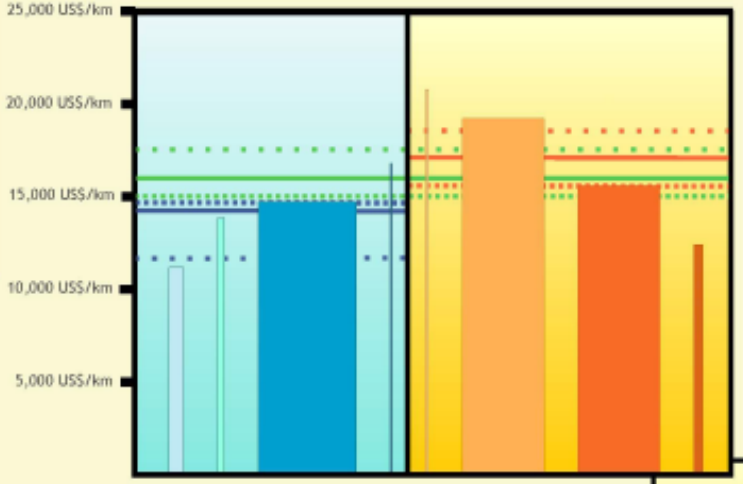
Average Equipment Based

- Contracted 18,502 US$/km
- Total 17,710 US$/km
- Force Account 15,528 US$/km

- Department of Public Works and Transport
  Urban Road Restoration Project (contracts)
  12 Km @ 20,678 US$/km
- Ministry of Public Works and Transport
  Primary Road Restoration Project (contracts)
  438 Km @ 19,121 US$/km
- Ministry of Public Works and Transport
  Rehabilitation Emergency Project (force account)
  438 Km @ 15,528 US$/km
- Norwegian Peoples Aid and
  Action Nord Sud (contracts)
  48 Km @ 12,356 US$/km

Total Average

- Contracted 17,504 US$/km
- Total 15,928 US$/km
- Force Account 15,011 US$/km



X-axis scale

500 km

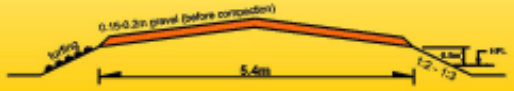
The width of the columns indicates the volume of the works reviewed in kilometres.

5,000 US$/km

Y-axis scale

The height of the columns indicates the average price per kilometre in US Dollars (1999) adjusted to the volumes of work of a typical rural road with the technical specifications as described below.

0 US$/km



8.2 Observations

On the basis of the above results, some important observations can be made. The observations should be treated, however, with caution, as large variances between individual projects and project groups do exist, and only limited adjustments could be made to normalise the data to fit one design standard. Also, many circumstantial differences could not be accounted for, and thus restrain the validity of the observations. The limited availability of data has added to this effect. Nevertheless, the following observations and conclusions seem to be justified.

The first is that the overall weighted average cost of labour-based works is 17% lower than equipment-based works. The lowest cost were recorded in the labour-based work carried out by contract under the Rural Infrastructure Improvement Project (11,116 US$/km), while the highest cost were recorded by the equipment-based contracts of the Urban Restoration Project of the Department of Public Works and Transport (20,678 US$/km).

The second is that irrespective of the implementation modality (i.e. force account or contracted works), the weighted average cost of labour-based projects is consistently lower than equipment-based projects, viz.:

(i) When works are carried out using labour based methods force account operations, the cost saving is 9% compared to using equipment based methods. This is based on large samples of both labour based and equipment-based works in which the variance is relatively small. The overall average of 15,416 US$/km is therefore not surprising and should be acceptable.

(ii) For the contracted out labour-based works, the cost saving is an amazing 37% when compared with equipment based works. This is based on a small sample of labour-based works and a large (but heavily corrected) sample of equipment-based works, in which the variances are very large. The results from the RIIP programme are encouraging, with a significant reduction in costs, however, the ILO contracts are at much higher cost than the average. Therefore, there is scope for improvement of the validity of the overall average of 17,456US$/km, but nevertheless it supports the final conclusions of this study.

The third is the very large employment potential in rural road works. The average unskilled labour content of equipment-based work is as low as 1% percent of total costs, compared to 37% for labour-based works. Labour-based rural road works require nearly 5,000 unskilled workdays per km as opposed to 200 workdays on an equipment-based operation. As the variance of these figures is small, the figures are considered valid.

The fourth observation, that does not appear from the figures, but from the experience of the research team, is the apparent lack of concise data on cost breakdowns. Records are in general being well kept, but for labour-based works programmes more attention needs to be given to the monitoring of equipment costs, while for the equipment based works more attention needs to be given to the monitoring of equipment as well as labour costs.

8.3 Employment Potential of Future Rural Road Works

On the basis of the observations made above, several scenarios have been developed to assess the potential to increase employment opportunities through rural road works in Cambodia. Some additional background information is provided below to support this assessment.

The responsibility for Cambodia's road network is currently divided between the Ministry of Public Works and Transport and the Ministry of Rural Development. Much of the Cambodian rural road network is still in a very poor condition and as a result is frequently impassable in the rainy season.

MPWT has some 7,700 km of national (primary) and provincial (secondary) roads. According to the MPWT priority assessments, some 4,700 km need urgent repairs. The current five year plan aims to rehabilitate 1,000 km a year with external financial assistance.

The exact situation with tertiary roads under MRD is still being assessed. According to a 1999 inventory[2] of 3,845 km, 309 km were in good condition, 1790 were poor but passable condition, and the balance of 1745 were impassable in the wet season. In addition, there are at least another 24,000 km of local commune and village roads which require upgrading to a reliably trafficable condition.

In order to assess the potential to create employment through rural road works, the focus could be given to the use of labour-based works technology. By its definition, the labour content of labour-based works exceed the labour contents of equipment-based works, which is confirmed in Chapter 8.2. However, labour-based technology is not always the most appropriate choice, as the most appropriate work methods should be rationally chosen by assessing its impact on timing, quality, and costs in line with the specific design and conditions in the project.

[2] *Creation of a Rural Roads Department, presentation – Ngy Chanphal, Under-secretary of State, MRD, 2000*

The scope for interventions using labour-based methods in road rehabilitation has a greater potential for the tertiary network, although there certainly are opportunities for some aspects of the improvement works on national and provincial roads. A number of roads rehabilitated by the labour-based programmes since 1993, have either been provincial roads, or have served that function in the absence of a viable alternative. Further, maintenance can be carried out using labour-based methods on both networks, although again it would conventionally be restricted to off pavement activities for bitumen surfaced roads. This study includes an assessment of increasing the use of labour-based methods in a proposed programme of rehabilitating and maintaining MRD roads and maintaining MPWT roads.

The labour-based work programmes have rehabilitated more than 1,000 km of rural roads in the period since 1993. However, the average annual output during this period has not exceeded 150km. To deal with the existing backlog in a reasonable time frame, it will be necessary to aspire towards rates of 1,000 km a year, although 500 km might be more realistic initially (on the basis of two contracts per province, each achieving 10 to 12 km a year).

Table 29 and Table 30 set out the annual employment potential for these two scenarios, including the establishment of a proper labour-based maintenance organisation in MPWT and the rehabilitation and maintenance of a core network of 5000 km of rural works.

Table 29: Expansion of rural network at 1000 km a year, situation at year 5 (Scenario 1)

Activity	input wd/km	output km	Value US$	total workdays generated
Rehabilitating & upgrading rural roads	4,958	1,000	13,773,000	4,958,000
periodic maintenance on rural roads	284 [1]	1,500 [2]	5,070,000 [3]	426,000
routine maintenance on rural roads	108 [4]	5,000	1,555,000 [5]	540,000
routine off-pavement maintenance s on MPWT road	100 [6]	7,700	2,387,000 [7]	770,000
Totals			**22,785,000**	**6,694,000**

Notes:
[1] ILO Cambodia estimates, see Annex 5.
[2] Assumed that 30% of all gravel road surfaces need regravelling annually
[3] Based on ILO Cambodia rate of 3,380 US$/km
[4] RIIP Cambodia estimates, see Annex 5.
[5] Based on RIIP Cambodia rate of 310 US$/km
[6] Accepted international norm
[7] Similar rate assumed as for rural roads

Table 30: Expansion of rural network at 50s0 km a year, situation at year 5 (Scenario 2)

Activity	input wd/km	output km	Value US$	total workdays generated
Rehabilitating & upgrading rural roads	4958	500	6,886,500	2,479,000
periodic maintenance on rural roads	284 [1]	750 [2]	2,535,000 [3]	213,000
routine maintenance on rural roads	108 [4]	2,500	777,500 [5]	270,000
routine off-pavement maintenance on MPWT roads	100 [6]	7,700	2,387,000 [7]	770,000
Totals			**12,586,000**	**3,732,000**

Notes:
[1] *ILO Cambodia estimates, see Annex 5.*
[2] *Assumed that 30% of all gravel road surfaces need regravelling annually*
[3] *Based on ILO Cambodia rate of 3,380 US$/km*
[4] *RIIP Cambodia estimates, see annex 5.*
[5] *Based on RIIP Cambodia rate of 310 US$/km*
[6] *Accepted international norm*
[7] *Similar rate assumed as for rural roads*

Assuming a 200 day working year, this represents between 18,660 and 33,470 full time jobs in the road sector, at an average investment value of 3.4 US$ per day for each job created.

If the work were to be carried out by small scale contractors, it is also possible to make a rough estimate of the number of enterprises involved:

- 50 to 100 labour-based road rehabilitation contracts, employing some 250 workers
- 35 to 70 periodic maintenance contracts employing some 30 workers
- 150 to 200 routine maintenance contractors employing some 20 workers

This would of course require a significant training and development effort over and above the existing programmes which have trained some 20 contractors and 60 petty contractors to date. However it would fit well with two of the government's top priorities, viz. creating rural employment and reinstating access to rural communities.

8.4 Conclusions

The overall conclusions are:

(i) While delivering the same quality and with the same specifications, the use of labour-based road work methods firmly proved to be a cost saving alternative compared to equipment-based works in Cambodia.

(ii) Cost savings were enhanced further when implementation was arranged through contracts with proper management and supervision instead of as force account operations.

(iii) In addition to the cost savings, labour-based projects have effectively provided employment (although for a temporary period) to a larger extent than previously envisaged, and as expected, significantly above the level of equipment-based projects.

(iv) It is estimated that using labour-based work methods to carry out a programme of rural road rehabilitation, combined with labour-based maintenance of the existing maintainable road network could generate between 3.7 and 6.7 million workdays per year, depending on the extent of the programme. Taking the maximum figure, this is equivalent to 33,000 full time jobs, and would also increase market opportunities for the local construction industry through the award of 100 rehabilitation contracts and 270 maintenance contracts per year.

Furthermore, labour-based methods could have an application for the primary and secondary road restoration programme, particularly were these roads are being restored to a gravel surface standard, or where alternative more durable surfaces can be adapted to a labour-based approach.

Bridge works by local contractor in Kampot Province, RIIP 2001.

9 Chapter

Recommendations

On the basis of the observations and conclusions in the former sections of this study, the following recommendations can be made:

(i) Labour-based work methods, as currently developed in Cambodia, should be adopted as the standard approach for all rural road rehabilitation and maintenance, works in order for the government to increase employment opportunities in the rural areas. This will have no negative implications for the efficiency, cost effectiveness or quality of the business of managing the rural road sector.

(ii) The potential for using labour-based work methods on some aspects of the primary and secondary road and maintenance restoration programme should be seriously considered.

(iii) The modalities for appropriate contracting methods to maximise employment impact and minimize costs could be analysed further.

(iv) More attention needs to be given to the record keeping of road work projects to facilitate future comparisons.

Restoration works on Monivong Boulevard, Phnom Penh 2002.


CATERPILLAR

Cost and Employment Generation of Rural Infrastructure Improvment Project

Road	Road	Cost, US$							Structures			Inputs			
Project	Length, km	Casual Labour	Skilled Labour	Structures	Laterite	Equipment Operation	Miscella-neous	Total	Cost per km	Culverts	Bridges	Cost/ culvert	Clearing (m2)	Earthworks (m3)	Laterite (m3)
Prey Veng															
RR1	4.6	24,025	7,900	7,535	17,305	8,002	17,327	82,094	17,847	9	0	837	4,600	20,442	3,965
RR2	10	65,245	15,963	6,174	36,465	16,962	26,730	167,539	16,754	5	0	1,235	200,000	31,742	8,580
RR3	1.5	5,792	1,448	0	3,812	1,488	2,391	14,931	9,954	2	0	na	11,250	5,140	1,287
RR4	3.06	9,344	2,322	3,210	6,214	5,056	4,569	30,715	10,038	6	0	535	16,275	13,649	2,625
RR5	9.7	46,938	9,738	4,890	33,797	12,627	11,940	119,930	12,364	12	0	408	93,120	45,153	8,323
RR6	10	44,696	7,477	22,791	33,240	4,920	8,383	121,507	12,151	13	2	na	85,000	35,128	8,580
RR7	10.45	61,340	10,773	9,395	20,456	10,181	10,926	123,071	11,777	19	0	494	71,500	55,686	8,966
RR8	9.9	58,709	10,890	20,941	32,833	7,232	10,458	141,063	14,249	14.4	1	na	87,120	34,821	8,494
RR10	12.5	51,486	11,376	7,825	19,511	9,446	5,280	104,924	8,394	na	na	na	na	na	na
RR13	7.5	52,381	17,445	6,393	34,987	10,106	24,621	145,933	19,458	na	na	na	na	na	na
Svay Rieng															
RR1	5	22,255	11,999	8,675	24,900	7,707	9,314	84,850	16,970	9	1	na	45,000	15,737	4,290
RR2	10	55,595	35,273	47,706	40,032	21,244	16,421	216,271	21,627	17	4	na	200,000	19,835	8,580
RR3	8.5	35,049	11,954	4,334	15,296	5,769	6,677	79,079	9,303	9	0	482	72,250	30,298	7,293
RR4	9.9	42,640	18,936	7,340	21,772	10,084	9,621	110,393	11,151	13	0	565	85,000	47,677	8,494
RR5	12	60,816	6,104	14,214	51,608	11,729	27,591	172,062	14,339	19	0	748	90,000	45,878	10,296
RR6	13	61,335	12,452	16,291	56,160	10,251	20,083	176,572	13,582	na	na	na	na	na	na
RR13	6	35,932	8,612	11,621	37,842	5,393	18,929	118,329	19,722	na	na	na	na	na	na
RR14	6.15	42,303	10,109	3,800	34,751	8,893	22,496	122,352	19,895	na	na	na	na	na	na
RR15	10.8	22,005	10,845	3,470	46,552	5,115	14,573	102,560	9,496	na	na	na	na	na	na
Kampong Cham															
RR1	6	23,330	10,465	10,115	9,792	5,891	4,824	64,417	10,736	5	0	2,023	60,000	10,173	5,148
RR2	10	26,281	17,767	19,191	20,420	11,079	3,275	98,013	9,801	23	3	na	100,000	27,959	8,580
RR3	13.6	60,216	12,875	26,551	19,264	15,638	6,743	141,287	10,389	20	4	na	108,800	65,637	11,669
RR4	7.5	28,822	7,337	10,777	5,670	6,623	2,674	61,903	8,254	22	0	490	75,000	21,688	6,435
RR5	6.2	20,186	7,388	6,718	9,660	3,085	3,244	50,281	8,110	11	0	611	50,400	19,949	5,320
RR6	8.27	36,122	4,022	16,171	12,478	24,907	3,055	96,755	11,700	na	na	na	na	na	na
RR7	7	22,194	7,641	6,510	2,725	3,786	1,496	44,352	6,336	11	0	592	56,000	28,730	6,006
RR9	4.735	21,095	10,766	24,320	5,195	6,435	1,399	69,210	14,617	na	na	na	na	na	na
RR10	10.9	38,540	12,913	4,291	8,692	6,500	2,938	73,874	6,777	6	1	na	65,400	12,854	9,352
RR11	15.25	75,224	40,175	16,528	21,800	23,357	6,788	183,872	12,057	na	na	na	na	na	na
RR13	3.01	11,144	1,907	6,595	7,941	4,273	2,994	34,854	11,579	na	na	na	na	na	na

Kandal															
RR1	5.6	29,045	11,002	8,557	10,640	7,475	4,515	71,234	12,720	9	0	951	67,200	30,421	4,805
RR2	9	42,213	14,073	17,784	18,430	9,624	5,266	107,390	11,932	11	1	na	13,000	30,027	7,722
RR3	8.5	43,752	10,585	19,660	19,393	13,723	3,185	110,298	12,976	14	2	na	85,000	21,415	7,293
RR4	14	65,504	12,338	9,199	17,710	12,504	6,252	123,507	8,822	20	0	460	4,000	45,055	12,012
RR5	7.6	37,513	11,314	2,538	14,879	5,394	3,136	74,774	9,839	7	0	363	60,800	30,105	6,521
RR7	3.3	21,289	4,360	825	3,535	3,193	1,501	34,703	10,516	1	0	825	33,000	20,662	2,831
RR9	10	50,581	13,970	7,846	11,800	7,628	3,010	94,835	9,484	12	0	654	80,800	15,170	8,580
RR11	5.27	23,344	22,080	7,350	19,183	9,887	8,415	90,259	17,127	na	na	na	na	na	na
RR12	8	144,362	55,558	37,034	37,036	26,392	13,604	313,986	39,248	na	na	na	na	na	na
Takeo															
RR1	16.5	72,839	27,996	36,429	31,667	13,654	10,555	193,140	11,705	26	2	na	181,500	40,380	14,157
RR2	8.3	17,349	7,492	0	18,675	3,450	2,845	49,811	6,001	0	0	na	41,500	8,960	7,121
RR3	2.3	10,823	2,522	4,420	4,353	2,927	476	25,521	11,096	7	0	631	20,720	5,826	1,973
RR4	9.9	57,900	7,340	32,507	39,641	12,484	4,560	154,432	15,599	25	2	na	52,139	40,132	8,494
RR5	8	42,929	5,680	17,100	31,680	5,307	2,445	105,141	13,143	16	1	na	69,600	25,822	6,864
RR6	5.2	30,829	2,496	9,827	22,109	2,584	1,035	68,880	13,246	17	0	578	52,200	20,808	4,462
RR7	10.4	57,486	5,694	20,999	46,790	5,123	2,127	138,219	13,290	21	1	na	63,000	24,312	8,923
RR8	8	36,919	10,967	20,535	45,643	7,555	4,159	125,778	15,722	na	na	na	na	na	na
RR9	13.7	69,646	22,801	19,206	39,718	16,411	11,082	178,864	13,056	na	na	na	na	na	na
RR10	4.1	26,418	12,142	14,937	11,250	7,670	4,724	77,141	18,815	na	na	na	na	na	na
RR14	3.3	11,243	3,981	626	10,735	2,100	1,658	30,343	9,195	na	na	na	na	na	na
RR15	1	10,890	1,668	1,786	2,800	135	341	17,620	17,620	na	na	na	na	na	na
RR16	4.15	31,557	10,780	11,904	13,303	3,789	2,635	73,968	17,824	na	na	na	na	na	na
Kampot															
RR1	6.4	30,808	10,540	16,527	18,531	6,288	5,028	87,722	13,707	6	1	na	83,200	12,133	5,491
RR2	8.5	34,160	11,474	10,824	15,334	11,827	5,462	89,081	10,480	12	0	902	110,500	25,244	7,293
RR3	11.5	67,932	19,859	50,943	13,196	18,569	9,884	180,383	15,685	22	4	na	253,000	37,628	9,867
RR4	11.5	78,290	20,131	53,719	15,525	14,093	9,112	190,870	16,597	17	5	na	253,000	30,648	9,867
RR5	11	63,362	18,294	45,126	16,269	12,962	10,941	166,954	15,178	17	4	na	242,000	29,144	9,438
RR6	10.3	66,965	27,371	28,329	27,807	20,834	13,161	184,467	17,909	na	na	na	na	na	na
RR7	8.15	59,360	16,348	37,315	15,883	8,256	7,434	144,596	17,742	na	na	na	na	na	na
RR9	6.7	45,859	14,174	19,673	14,204	11,295	6,924	112,129	16,736	na	na	na	na	na	na
RR11	11.5	102,904	46,099	68,448	24,668	24,664	24,660	291,443	25,343	na	na	na	na	na	na
TOTAL	**524.7**	**2,861,797**	**927,498**	**997,730**	**1,450,984**	**641,469**	**517,482**	**7,396,960**	**14,098**	**505**	**39**	**643**	**10,029**	**3,246**	**858**
Percentage		**39%**	**13%**	**13%**	**20%**	**9%**	**7%**								
Correction for Depreciation Equipment at 12%					*296,456*										
TOTAL															
Adjusted	**524.7**	**2,861,797**	**927,498**	**997,730**	**1,450,984**	**937,925**	**517,482**	**7,693,416**	**14,663**						
Percentage		**37%**	**12%**	**13%**	**19%**	**12%**	**7%**								

The above totals are based on the limited sample size of 333.31 km of roads constructed in 1998 and 1999. The average cost per culvert was deduced from only those instances were no bridges were constructed.

The above averages are based on the limited sample size of 333.31 km of roads constructed in 1998 and 1999

Road Project	Length	Cost, US$					Workdays	
	km	Earthworks	Structures	Laterite	Total	per km	Total	per km
Kampot								
RR8	9.37	92,323	23,974	16,740	133,037	14,198	38,813	4,142
Takeo								
RR11	9.2	82,862	24,249	28,739	135,850	14,766	42,112	4,577
RR12,RW1, RR2, RW2	10	74,167	9,117	26,500	109,784	10,978	22,296	2,230
RR13	7.7	48,985	22,607	21,571	93,163	12,099	13,066	1,697
Kandal								
RR11	5.27	41,010		19,183	60,193	11,422	38,021	7,215
Kampong Cham								
RR8	12	71,643	28,572	19,650	119,865	9,989	24,714	2,060
RR9	3.4	22,014	3,744	5,891	31,649	9,309	7,887	2,320
RR10	8	29,862	7,685	6,380	43,927	5,491	11,812	1,477
RR12	12.4	99,906	8,686	23,641	132,233	10,664	92,626	7,470
TOTAL	**77.34**	**562,772** **65%**	**128,634** **15%**	**168,295** **20%**	**859,701**	**11,116**	**291,347**	**3,767**

Labour-based Rural Infrastructure Works Programme

Force Account Data

			Laterite	Structures		Labour		Materials	Equipment	Total
	km	wd		Culverts	Bridges	Unskilled	Skilled			
Wat Brie	5	19,072	5,000	10	1	19,072	1,652	52,591	na	73,315
Svay Chek -Don Keo	16.5	87,612	16,500	32	2	87,612	5,512	124,392	na	217,516
Chreiv -Ouv Lok	6	21,108	6,000	26	1	21,108	988	24,660	na	46,756
Trapeng Svey - Taprok	4.1	21,196	4,100	15	1	21,196	1,096	32,384	na	54,676
Pouk - Tasek	4	25,786	4,000	11	2	25,786	1,296	50,360	na	77,442
Total	**35.6**	**174,774**	**35,600**	**94**	**7**	**174,774**	**10,544**	**284,387**	**na**	**469,705**
Average		**4,909**	**1,000**	**2.64**	**0.20**	**4,909**	**296**	**7,988**	**na**	**13,194**

Item	Work Description	Unit	6033, Ch. 05+750 - 06+750			672, Ch. 1+000 - 2+000			6033, Ch. 3+850 - 4+750			672, Ch. 3+000 - 3+8000			6033, Ch. 6+750 - 7+650			6033, Ch. 4+750 - 5+750			672, Ch. 0+000 - 1+000			Summary		
			Quantity	Rate	Amount	Quantity	Rate	Amount	Quantity	Rate	Amount	Quantity	Rate	Amount	Quantity	Rate	Amount	Quantity	Rate	Amount	Quantity	Rate	Amount	Quantity	Rate	Amount
A10	Setting up Camp	L.S.			200			200			200			200			200			200			200			1,400
A20	Removal of Camp	L.S.			100			100			100			100			100			100			100			700
B10	Setting out alignment	m	3,000	0.11	340	3,000	0.11	340	2,700	0.11	306	3,000	0.11	340	2,700	0.11	306	3,000	0.11	340	3000	0.11	340	20,400	0.11	2,311
B20	Clearing	m²	20,000	0.03	600	13,000	0.03	390	18,000	0.03	540	11,900	0.03	357	20,000	0.03	600	20,000	0.03	600	16,000	0.03	480	118,900	0.03	3,567
B30	Grubbing	m²	20,000	0.03	600	13,000	0.03	390	5,400	0.03	162	11,900	0.03	357	18,000	0.03	540	10,000	0.03	300	16,000	0.03	480	94,300	0.03	2,829
B40	Removal of Top Soil up to 150 mm	m²		0.12	0		0.12	0		0.12	0		0.02	0		0.12	0		0.12	0		0.12	0		0.12	0
B50	Remove unsuitable materials at depths exceeding 150 mm	m³		0.76	0		0.76	0		0.76	0		0.76	0		0.76	0		0.76	0		0.76	0		0.76	0
C10	Excavate rock and boulders	m³		1.62	0		1.62	0		1.62	0		1.62	0		1.62	0		1.62	0		1.62	0		1.62	0
C20	Excavate side drains in soil	m³	300	0.76	228	708	0.76	538	270	0.76	205	500	0.76	380	210	0.76	160	150	0.76	114		0.76	0	2,138	0.76	1,625
C21	Excavate side drains in weathered rock	m³		1.62	0		1.62	0		1.62	0		1.54	0		1.62	0		1.62	0		1.62	0		1.62	0
C30	E/W excavation and haul upto 200 m. and compact in layers not exceeding 150 mm	m³	5225	1.05	5,486	3,818	1.05	4,009	3,772	1.05	3,961	1,600	1.05	1,680	7,670	1.05	8,054	4,898	1.05	5,143	4,494	1.05	4,719	31,477	1.05	33,051
C40	Construction of Scour Checks	Nos.		1.62	0		1.62	0		1.62	0		1.62	0		1.62	0		1.62	0		1.62	0		1.62	0
C50	Mitre and catch water drains	m		0.64	0		0.64	0		0.64	0		0.64	0		0.64	0		0.64	0	120	0.64	76.8	120	0.64	77
D10	Reshape E/W Camber	m²	5500	0.06	330	5,400	0.06	324	4,950	0.06	297	4,590	0.06	275	4,950	0.06	297	5,500	0.06	330	5,400	0.06	324	36,290	0.06	2,177
D20	Spread, shape to Camber and compact gravel*	m³	750	3.38	2,531	750	2.9	2,175	675	3.16	2,130	600	2.9	1,740	675	3.49	2,352	750	3.27	2,449	750	2.9	2,175	4,950	3.14	15,552
E10	Turfing	m²	6000	0.11	630	4,000	0.07	280	5,400	0.11	567	3,400	0.07	238	5,400	0.11	567	6,000	0.11	630	4,000	0.07	280	34,200	0.09	3,192
E20	Tree Planting Equipment	Nos.		3	0		3	0		3	0		3	0		3	0		3	0		3	0	0	21	0
	Cost	L.S.			4,950			4,950			3,850			3,300			6,050			4,950			4,950	0		33,000
	Culvert	Est.			1,550												1,014							0		2,564
	Total				17,545.4			13,695.9			12,317.3			8,967			20,239.4			15,155.6			14,124.4			102,045
Workdays					**4,946**			**2,784**			**3,760**			**3,380**			**5,886**			**5,940**			**3,207**			**29,903**

* The quantity of gravel is converted into the standard of RIP, ie from 0.20 to 0.15m thickness

Norwegian People's Aid Data (Original BoQ)

Road 1

No.	Description	Unit	Length km	Quantity	Unit Rate US$	Amount US$	Per km US$
1	Clearing*	m^2	19.8	160,000	0.1	16,000	808
2	Earthwork for embankment	m^3	19.8	64,350	0.80	51,480	2,600
3	Watering, Compacting before spreading laterite	m^2	19.8	99,000	0.15	14,751	745
4	Laterite Delivery up to the site	m^3	19.8	23,760	2.30	54,648	2,760
5	Spreading, watering and compaction	m^2	19.8	99,000	0.25	25,047	1,265
6	Reshaping	m^2	19.8	2,400	0.08	8,267	418
7	Turfing	kg	19.8		0.25	600	30
8	Causeways (3 locations)	m			150	10,500	530
9	Bridges (5 locations)	m			900.00	40,500	2,045
10	Culvert, 100cm.	Nos			700.00	2,100	106
11	Culvert, 80 cm.	Nos			550.00	2,750	139
12	Culvert, 60 cm.	Nos			400.00	2,800	141
Sub total Cost						229,443	11,588
Overhead for supervision and other indirect costs @ 7%						16,061	811
	Total Cost					**245,503**	**12,399**

*Acquired people's participation for clearing

Road 2 Poipet Commune, O Chrov District

No.	Activities	Length m	Area m^2	Volume m^3	Unit rate US$	Total cost US$	Per km US$
2	Levelling small hills, located in area for road construction	40	0	800	0.45	360	61
3	Earthwork, preparing layer by layer, road camber, including watering and compaction	5,900	0	36,272	0.83	30,106	5,103
4	Loading and unloading of laterite	5,900	0	4,779	2.05	9,797	1,661
5	Spreading, watering, and compact laterite	5,900	26,550	0	0.165	4,381	743
6	Sloping both side slopes of road shoulder	5,900	11,800	0	0.06	708	120
7	Grassing both side slopes on road embankment	5,900	11,800	0	0.15	1,770	300
8	Sloping both sides of the ditch	23,600	0	0	0.032	755	128
9	Reshaping both sides of the ditch	5,900	29,500	0	0.055	1,623	275
	Grand total					**49,499**	**8,390**

Road 3 Beng Trakuon to Phum Kdep Thmor

No.	Activities	Length m	Area m^2	Volume m^3	Unit rate US$	Total cost US$	Per km US$
1	Clearing & top soil removal, thickness 30 cm	5,800	52,200	0	0.03	1,566	270
3	Earthwork, including watering and compaction	5,800	0	29,991	0.55	16,495	2,844
4	Loading and unloading laterite	5,800	0	6,960	1.5	10,440	1,800
5	Spreading, watering, and compaction of laterite	5,800	29,000	6,960	0.1	2,900	500
6	Reshaping	5,800	29,000	0	0.053	1,537	265
7	Grassing	5,800	11,600	0	0.15	1,740	300
	Side drain protection	15	0	0	15	225	39
8	Site preparation, Barricade	3			270	810	140
	Signboard	2	0	0	50	100	17
9	Concrete pipes:						-
	Dia. 80 cm	3	0	0	1,350	4,050	698
	Dia. 60 cm	2			380	760	131
	Grand total					**40,623**	**7,004**
Grand Total with 5% discount						**38,592**	**6,654**

Action Nord Sud Data (Original BoQ, excluding bridge Works, included all the bidders of a job)

Activity	Unit	Qty.	Leang		Chhay		Heng-Leu		Sopho		Hay		Komarith		Kreusna		Chhoeum		Average	
Road Length	km	16.7	Rate	Amount	Rate	Amount	Rate	Amount	Rate	Amount	Rate	Amount	Rate	Amount	Rate	Amount	Rate	Amount	Rate	Amount
Earthworks by Equipment	m^3	19,476	0.91	17,723	0.65	12,660	0.85	16,500	0.90	17,495	0.58	11,230	0.75	14,523	1.10	21423	1.08	21,060	0.85	16,577
Earthworks by Food for Work	m^3	77,996	0.91	70,976	0.65	50,684	0.85	66,279	0.90	70,178	0.58	45,226	0.75	58,482	1.10	85773	1.08	84,214	0.85	66,492
Compaction of Earthworks	m^3	97,472	0.11	10,517	0.13	12,670	0.08	7,800	0.08	8,199	0.15	14,940	0.17	16,656	0.08	7602	0.12	12,000	0.12	11,298
Watering of Earthworks	m^2	97,472	0.09	8,363	0.06	6,335	0.06	5,700	0.04	3,823	0.10	9,700	0.11	11,136	0.08	7602	0.11	11,050	0.08	7,964
Shape Earthworks	m^2	167,930	0.03	4,600	0.08	13,440	0.02	3,360	0.03	5,446	0.05	8,250	0.05	9,000	0.06	10075	0.11	18,928	0.05	9,137
Compaction of Laterite	m^3	10,020	0.42	4,200	0.36	3,607	0.38	3,800	0.45	4,500	0.34	3,396	0.34	3,396	0.40	3968	1.56	15,600	0.53	5,308
Watering of Laterite	m^3	10,020	0.48	4,800	0.12	1,200	0.23	2,338	0.33	3,257	0.22	2,235	0.26	2,556	0.40	3968	0.91	9,100	0.37	3,682
Shaping of Laterite	m^2	66,800	0.08	5,544	0.08	5,300	0.04	3,000	0.06	3,800	0.02	1,549	0.06	4,333	0.10	6680	0.13	8,650	0.07	4,857
Transportation of Laterite (loose)	m^3	12,024	2.5	30,060	2.00	24,048	2.30	27,655	0.75	8,979	0.8	9,620	0.91	11,000	2.00	24048	0.29	3,500	1.44	17,364
Culverts																				0
2*600		2	730	1,460	400	800	720	1,440	605	1,210	600	1,200	725	1,450	600	1,200	598	1196	622	1,245
1*800		9	590	5,310	450	4,050	580	5,220	469	4,221	500	4,500	528	4,750	650	5,850	572	5,148	542	4,881
2*800		3	870	2,610	670	2,010	850	2,550	721	2,163	700	2,100	783	2,350	900	2,700	911	2,733	801	2,402
1*1000		7	780	5,460	600	4,200	750	5,250	512	3,584	700	4,900	736	5,150	800	5,600	856	6,055	718	5,025
2*1000		10	1,180	11,800	900	9,000	1140	11,400	835	8,347	1,100	11,000	1,125	11,250	950	9,500	1,210	12,100	1,055	10,550
3*1000		2	1,680	3,360	1,200	2,400	1650	3,300	1,214	2,427	1,750	3,500	1,875	3750	1,400	2,800	1,686	3,372	1,557	3,114
Total				186,783		152,404		165,592		147,629		133,346		159,782		198,789		214,706		169,894
Total/km (without bridge)				11,185		9,126		9,916		8,840		7,985		9,568		11,904		12,857		10,173

National Road No 5, Krakov to Svay Duam Keo. Package 5B & C, Nawarat Patanakarn Public Company Ltd. Bid Feb 9 1999.

Item	Rate	% distribution				Standard Rural Road Quantity m^3	cost component US$				Total cost/km US$
		labour	equipment	skilled	materials		labour	equipment	skilled labour	materials	
Clearing and grubbing	0.36 per m^2	7	70	23	0	10,022	253	2,526	830	0	3,608
Earthworks	4.36 per m^3	2	86	12	0	3,506	306	13,145	1,834	0	15,285
Laterite	8.1 per m^3	2	42	19	37	780	126	2,654	1,200	2,338	6,318
Culverts	48 per lm	2	10	2	86	15.2	15	73	15	627	730
Bridges	5,780 each	2	10	2	86	0.12	14	69	14	596	694
						Total	**713**	**18,466**	**3,893**	**3,562**	**26,634**
						%	**3%**	**69%**	**15%**	**13%**	

National Road No 6, Sth Kg Thmor to Kg Thom. Package 6B Muhibbah Engineering Cambodia. Bid Feb 9 1999. Package 7A, National Road No 7.

Item	Rate	% distribution				Standard Rural Road Quantity m^3	cost component US$				Total cost/km US$
		labour	equipment	skilled	materials		labour	equipment	skilled labour	materials	
Clearing and grubbing	0.06 per m^2	3	97	0	0	10,022	18	583	0	0	601
Earthworks	2.04 per m^3	0	100	0	0	3,506	0	7,152	0	0	7,152
Laterite	2.47 per m^3	1	49	0	50	780	19	944	0	963	1,927
Culverts	140.4 per lm	3	9	0	88	15.2	64	192	0	1,878	2,134
Bridge	5,780 each	2	10	2	86	0.12	14	69	14	596	694
						Total	**115**	**8,940**	**14**	**3,438**	**12,507**
						%	**1%**	**71%**	**0%**	**27%**	

China Jilin International package 7E, National Road 5

Item	Rate		% distribution				Standard Rural Road Quantity m^3	cost component US$				Total cost/km US$
			labour	equipment	skilled	materials		labour	equipment	skilled labour	materials	
Clearing and grubbing	0.37	per m^2	5	83.5	11.5	0	10,022	185	3,096	426	0	3,708
Earthworks	2.54	per m^3	1	93	6	0	3,506	89	8,281	534	0	8,904
Laterite	5.38	per m^3	1.5	45.5	9.5	43.5	780	63	1,909	399	1,825	4,196
Culverts	78	per lm	2.5	9.5	1	87	15.2	30	113	12	1,031	1,186
Bridge	5,780	each	2	10	2	86	0.12	14	69	14	596	694
							Total	**381**	**13,469**	**1,385**	**3,453**	**18,688**
							%	**2%**	**72%**	**7%**	**18%**	

CEC - Nopawang J.V. Greater mekhong Region Infrastructure Development Programme, Phnom Penh to Ho Chi Minh City Highway Improvement Project (Road No. 1)

Item	Rate		% distribution				Standard Rural Road Quantity m^3	cost component US$				Total cost/km US$
			labour	equipment	skilled	materials		labour	equipment	skilled labour	materials	
Clearing	0.08	per m^2	5	83.5	11.5	0	10,022	40	669	92	0	802
Earthworks	2.72	per m^3	1	93	6	0	3,506	95	8,868	572	0	9,535
Laterite	9.09	per m^3	1.5	45.5	9.5	43.5	780	106	3,226	674	3,084	7,090
Culverts	64.2	per lm	2.5	9.5	1	87	15.2	24	93	10	849	976
Bridge	5,780	each	2	10	2	86	0.12	14	69	14	596	694
							Total	**280**	**12,926**	**1,362**	**4,530**	**19,097**
							%	**1%**	**68%**	**7%**	**24%**	

Notes

Earthworks have been taken from the embankment item and adjusted to 5.4 meter road width
Laterite has been taken from laterite sub-base item and adjusted to 5.4 meter road width and 15 cm layer thickness
Culverts has been taken from culvert item
All rates less VAT where applicable

RIIP Routine Maintenance Costs

	Length (km)	Labour Input (wd)	Costs						
			Labour	Materials	Equipment	Sub-Total	Overheads 10%	Total	Average
1998									
Takeo	40	3,913	4,696	4,957	1,887	11,540	1,154	12,694	318
Kandal	9	819	983	1,166	400	2,549	255	2,804	298
1999									
Takeo	61	4,880	5,887	8,922	820	15,629	1,563	17,192	282
Kandal	33	2,770	3,316	3,279	661	7,256	726	7,982	246
Kampong Cham	16	1,222	1,477	95	718.2	2,290.6	229	2,520	157
Kampot	15	847	1,021	321.26	680.82	2,023.48	202	2,226	149
Prey Veng	5	524	632	175	177.55	984.48	98	1,083	235
Svay Rieng	5	436	523	99.87	239.55	862.77	86	949	190
2000									
Takeo	123	14,969	20,656	10,284	3,779	34,719	3,472	38,191	310
Kandal	85	10,423	14,381	8,346	3,180	25,907	2,591	28,498	334
Kampong Cham	81	10,317	14,236	5,550	3,396	23,182	2,318	25,500	314
Kampot	69	8,292	11,440	5,665	2,859	19,964	1,996	21,960	317
Prey Veng	61	6,445	8,893	8,373	2,893	20,159	2,016	22,175	364
Svay Rieng	60	5,973	8,241	8,023	2,903	19,167	1,917	21,084	351
Total	**663**	**71,830**	**96,383**	**65,256**	**24,594**	**186,233**	**18,623**	**204,857**	**309**
Average		**108**	**145**	**98**	**37**	**281**	**28**	**309**	

ILO Labour-based Rural Infrastructure Works Programme
Periodic Maintenance Costs

	Chreav Ouv	Loley	Tram Neak	Barai	Chreav	Svay Chek	Total	Average
Length (km)	5.4	9	7	4	6.2	1.9	33.5	
Work days								
Skilled	122	209	146	78	56	36	647	19
Unskilled	1,722	3,017	1,936	979	754	460	8,868	265
Key outputs								
Setting Out (m)	5,400	9,000	7,000	4,000	2,600	1,900	29,900	893
Reshaping (m^2)	27,000	43,200	32,200	16,000	13,000	8,740	140,140	4,183
Laterite (m^3)	5,738	9,720	6,038	3,000	2,336	1,311	28,143	840
Costs								
Materials	9,531	16,304	16,604	11,220	6,207	3,894	63,760	1,903
Labour	2,001	3,497	2,264	1,152	879	541	10,334	308
Equipment	306	550	428	245	159	116	1,804	54
Supervision	2,792	4,642	3,622	2,068	1,344	982	15,450	461
O & M	2,093	3,489	2,714	1,551	1,008	737	11,592	346
Sub-Total	**16,723**	**28,482**	**25,632**	**16,236**	**9,597**	**6,270**	**102,940**	**3,073**
Overhead (10%)	1,672	2,848	2,563	1,624	960	627	10,294	307
Total Cost	**18,395**	**31,330**	**28,195**	**17,860**	**10,557**	**6,897**	**113,234**	**3,380**

ASIST AP is a regional programme of the Employment Intensive Investments Programme (EIIP) of the ILO, concerned with developing and mainstreaming poverty alleviation strategies through sustainable infrastructure development. The programme is implemented through four major fields of operation, viz: accessibility planning, labour-based works technology, small-scale contracting and infrastructure maintenance, thus providing a comprehensive approach to infrastructure development covering all stages from planning and construction to maintenance and operation.

Based in Bangkok, ASIST AP provides a full range of expert support to all stages of the project cycle from formulation, implementation, monitoring to final review and evaluation. These services include activities such as:

- planning, policy development and design of infrastructure programmes,
- influencing public investments in infrastructure towards the greater use of local resources,
- technical and managerial support to project implementation,
- information services,
- preparation of planning and implementation guidelines,
- developing appropriate methods for increased involvement of the domestic construction industry in infrastructure works,
- design and conduct of tailor-made training programmes, and
- design of appropriate maintenance management systems.

This document forms part of a series of publications from ASIST AP, in its efforts to develop and disseminate general and country specific guidelines, best practices and lessons learned in the context of planning and implementing infrastructure works programmes.

More information about ASIST AP can be found at **www.iloasist.org** or by contacting us at

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JOBS OR MACHINES

Comparative Analysis of Rural Road Work in Cambodia

The use of labour-based works technology has formed a central part of the delivery mechanism for reinstating rural access in Cambodia over the past decade. The use of labour-based work methods for constructing and maintaining rural roads has provided effective solutions in terms of both costs, quality and time, while at the same time increasing employment opportunities in the rural areas.

For this technology choice to be widely applied and mainstreamed in the construction sector, it is necessary to demonstrate that the outputs are competitive with the use of conventional work methods, which rely on the extensive use of heavy construction equipment. This study has been undertaken to compare the costs and potential benefits of various implementation arrangements and choice of technology for rural road rehabilitation and maintenance, applied in various projects in recent years in Cambodia.

The study has analysed the results of a number of projects in which different implementation modalities were chosen, including force account operations, the involvement of local contractors, use of equipment as well as the application of labour-based methods supported with light construction equipment.

The appropriate choice of technology has additional benefits relating to issues beyond the confines of the rural road sector. Through the careful choice of technology, it is possible to increase employment and cash earnings among people living in the rural areas. Through appropriate contracting arrangements, the works can provide the local construction industry with increased market prospects. The study looks at such potentials as a result of a decision to mainstream the use of labour-based work methods carried out by local contractors for the provision of rural roads in the country.

International Labour Orginization
Regional Office for Asia and the Pacific

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