RURAL ROAD ECONOMIC APPRAISAL METHODOLOGY

J. Lebo and D. Schelling, World Bank (2001)

Objectives of the paper

Abstract

For some time now, it has been clear that rural transport infrastructure (below 50 vpd), is ill suited for appraisal using the conventional economic cost-benefit analysis as it is applied to highly trafficked main roads. Rather, a wider view is needed to assess the role of low-volume transport infrastructure interventions including the social importance of ensuring basic access to resources and opportunities.

Where benefits cannot be measured in monetary terms, it is recommended to use the Cost Effectiveness Approach (CEA) which compares the cost of interventions with their intended impact (Cost/population served). To overcome the problem of open-ended threshold associated with the CEA method, an extended Cost- Benefit Analysis is used on a sample of projects. The extended CBA approach includes better assessment of RTI project such as NMT operating costs and modal change savings and valuation of social benefits from improved access to schools and health centers.

Key issues

➢ The need to incorporate the *socio-economic* role of rural transport infrastructure (RTI) (including poverty alleviation) into prioritizing improvements.

➢ Ranking of rural transport infrastructure using the cost effectiveness method supported by sample cost benefit analysis on selected links, where appropriate.

➢ Extending the conventional Cost Benefit Analysis (CBA) to assess the role of RTI projects, including the social importance of ensuring a basic access level to resources and opportunities.

Key topic areas

➢ Participatory planning approach
➢ Selection and priority settings methods
➢ Screening and Ranking methods
➢ The Cost Effectiveness Analysis and the extended CBA approach

1   INTRODUCTION

The provision of motorable basic access roads (below 50 vpd) is constrained by available resources, especially maintenance and capital budgets. What is affordable depends on the local population's capacity to maintain their own basic access infrastructure over the long-term[1]. Determining what is affordable depends on the complex relationship between this local capacity, available skills, income levels, population density, geographic conditions, and political will[2]. Appraising these factors will shed light on Rural Transport Infrastructure (RTI) sustainability, and should be undertaken as part of the investment appraisal process.

This paper discusses appraisal in the context of participatory approaches for the selection and priority setting of RTI interventions and projects, as well as the economic rationale of the planning process. It also describes alternative screening and ranking methods, in particular cost-effectiveness and cost-benefit approaches.

Because traditional Cost Benefit Analysis (CBA) approaches do not account for many of the benefits of RTI investments, extending the framework of CBA holds promise for improved analysis.

This paper describes the possibilities to extend the enhancements of traditional CBA techniques, which are aimed at finding broader measures of economic benefits and costs applicable to RTI.

The possible enhancements of the CBA approach, discussed in this paper include:

(i)   better assessment of the costs of interrupted access;
(ii)   estimating operating cost savings of NMT;
(iii)   savings due to mode changes (from NMT to motorized transport);
(iv)   improved valuation of time savings; and
(v)   valuation of social benefits from improved access to schools and health centers.

Finally, the paper presents examples of economic appraisals applied in recent World Bank rural transport projects that illustrate this extended CBA approach.

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[1]   In the rare cases where transfer arrangements from central budgets or road funds exist for financing RTI maintenance, local communities must still provide substantial contributions. This is one of the main reasons for local level ownership through a participatory approach to planning, monitoring and evaluation for this type of intervention.

[2]   Some empirical evidence from recent World Bank projects suggests that the limit of what can be afforded in terms of RTI investment is close to the annual per capita GDP of the population served.

2   APPRAISING RTI, THE BASIC ACCESS APPROACH

A basic access intervention, in this context, can be defined as the least-cost (in terms of total life-cycle cost) intervention for ensuring reliable, all-season passability for the locally prevailing means of transport. Consistent with a basic needs focus, the basic access approach gives priority to the provision of reliable, all-season access, to as many villages as possible, over the upgrading of individual links to higher than basic access standard.

In this context, project appraisal is used in its widest sense, it includes the analysis and assessment of social, economic, financial, institutional, technical, and environmental issues related to a planned Basic access intervention.

Local communities are the main stakeholders and users of RTI. In recognition of this, there is now wide acceptance that their participation in the preparation and implementation of investment programs enhances local ownership and commitment, and fosters better accountability, management and sustainability[3].

2.1 A Participatory Planning Approach

Due to the increasingly decentralized framework for the provision of local services, and in order to build ownership and mobilize local resources, the planning (and monitoring and evaluation) process for RTI must be participatory. Whereas simultaneously "bottom-up" and "top-down" iterative approaches are required, the starting point for the process consists of consultations at the local government and community level.

A key tool for the participatory planning process is a local government or community transport plan. Local engineers or consultants, in consultation with communities, should conduct a low-cost inventory and condition survey of the local transport network, including roads, tracks, paths and footbridges, with a focus on existing obstacles. On the basis of the information generated, and additional economic, social and demographic information, an "as is" map should be produced. Based on such information, stakeholders can co-operatively decide upon desired improvements in the RTI network, taking into account objectives and available resources.

It has been argued that participation can replace the economic selection process. This might be the case if investments are entirely locally financed, but even then the "wish list" will typically be more sizeable than available resources and a rational process (using economic criteria) should be used to help prioritize alternative investments.

[3.]   For more on participatory approaches see World Bank, Social Development web site: *http://www.worldbank.org* – Topics and Sectors – Social Development.

2.2 Selection and Priority Setting Methods

Screening and Ranking: Selection and priority-setting methods for basic access RTI interventions consist of two broad types of methodologies which are usually applied in succession: (a) screening and (b) ranking. *Screening* decreases the number of investment alternatives given budgetary constraints, which may involve: (a) targeting disadvantaged areas or communities based on poverty indexes, or (b) eliminating investments into low-priority sections of the network selected based on agreed criteria.

Targeting Poor and Disadvantaged Communities: One of the purposes of screening is to target investments to disadvantaged regions, local governments and communities. Screening approaches were developed initially for targeting isolated or economically deprived communities and regions. They have since been adapted for the selection of districts, communities, and municipalities on the basis of poverty criteria—measuring economic standing and potential, as well as social development (such as literacy and health statistics). In China, for example, poverty-based pre-screening was used to identify "priority counties." A second- and third-stage screening process was then used to identify specific road sections and corresponding design standards (Box 1).

Eliminating low-priority links of the network: Another use of screening is to eliminate low priority links from consideration for investments. For example, in the case of the Andhra Pradesh district transport master planning process in India, it was decided that for each village only one link, normally the shortest one, would be upgraded to basic access standard. This reduced the road network that was considered for interventions from about 5,000km to 3,000km per district. There are many other examples of elimination by screening[4].

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[4]. For example, in the province of Saskatchewan in Canada, wheat farms are based on square mile lots. Along the perimeter of the lot, there is normally a public access road from which a penetration road leads to the farm house. When selecting which of these access roads should be gravelled (which means the provision of costly "crusher-run" material because the in-situ soils are mainly clays) it has been decided that, per farm, only one access road to the main road system (and normally the shortest one) is being gravelled (and therefore becomes an all-season road) while the others remain seasonal earth roads. This represents the provision of "basic access" under budget constraints in a developed country.

Box 1: Selecting Road Improvement Components for Poverty Alleviation

Two recent Bank-financed highway projects in China (Second Henan Provincial Highway Project, 1996, and Second Shaanxi Provincial Highway Project, 1996) included a poverty-focused component. The component was proposed in line with the provincial government programs of Road Improvement for Poverty Alleviation (RIPA), which aimed to provide all-weather access through rehabilitation, upgrading, and construction of rural roads to a main provincial road axis for every poor county township and the majority of villages.

A three-stage screening procedure was developed to select rural roads to be included in the project's RIPA component. The first stage of screening identified the "priority counties" that were most in need of improved road transport as an element in alleviating their poverty. The criteria used to prioritize included average income per capita, number of the "very poor" per 10,000 population, value of agriculture production, value of mineral production, and other social development indicators (including literacy rate, health workers per thousand population, and access to clean drinking water).

The second stage of screening used a cost-effectiveness criterion to select rural road systems from these priority counties. In this stage, rural roads for improvement in these counties were grouped into the RIPA systems based on three criteria: (1) continuity of the system; (2) maximization of the population served; and (3) connectivity to as many settlements as possible. Then a cost-effectiveness criterion—the proposed investment cost divided by population served in the influence area of the system—was used to screen the RIPA road systems. The very high unit cost systems were dropped. Finally, available financial resources were taken into consideration in deciding the number of systems and size of the RIPA packages that passed this stage of the screening.

The third stage of screening consisted of an analysis of the economic and social benefits of each of the road systems included for consideration at the end of the second stage. The analysis also included a review of motorization trends to guide the selection of proper road class and road engineering design that would meet the future needs of both motorized and non-motorized traffic in these rural areas.

Source: Hajj and Pendakur.

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3   RANKING METHODS

After screening methods have been applied to a given set of investment choices, resources are still unlikely to be sufficient to finance the balance of the remaining desirable interventions, and hence a ranking or prioritization exercise is required. The following three main ranking methods for RTI are discussed in the following paragraphs: (a) multi-criteria analysis; (b) cost-effectiveness analysis; and (c) cost-benefit analysis.

3.1 Multi-Criteria Analysis

Multi-criteria analysis (MCA) is commonly used to rank RTI investments. Criteria such as traffic level, proximity to health and educational facilities and agricultural assets receive weights (points) relative to their perceived importance. Each road link is then allocated the number of points corresponding to the fulfillment of the particular criteria. The aggregate number of points that each intervention receives is computed by simply adding the points allocated per indicator, or through the application of a more complex formula. The result of this process leads to a ranking of the investment options.

In most examples, indicators used under MCA implicitly reflect economic and subjective evaluations. If the weights and points are decided upon and allocated in a participatory way, MCA has the potential to be a participatory planning method based on implicit socio-economic valuation. However, it tends to be applied by consultants or planners in isolation without consultation with the concerned users and stakeholders. The outcome of the MCA methodology, is often, unfortunately, non-transparent, especially if too many factors are considered and a complicated formula applied. Therefore, if adopted, this method has to be used with great care and kept simple, transparent, and participatory.

3.2 Cost-Effectiveness Analysis

A subset of the MCA is the cost-effectiveness analysis (CEA). CEA compares the cost of interventions with their intended impacts. CEA is widely used to appraise investments in the social sector, however, has rarely been used in the transport sector. This has largely been due to the belief that the impacts of transport interventions are mainly economic in nature and should be measured. With the increased focus on the poverty and social impacts of transport investments, and their justification on these broader grounds, CEA has recently become more prominent.

The operational policies[5] of the World Bank allow the use of CEA in situations where benefits cannot be measured in monetary terms, or where measurement is difficult. There are provisions, however, that (a) the objectives of the intervention are clearly stated and are part of a wider program of objectives (such as poverty alleviation); and (b) the intervention represents the least-cost way of attaining the stated objectives. "Least-cost" in the context of RTI means that "basic access standards" have been applied.

For example, one of the first Bank-financed rural transport projects where CEA was intensively used for the ranking of rural road investments was the Rural Roads Component of the Andhra Pradesh Economic Restructuring Project. The selection process used in this project is described in Figure 1. The CEA was applied to rank individual links of a "core network" selected on the basis of screening criteria. The cost-effectiveness indicator was defined as the cost of improving a particular link to "basic access standard"[6] divided by the number of people served by the link.
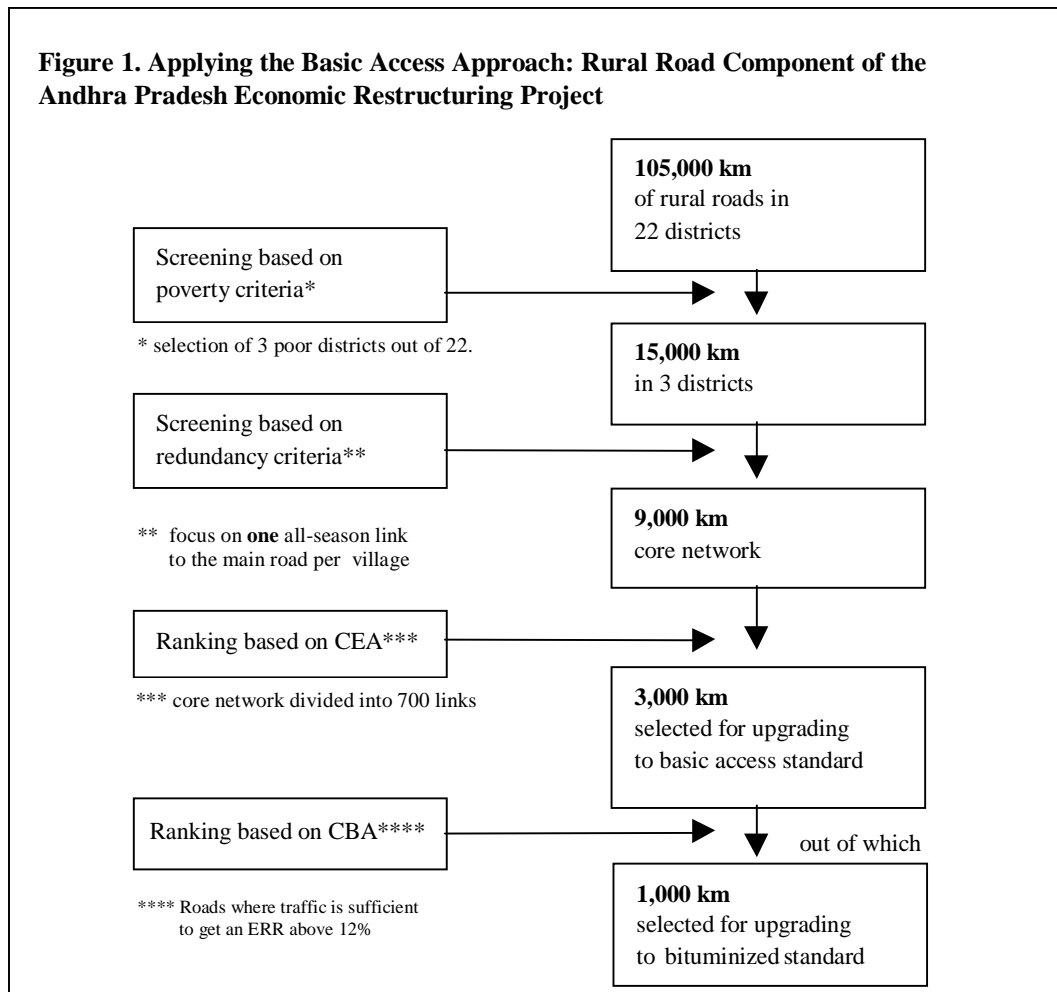
$$\textbf{Cost-effectiveness indicator of link}_{(i)} = \frac{\textbf{Cost of upgrading of link}_{(i)}\ \textbf{to basic access standard}}{\textbf{Population served by link}_{(i)}}$$

On this basis, up to 700 individual links were ranked. In view of the available financing, it was then decided that the maximum amount of investment allowed per link would be

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[5]   OP 10.04.

[6]   Normally, life cycle costs should be used in this formula (including maintenance). However, in this case, maintenance costs were found to be uniform over the network and there was no need to consider them..

US$50 per person served.[7] CEA also lends itself to the incorporation of poverty and other factors as is shown in Box 2 below.

Figure 1. Applying the Basic Access Approach: Rural Road Component of the Andhra Pradesh Economic Restructuring Project

	105,000 km of rural roads in 22 districts
Screening based on poverty criteria*	
* selection of 3 poor districts out of 22.	**15,000 km** in 3 districts
Screening based on redundancy criteria**	
** focus on **one** all-season link to the main road per village	**9,000 km** core network
Ranking based on CEA***	
*** core network divided into 700 links	**3,000 km** selected for upgrading to basic access standard
Ranking based on CBA****	out of which
**** Roads where traffic is sufficient to get an ERR above 12%	**1,000 km** selected for upgrading to bituminized standard

3.2.1 Thresholds for Cost-Effectiveness

Unlike CBA, where projects normally are deemed "uneconomic" when their ERR falls below 10-12%, there are no well established criteria for determining "opportunity cost" thresholds when ranking on the basis of cost-effectiveness. Such a determination is then left to policy makers. For example, if access can be provided to two, otherwise similar communities at US$100 per person served and US$50 per person served, respectively, cost-effectiveness criteria would clearly "rank" the latter community higher. However, the question that remains is whether US$50 per capita is a sufficient "return" to justify intervention (could that US$50 per person be spent with more impact in another sector, or would it yield an ERR of 10-12% considering the opportunity cost of capital in the country?) In practice, for basic access RTI, such thresholds do not usually become a point

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[7]   The cost of upgrading of all link that cost less than $50 per person served would exhaust the available budget.

of debate, because project budgets are normally pre-set and are exhausted before what most planners agree are reasonable cost-effectiveness limits.

Box 2. Applying the Basic Access Approach: Vietnam's Second Rural Transport Project

The overall goal of this project is to contribute to poverty reduction in rural Vietnam. To meet this objective, the project aims to provide "basic road access" to all communes in participating provinces. For purposes of the project, basic road access is defined as year-round motorized access from the commune center to the closest district center. District centers have many of the higher level facilities – hospitals, upper secondary schools, market centers. Effective year-round road access to the district center can be expected to make significant impacts on living standards in the communes.

A) Basic Access Roads: Before project implementation, it was not clear whether the budget would be sufficient to provide basic access roads to all communes; (there was also the possibility that it would be too much). A cost-effectiveness methodology that takes poverty, population and project costs into account was thus used to prioritise between eligible roads. Among the different groups in the population, the formula put about three times more weight on the poor than on the non-poor. The choice of three as the relative weight on the poor was discussed and agreed to in focus-group meetings with local non-transport experts and with the Ministry of Transport. The index for ranking alternative basic access roads is then:

CE_1 = (# of poor + 0.3* # of non-poor)/total cost of rehabilitation

B) Selected rehabilitation and spot improvement on other roads: Once basic road access needs are met, remaining funding can be devoted to selected rehabilitation and upgrading of other roads. This budget is allocated to the highest priority road projects as determined by cost-effectiveness rankings based on a formula that takes into account poverty, population served, potential for agricultural development (as measured by unused land with agricultural potential and number of social and other facilities) and costs of the proposed works. The index for ranking roads for rehabilitation/spot improvement is:

CE_2 = {[1 + (unused land/per person) + (facilities /per person)]*[# of poor + 0.3* # of non-poor]}/ total cost of rehabilitation

Again, the choice of variables (subject to data availability) were discussed and agreed to in focus group meetings with local non-transport experts and with the ministry of transport.
Source: Dominique Van de Walle 1999.

3.2.2 Sample Study to Indicate Economic Viability

To overcome the problem of open-ended thresholds associated with the CEA method, it is desirable to complement the CEA method with a sample study based on cost-benefit analysis for one or two roads in the project area (see below). If this sample study can establish that a per-capita threshold of investment meets the prescribed economic rate of return for the sample link (such as the US$50 used in the Andhra Pradesh appraisal mentioned above), then all links above the threshold are likely to be viable. Such an approach has been shown to provide a good economic basis for applying the CEA method to a broad RTI investment program, especially where socio-economic characteristics do not vary greatly.

4   COST-BENEFIT ANALYSIS

The most common approach for the economic evaluation of road investments is cost-benefit analysis (CBA). CBA is a comprehensive accounting of all the real costs and

benefits associated with a (road) project. This includes users and non-users, as well as the road agency. Where the impact on non-users is negligible, a CBA of road alternatives centers around the trade-offs between total life-cycle costs of infrastructure (capital and maintenance) and user costs and benefits (operating cost of the primarily vehicle and time savings). The outcome of CBA permits ranking of alternative interventions on a particular link based on the net present value (NPV). Where a number of different but independent links are being considered (and there is a fixed capital budget) ranking can be based on the net present value per financial investment outlay ratio (NPV/INV), or net present value per kilometer (NPV/KM) if road infrastructure costs (capital and maintenance) are the same for all links. The benefit from cost savings for transport users can be considered an increase in "consumer surplus", if such savings accrue to the users as reduction in transport costs or charges. Alternatively, if transport cost reductions lower producers' input and output costs, and result in higher net income, then the benefits can be considered as an increase in "producers' surplus" (Lebo and Gannon, 1999).

4.1   Producer Surplus Methods

Producer surplus methods are discussed in detail in the well known works of (Carnemark, 1976, Beenhakker, 1983 and others). The method requires assumptions concerning the impact of transport investments on local agricultural productivity and output which are difficult to assess, particularly in a situation where interventions are expected to open up new areas and adequate production data may be difficult to compile. To the extent that RTI investments are increasingly focused on existing networks and often put more emphasis on social rather than economic objectives, the application and relevance of the producer surplus method has decreased in recent years.

4.2   Consumer Surplus Methods

Consumer surplus methods are well established and applied in road investment models, such as the Highway Development and Management Model, Version 4 (HDM-IV). The methods are reliable to apply to higher-volume roads (>200 VPD). However, its application to low-volume roads encounter problems related to the small magnitude of user benefits and the stronger influence of the environment rather than traffic on infrastructure deterioration. With traffic levels between 50 and 200 VPD, and particularly with regard to unpaved roads, a modified and customized approach can be taken, as is done in the recently developed Roads Economic Decision Model (RED). This method attempts to take into account uncertainty related to the input assumptions and an expanded treatment of user benefits (Box 3).

Box 3. Roads Economic Decision Model (RED)

The Roads Economic Decision Model (RED) provides an approach for improving the decision-making process for the development and maintenance of low-volume roads. RED is a consumer surplus model designed to help evaluate investments in roads with traffic volumes between **50 and 200** vehicles per day. The model is implemented in a series of Excel workbooks that estimate vehicle operating costs and speeds, perform economic comparisons of investment and maintenance options, switching values and stochastic risk analysis.

RED simplifies the economic evaluation process but at the same time addresses the following concerns related to low-volume roads: (a) reduces the input requirements; (b) takes into account the higher uncertainty related to the inputs; (c) computes internally generated traffic based on a defined price elasticity of demand to which induced traffic can also be added; (d) quantifies the economic costs associated with the days-per-year when the passage of vehicles is further disrupted by a highly deteriorated road condition; (e) optionally, uses vehicle speeds as a surrogate parameter to road roughness to define the level of service of low-volume roads; (f) includes road safety benefits; (g) includes in the analysis other benefits (or costs) such as those related to non-motorized traffic, social service delivery, and environmental impacts, if they are computed separately; and (h) presents the results with the capacity for sensitivity, switching values and stochastic risk analyses. RED can be downloaded free of charge at *http://www.worldbank.org/html/fpd/transport/roads/tools.htm*

Source: Archondo-Callao 1999.

For traffic levels below 50 VPD, as is the case on the majority of RTI, the consumer surplus approach is usually not recommended because the main benefits from such projects are not from savings in motor vehicle operating costs, but relate to the provision of access itself. As discussed previously, for various reasons the benefits of access are difficult to quantify. Also, traffic on such very low volume RTI typically consists of a majority of non-motorized vehicles (where part of the costs are human energy needed to pull or push the vehicles, which cannot be easily priced), animal transport such as haulage by mules, walking and head loading (porterage). Therefore, the following section proposes some extensions or special adaptations to the traditional CBA and discusses their appropriate application for RTI.

5   EXTENDING THE CBA FRAMEWORK FOR RTI

Because traditional CBA approaches do not account for many of the benefits of RTI investments, extending the framework of CBA holds promise for improved analysis. The proposed enhancements of traditional CBA techniques are aimed at finding broader measures of economic benefits and costs applicable to RTI. That is, while the principles of analysis are the same, the special features of RTI call for special methods of analysis. The methods described here can serve as a useful foundation for "pilot" or "sample" CBA to supplement CEA, or in the case of a low-volume road that presents a major investment, a new access option to a given area, or a proposed upgrading to a higher than basic access level. Possible enhancements of CBA include:

- Better assessment of the costs of interrupted access
- Estimating operating cost savings of NMT
- Savings due to mode changes (from NMT to motorized transport)
- Improved valuation of time savings, and
- Valuation of social benefits from improved access to schools and health centers.

5.1   Better Assessment of the Cost of Interrupted Access

For cases where passability suffers during the rainy season, an assessment can be made of the extent of interruption. Seasonal changes in transport quality can be assessed on the basis of local socio-economic impact, such as higher goods prices, lost productivity, or decreased social travel. In such cases, an assessment of the impact on particular activities may be necessary, since losses associated with seasonal interruptions will vary by activity (agriculture, marketing, travel for jobs and related wage earnings, school attendance and consequent decline in quality of education, health visits, etc). It may be difficult to directly observe the impact of seasonal access variations, and such information will usually need to be collected either through a local survey or other participatory processes. In addition, it may be possible to examine the costs associated with alternative (but longer) routes (that increase transport cost and time), or substitutes for transport (migration, storage), or even lost opportunities and income, to better understand the impact.

5.2   Estimating Operating Costs Savings of NMT

Methods for calculating the non-motorized transport user cost savings from road improvements have only recently become a part of project evaluation. Studies in Bangladesh and Indonesia have estimated user costs for a set of NMT and the results of these studies has been integrated in the HDM-4 model (Padeco, 1996) and (World Bank, 1996). In particular circumstances, additional country- or area-specific fieldwork may be necessary to get realistic estimates of NMT costs. Particular information is required regarding operating costs in relation to differing road surface conditions. Box 4 gives an example from Bangladesh.

Box 4: Rickshaw Operating Costs in Bangladesh

Studies in Bangladesh indicate how to realistically assess (changes in) the cost of transport services by rickshaws and rickshaw-vans that are used as a major form of rural transport The rickshaw-van is the most common NMT used for goods in rural Bangladesh, and it is driven (pedaled) by a van driver. It can carry about 400kg weight per trip. Since the main cost of its operation is the time and food-energy used by its driver, its operating cost is difficult to estimate. For project analysis, therefore, charges actually made by the rickshaw-van operators on different types of road conditions were collected through surveys. The vehicle operating cost savings used in the study are based on actual differentials in charges between existing poor roads and improved roads, as they substantially reflect the cost variations due to greater exertion, time and additional food for higher level of effort and energy needed for plying on rougher roads. Since NMT transporters operate in a highly competitive market where there are no significant externalities, these financial rate differences are taken to reflect economic cost differences. The surveys showed that the rate per ton-km on moving on a rough (earth) road was more than double the rate for a smooth asphalt road (about US$0.50 per ton-km for the rough road, compared to US$0.20 per ton-km on smooth roads). An interesting aspect of the case in Bangladesh was the realization that human–pulled vehicles need smooth surfaces even more than motor vehicles, and that road investments in black-topping could be justified when heavy NMT traffic exists, even though the number of motor vehicles in use is less than 50 per day. It was also clear that the people generally had small parcel loads or a few bags at a time to transport over short distances, which was best suited for the efficient form of NMT in Bangladesh (the rickshaw-van). Indeed, with road improvements there was a fast increase in both motor vehicles and NMT traffic. The Bangladesh studies also established that after road development there is dynamic growth in traffic and a change in vehicle composition: buses starting to appear for the first time, and overall traffic growth exceeded 100% even in the first year after project completion. The study also found that cost differences between the with- and without-project situations are best estimated through likely changes in the composition of vehicles (decline of bullock carts and head porterage, and increase in both NMT and motor vehicles) and related unit costs.

Source: (1) "Bangladesh, Rural Infrastructure Impact Study, with Special reference to RDP-7 and other projects", LGED; prepared by Socio-economic Monitoring and Environmental Research, Dhaka; September 1999". (2) Rural Infrastructure Strategy Study, 1996

5.3   Savings due to Mode Changes (from NMT to motorized transport)

Very significant savings can be made due to road improvement- or construction-induced changes in the modes of transport. Resulting cost reduction can ten fold as shown in Box 5.

Box 5. Savings due to Mode Changes in Ghana and Elsewhere

Studies in Ghana (and elsewhere) have established that head porterage takes about two person-days to move one ton-km, using factors of average load size, walking speed per hour, and time for the return trip (without load). Using the minimum wage rate, this amounted to about US$2 to 2.50 per ton–km. The minimum wage is taken as a proxy for the resource costs (food, expenses, etc.), and for the time and effort involved.

More recent studies indicate that where transport is not available, the rural poor experience a shortage of productive time in doing various chores in their daily lives and farming, marketing, and transport activities, and therefore their time should be given a higher monetary value. This is indeed a valid consideration, but not reflected in the price noted above (see also next paragraph on the valuation of timesavings). The estimated rate of US$2 to 2.50 per ton-km mentioned above was also found to reflect the actual market charges for such operations.

This rate range is found valid for head porterage in many developing countries. In Balochistan (Pakistan), Nepal, and Bhutan, where mule transport is a common form of transport in rural areas, the actual cost is found to be about US$3 to 4 per ton-km, including the cost of the mules and the persons walking with them. In Bhutan, a similar rate was found through market inquiries of actual charges levied, and also from indicative tariff rates published by the Royal Government of Bhutan. This rate should be compared with about US$0.20 per ton-km for trucking operating costs on low-volume roads, which would become applicable after road construction or improvement.

Adapted from: Tampil Pankaj 1991.

5.4 Improved Valuation of Time Savings

A critical aspect of examining alternative RTI interventions is an understanding of the impact of improvements in infrastructure on journey times, and therefore (beyond the impact on vehicle operating costs) on productive time saved, including those associated with non-motorized travel and transit time of freight. The process of valuing time in transport operations is not without controversy (Box 6), and while there are currently no universally accepted methods for determining a "value of time," some general guidance is possible For additional, information on valuing travel time savings, see (Gwilliam (1997)).

Box 6. Valuing "Journey Time Saving" in Developing Countries

The issue of valuing time, or more specifically journey timesavings, has been the subject of extensive theoretical and empirical investigation. However, most of this work has focused on conventional journeys of people by road and reflects the traditional arguments of transport economics. These revolve around the use of resource assessments of value, or inferring resource values from the behavior of travelers. Walking trips and those by other non-motorized means of transport have largely been ignored. Moreover, debate has generally centered around the issue of valuing journeys in working time or non-working time. The first of these categories refers to time for which the traveler is paid out of employment remuneration, and the second to all other uses of time such as commuting, shopping or social purposes. These categorizations are appropriate to the economic and social structures of developed countries, yet they are less helpful when the study population comprises rural household members who are: (a) predominantly self-employed; and (b) characteristically engage in multi-purpose, or simultaneous task trips. The latter is especially true of women who in many societies are the dominant transporters at the household level (see Bryceson, 1995).

Most transport economics literature assumes that the majority of the rural population in developing countries will be in non-wage employment, and it is therefore considered to be traveling in non-working time which is ascribed a zero value. This clearly does not make sense, either in resource or behavioral terms. Walking journeys consume both energy and time, which are both valuable resources in rural subsistence households. The creation of energy is rarely a free good. Moreover, there are numerous examples where the behavior of such societies indicates that they place a relatively high value on their time.

Source: Howe 1997.

In collecting data on the value of time, special attention should be given to estimating values which can be applied to particular modes of travel, such as bus versus bicycle travel. In addition, overall journey length may change stated time values, as can income level. Both should be evaluated in survey data. Finally, time required for walking, waiting, or transfer may need to be valued differently than specific travel time (on or in vehicles) and should be reported separately where possible. Where it is not possible to

obtain local values for travel time, estimates from household income or shadow wages should be substituted. Table 1 offers relevant guidelines:

Table 1. The Valuation of Time Savings from Transport Improvements in Developing Countries Where it is not possible to derive values locally, the following bases should be used: (W = wage rate per hour; H =household income per hour)		
Trip Purpose	**Rule**	**Value**
Work trip	Cost to employer	1.33 w
Business	Cost to employer	1.33 w
Commuting and Other non-work	Empirically Observed value	0.3 H (adult) 0.15 H (child)
Walking/waiting	Empirically Observed value	1.5 x value for trip Purpose
Freight/Public Transport	Resource cost Approach	Vehicle time cost + driver age cost + occupants time
Source: Gwilliam 1997.		

5.5   Valuation of social benefits from improved access to schools and health centers

It is often argued that the most important impacts of rural infrastructure improvements take place through changes in the patterns of personal mobility and increased social travel (Cook and Cook, 1996). Improved rural access provides social benefits in promoting education, particularly through increased enrolment of girls, health benefits, increased labor mobility, the spread of information and knowledge, and also improved access to markets. Many studies demonstrate the dynamic changes that improved rural mobility brings to the social and economic life of rural areas. A study in Bangladesh comparing two sets of villages showed that villages with road access, compared with villages without access, fared much better in farm-gate price of produce, fertilizer use, land under irrigation, household income, income per acre of field crops, wage income of landless labor, and percentage of employed women (Ahmed and Hosain, 1990). Another comparative picture of villages from Bhutan, all under the same agro-climatic and cultural environment and also in the same district, not far from each other, demonstrate similarly impressive contrasts in school enrolment levels and other aspects (see Table 2.).

Table 2. Access, Income, and Education in Bhutan (World Bank, 1999)		
	"Accessible" (0-0.5 days walk to nearest road)	"Not accessible" (1-3 days walk to nearest road)
Distance to nearest road (walking time)	0-0.5	1-3

Average annual income/farm household	$176 equivalent	$71 equivalent
Enrolment of boys (age 6-16)	73%	42%
Enrolment of girls (age 6-16)	64%	22%
Source: Project Appraisal Document on a proposed credit to Bhutan for a rural access project, World Bank, November 1999.		

One common approach to quantifying social benefits (particularly benefits from improved access to education and health facilities) is to use a sample case as guidance for assessing similar benefits from other roads improvements in similar areas or regions in the same country. Such estimates can be considered together with the usual transport cost savings estimated separately. However, care must be taken to ensure that there is no double counting of benefits in the process. In the above study, benefits from education were estimated from increased school enrolment levels (due to improved access), using estimates of the incremental life earnings of the children who would have otherwise remained unskilled. Health benefits were assessed based on reduced sick days away from work, lost net income, and other health savings from better access to health centers. Such an approach may involve considerable field data collection and analysis. The first study along these lines for appraising a rural infrastructure investment was done recently for the Bhutan Rural Access Project, which was approved by the Board of the World Bank in December 1999. The Bhutan case also highlights other important approaches for the careful assessment of benefits from rural road access improvements. These benefits include the estimation of mule-haulage costs in the without-project situation, and the use of a 40-year life assumption for the road, which specifically is defined as a well-designed and erosion-protected mountain road with a gravel surface with expected good maintenance. (in the case of Bhutan). Sensitivity analysis regarding these assumptions was done.

6   CONCLUSION

Establishing the priorities of an RTI intervention requires a selection process consisting of a combination of screening and ranking procedures. The screening process reduces the number of investment alternatives. This can be done, for example, through targeting of disadvantaged communities based on poverty indexes, or by eliminating low-priority links from the list according to agreed-on criteria.

The balance of the alternatives will need to be ranked according to priority. Three methodologies for ranking are discussed: (a) multi-criteria analysis (MCA); (b) cost-effectiveness analysis (CEA); and (c) cost-benefit analysis (CBA). MCA often leads to non-transparent results, and is recommended only if cost criteria are included, and if the criteria are few, relevant, and have been determined (including their relative weights) in a participatory way.

This paper discussed a specific CEA approach for the majority of RTI where traffic is less than 50 motorized four-wheeled vehicles per day. A priority index is defined for each RTI link based on a cost-effectiveness indicator equal to the ratio of the total life-cycle cost of ensuring basic access divided by the population served. With this approach, a threshold CE-value needs to be determined below which a link should not be considered for investment. The recommended method for determining a threshold CE-value is to do a sample cost-benefit analysis on a few selected links applying enhanced benefit measurement approaches for establishing a threshold CE-value.

For roads where higher than basic access standards seem justified—those that provide an alternative access to the same location, or experience traffic levels above 50 VPD (but below 200 VPD)—the use of standard cost-benefit analysis is recommended. Appropriate computer-assisted models exist to aid transport planners and road agencies to optimize decisions on, for example, the threshold traffic for upgrading to a higher standard gravel or bituminous surface road. Such models include enhanced CBA and RED (see Box 4.4). For roads that carry above 200 VPD, the utilization of HDM-4 is recommended.

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