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Title of Paper: 101 THINGS THAT CAN GO WRONG IN AN ECONOMIC APPRAISAL OF RURAL ROADS IN DEVELOPING COUNTRIES

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ABSTRACT

The road sector consumes a considerable amount of investment resources in developing countries. With poverty reduction (and especially rural poverty reduction) being an important objective in the policies of developing country governments and development agencies, there is increasing emphasis on investment in rural roads which ranges from improvement of community access tracks and roads at the lowest end of the road network to the improvement of feeder roads that perform wider economic and socio-economic functions. It is generally agreed that selection of rural roads at the lower end of the network should not be based on economic criteria alone, but more important rural roads requiring higher levels of investment are still largely justified on the basis of economic criteria.

Until recently the economic analysis of rural road investments was difficult as the available models could not deal with some important features of the rural roads (e.g. the models lacked facilities to estimate the vehicle operating costs of non-motorised transport modes, predict cost and deterioration characteristics of unsealed roads and estimate benefits due to an improvement of disrupted passability). Recent development of some user friendly road economic appraisal models (e.g. the World Bank's Road Economic Decision (RED) Model and components of HDM-4) have made economic appraisal of rural roads easier.

Like other road economic appraisal models, these improved economic appraisal tools use functional relationships to calculate costs and benefits based on the inputs from the model users. Evidently, the quality of model output is dependent on the quality of the input data. However, in many cases adequate data are not available and a balance has to be struck to ensure adequate quality of data (and assumptions) with acceptable cost of collecting them and taking account of the available data collection capability. The paper draws on the experience of the authors in the appraisal of rural roads in various developing countries to identify some of the common issues and problems faced by practitioners and provides guidance on avoiding some of

the pitfalls. It is based on currently available theoretical and empirical evidence and makes reference to other sources for further details.

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KEY WORDS

ROADS / ECONOMIC APPRAISAL / RURAL / DEVELOPING COUNTRIES

1. INTRODUCTION

The road sector consumes a considerable amount of investment resources in developing countries. With an overarching objective of poverty reduction pursued by the governments of most developing countries and international development agencies, there is increasing emphasis on investments in rural roads. Rural roads investments range from improvement of community access tracks and roads at the lowest end of the road network to the improvement of feeder roads that perform more important economic, socio-economic and administrative functions.

It is generally agreed that selection of rural roads at the lower end of the network should not be based on economic criteria alone. Such roads are typically ranked on the basis of total points scored by a road on a selection of access criteria (multi-criteria appraisal) with the emphasis being on providing low-cost basis access for the selected routes (Lebo and Schelling, 2001). However, investments on roads at the top end of the rural roads network (roads that perform wider economic, socio-economic functions) are being justified on the basis of economic criteria.

Until recently the economic analysis of rural road investments was difficult as the available models could not deal with some important features of rural roads (e.g. they lacked facilities to estimate the vehicle operating costs of non-motorised transport modes, predict cost and deterioration characteristics of unsealed roads and estimate benefits due to an improvement of disrupted passability). Recent development of some user friendly road economic appraisal models, for example the World Bank's Road Economic Decision (RED) Model and components of HDM-4, have made economic appraisal of rural roads easier.

Like other road economic appraisal models, these improved economic appraisal tools are based on pre-defined functional relationships to calculate costs and benefits of road investments. Inputs from model users are used in the calculation of costs and benefits using the functional relationships. Therefore, the quality of the model outputs is dependent on the quality of the users' inputs. A ranking on the basis of flawed model outputs due to incorrect users' inputs will result in an improper resource allocation.

The paper draws on the experience of the authors in the appraisal of rural roads in various developing countries to identify some of the common issues and problems faced by practitioners. Based on currently available theoretical and empirical evidence, the paper provides guidance on avoiding some of the pitfalls. Reference to other sources for further details is made where appropriate.

The following section sets out the list of data and assumptions items that need attention in using the models, what can go wrong when conducting an economic appraisal of rural roads, with explanations of why attention to these aspects is important. Guidance is also provided on avoiding the pitfalls.

2. A LIST OF THINGS THAT CAN GO WORNG AND APPROPRIATE GUIDANCE

2.1. Traffic figures

2.1.1. Wrong representation of existing traffic

Existing traffic figures are one of the main inputs for economic appraisal of roads. Vehicle Operating Cost (VOC) savings of existing traffic account for a large proportion of the road improvement benefits. Also estimates of generated and diverted traffic are typically based on existing traffic figures. Therefore, a wrong estimate of existing traffic may result in wrong investment decisions.

Guidance

Definitional pitfalls: Practitioners often face difficulties because of the different terms used in defining traffic figures. The definitions of the most common terms used are as follows:
Annual Average Daily Traffic (AADT) represents the average flow if the count is conducted over the whole year;
Average Daily Traffic (ADT) represents the average daily flow for a given period (e.g. a week, a month).

The AADT figure may be different from a one-off count ADT figure as rural road traffic figures are affected by the following factors:

- harvest and non-harvest seasons;
- wet and dry seasons;
- market and non-market days;
- special activity days (like festival days, funeral days etc.); and
- time of the day.

Figure 1 presents a schematic diagram of potential level of errors due to one-off counting.

AADT is the ideal measure on which all traffic related analysis should be based. However, it is impractical to conduct traffic counts over the whole year, especially for low volume rural roads. Therefore, scaling factors (like seasonal factors, hourly factors etc.) are used to covert the ADT figure to the AADT figure.

Steps to establish the existing traffic figures:

1. Look for traffic count figures from the road agency for particular roads. Convert the ADT figure into AADT figure with the help of conversion factors. The conversion factors may be available from the road agency. However, make rational judgements as they may not represent the rural roads. Use of conversion factors will depend on the count duration and timing (explained below);
2. If traffic count figures are not available then conduct a traffic count – a 7-day count is preferable but a 2-day (one market and one non-market day) count will suffice. However, avoid non-representative day count (like festival days, government holidays etc.).Counting duration should least be 12 hours (preferably 6:00 AM to 6:00 PM);

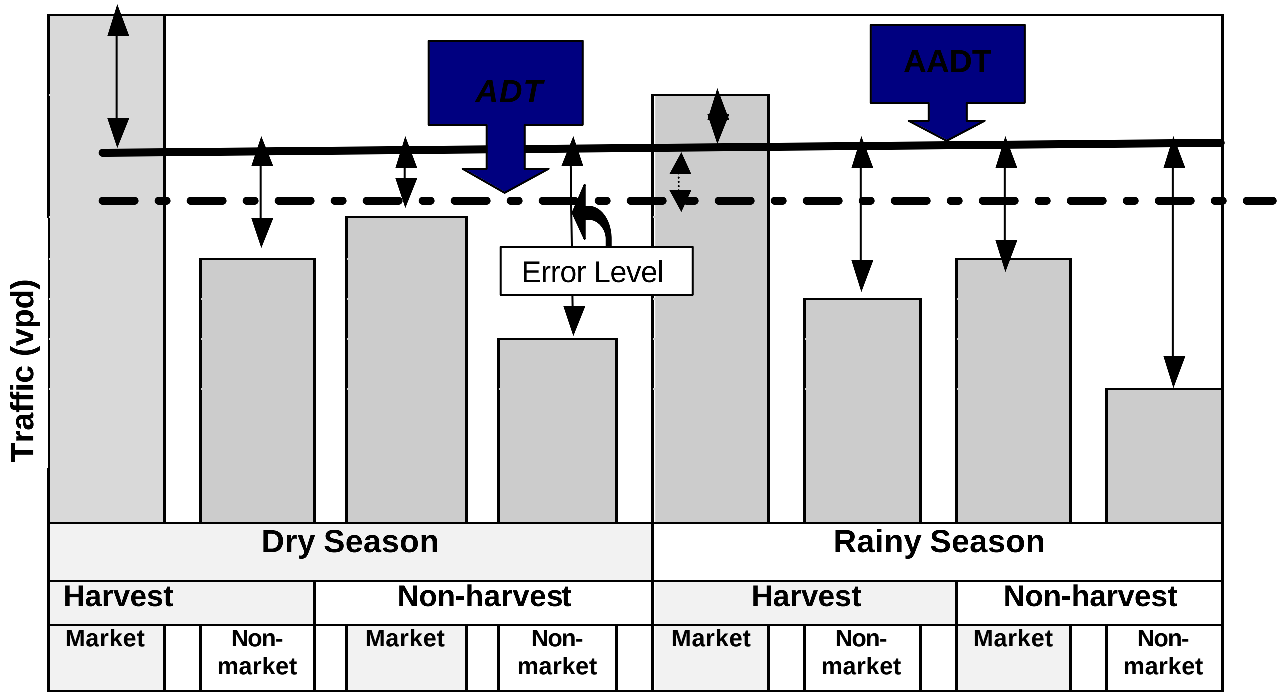

Figure 1 - A schematic diagram of error levels for a one-off counting regime

3. Convert the short duration count data into AADT using seasonal, day and time of count scaling factors. Table 1 presents a sample calculation of conversion of 2-day 12 hours traffic count figures to 7-day 24 hours count figures using the scaling factors. These factors may be available from the road agency. In the absence of credible locality-specific data, Lebo and Schelling (2001) suggested a scaling factor of 1.33 for conversion of 12 hours daylight traffic to 24 hours traffic. However, it may be difficult to get seasonal or day scaling factors. In such a case while conducting the economic analysis sensitivity tests using different traffic figures are suggested;
4. If fully fledged counting is not at all possible due to time and financial constraints then conduct moving observer surveys. Lebo and Schelling (2001) detail the methodology for conducting such surveys. However, when conducting such surveys, "non-representative" times (e.g. early morning or late afternoon, right before or after market opening times when traffic is high) should be avoided

Table 1 - Conversion of 2–day 12 hours count figures to 7-day 24 hours figures

	ADT	Count of Market day	No. of Market days	24-hr factor	Sub Total	Count of Non Market Day	No. of Non Market days	24-hr factor	Sub Total
Column	1=(5+9)/ 7 days	2	3	4	5 = (2*3*4)	6	7	8	9= (6*7*8)
Bullock Cart	12.0	17	2	1.39	47.1	6	5	1.24	37.1
Rickshaw	79.0	70	2	1.39	193.9	58	5	1.24	359.1
Rickshaw Van	10.2	19	2	1.39	52.6	3	5	1.24	18.6
Bicycle	210.0	173	2	1.39	479.3	160	5	1.24	990.6

2.1.2. Inaccurate traffic forecasting

Forecasting diverted traffic

If a transport mode shifts to the improved road from another road for making a trip between the same origin and destination at the same time of the year, it is defined as diverted traffic. A mode changes a route only when the total utility of using the improved route exceeds the earlier route. The analysis required to predict the amount diverted traffic is complicated and reliable data are unlikely to be available.

Guidance

It is best to be conservative in the treatment of generated traffic. Unless there is a strong case for taking it into consideration, it should not be considered in the calculations of traffic benefits. Even when they are considered sensitivity tests should be carried out to test whether the investment is justified in the absence of the assumed diverted traffic.

Forecasting generated traffic

Generated traffic is defined as the additional traffic (including increased frequency and new trips) generated because of lower transport costs after road improvement. Generated traffic may be crucial in economic appraisal of rural roads with very low existing traffic because the existing road is in very poor condition. However, existing methodologies for forecasting generated traffic are extremely crude.

Guidance

The most widely practiced method uses the concept of demand elasticity, i.e. the percentage change of existing traffic as a result of the generalised cost of travel (i.e. total cost of a door-to-door trip, not only the costs incurred while travelling on the road). Suggestions also include using different elasticity figures for passenger and freight traffic, and agricultural and non-agricultural traffic. Typical demand elasticity figures range from -0.6 to -2.0. In the absence of a reliable local estimate, unit elasticity (i.e. a value of -1.0) is considered acceptable in forecasting generated traffic. This means that a one percent decrease in costs is assumed to lead to a one percent increase in existing traffic. However, it should be kept in mind that the whole growth of traffic can not be achieved instantly. There exists a time lag between the time of interventions and full build up of generated traffic. It is a common practice to assume 40-50% of the traffic generated in the first year and rest of the traffic generated in the next 2-4 years. For more discussions on the issue of forecasting generated traffic see DFID (2001)

Forecasting normal traffic growth

This is defined as the growth of existing traffic because of economic growth and other developments irrespective of the road improvement.

Guidance

Normal traffic growth figures are normally available from government transport policy documents For example, the Road Sector Development Programme documents in Uganda (Government of Uganda, 2001) quotes a figure of 4.0%

traffic growth. If figures are not available for rural roads, the overall country traffic growth figure may be the only option.

If current traffic growth estimates are not available from the road agency, the most usual method for predicting normal traffic growth is trend extrapolation. This can be done by plotting a trend line of traffic growth from historical data and finding the figures by extrapolation. This may be expressed either in terms of growth in number of vehicles per year or as a percentage yearly increase. DFID (2001) presents another approach of predicting normal traffic growth that uses historical data on the relationship between changes in traffic volume and Gross Domestic Product (GDP) figures to make future projections.

2.2. Vehicle operational characteristics and costs data for VOC estimation

Vehicle operational characteristics and costs data are used in the calculation of VOCs and therefore are one of the main sets of inputs for any economic appraisal of roads. The reliability of these data is vital for the validity of the appraisal. The appraisal models require data for financial and economic values.

Guidance

Data on vehicle operational characteristics and costs or VOCs are generally available at the national roads agency in a country. However, such data are usually estimated for vehicle operations on major roads and therefore may not appropriate for rural roads. If time and resources permit, it is best to conduct a short survey to establish representative rural road vehicle operational characteristics. If this is not possible, evidence from interviews with a small number of rural transport operators can be used to make appropriate adjustments to the main road agency values. .

2.3. Non-inclusion of NMT benefits

Rural road traffic in developing countries comprises motorised as well as non-motorised traffic, including pedestrians. On many rural roads, the volume of NMT traffic far exceeds motorised traffic. Clearly, ignoring non-motorised traffic will result in underestimation of the benefits due to improvements.

Guidance

It is essential to include non-motorised traffic figures in the economic appraisal of rural roads. If non-motorised traffic count figures are not available it is necessary to conduct a fresh traffic count on the roads to be appraised. DFID (2001) and World Bank (2001) provide procedures for such surveys including appropriate forms for non-motorised traffic counting. DFID (2001) elaborates the methodology for calculating NMT VOCs (including pedestrians) based on Odoki and Kerali (1999).

2.4. Treatment of traffic benefits

It is necessary to correctly represent the traffic benefits for users who would use the road with or without road improvement and users of the road after the improvement who would not have used the road without the improvement. Figure 2 summarises the method for measuring consumer surplus resulting from a road improvement. If the existing demand for travel is Q_0 units at cost C_0, and the potential post-improvement demand for travel is Q_1 units due to the fall of the cost to C_1, the benefits to users with or without improvement are the area of the rectangle "C_0dfC_1" and benefits generated for new users (who would not have travelled unless there was a cost reduction) are the triangle "def". It is clearly important to attribute the correct traffic benefits to the different types of users.

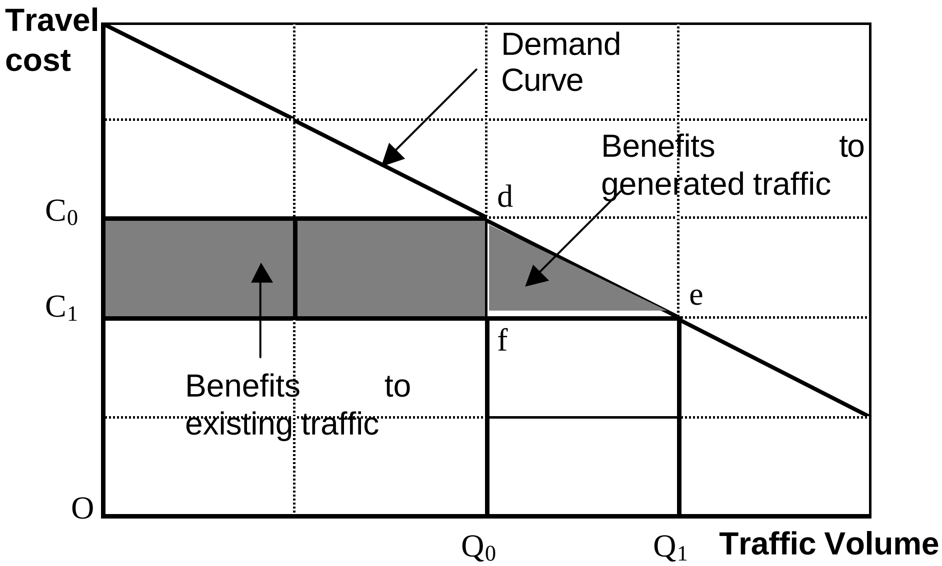

Figure 2 - Consumer surplus method in transport

Guidance

The basic of treatment of traffic benefits is to divide them into non-incremental (i.e. where it substitutes for alternative forms of supply), and incremental benefits (i.e. it does not substitute for alternative forms of supply). For normal, diverted and modal shift traffic (including future growth), the benefits are non-incremental. In principle, the savings for diverted traffic are not the same as for normal traffic on the road being appraised but data for introducing this refinement may not always be available. Generated traffic belongs to the new users category whose benefits are incremental. Table 2 presents a summary of the treatment of VOC benefits.

Table 2 – Treatment of VOC benefits

Type of traffic	Treatment of benefit
Normal Traffic	Non-incremental benefit
Generated Traffic	Incremental Benefit
Diverted Traffic	Non-incremental benefit
Modal Shift	Non-incremental benefit

2.5. Wrong representation of the improvement and maintenance costs

Costs are one of the main inputs in a road appraisal model. Costs include improvement and maintenance costs over the economic life of the project. As the net benefit of an investment is estimated by subtracting benefits from the costs, it is important that the costs are represented as accurately as possible. An estimation of costs is required for "with" and "without" intervention situations. Often an investment is justified under the assumption of a cost that is substantially lower than the final cost of intervention. This happens as the practitioners often make costs estimates based on secondary information that hardly represent the situation in the field. It is not also unusual that some costs (e.g. repair and reconstruction of bridges and culverts) are ignored during the process of cost estimation.

Guidance

It is first necessary to conduct field surveys for establishing the existing road conditions. This information should then be used to identify different interventions required to bring the road to desirable conditions and to estimate the physical quantities of different items of works. If a detailed survey is not possible, the following is suggested as the basic minimum:

- Step 1: Collect conditions data of the short-listed roads using a car or a motorbike. This can be done while driving through the road and stopping occasionally. Use a pre-designed survey form for quick data gathering. Data on the following items are seen as the basic minimum:

    - surface material condition (including thickness and quality);
    - drainage condition and quality
    - construction, reconstruction and maintenance requirements of drainage structures;
    - existence of potholes, corrugations and depressions and their nature
    - comfortable travelling speed of a car that may be used to subjectively assess road roughness in the absence of roughness figures.

- Step 2: Calculate the potential cost of different improvement options (e.g. spot improvement; full re-gravelling; rehabilitation etc.) using the condition data and available unit cost information.

2.6. Value of travel time savings or Value of Time (VoT)

Road appraisal models require travel time values as an input. VoT is one of the most contentious issues in rural transport in developing countries. Although the importance of including VoT is recognised by many analysts in principle, they are rarely included in actual appraisals. Two interrelated reasons for excluding these benefits are (a) scepticism on the part of many practitioners on the significance of time value for rural travellers and (b) a paucity of empirical evidence to support the inclusion of time values and to determine the time values. Where time values are used, they are not based on sound theoretical and empirical bases.

Guidance

In theory, VoT is the difference between the marginal value of travelling time and the marginal value of leisure time. There are two types of travel time savings: working (relating to travel for work) and non-working (relating to non-work travel, including commuting) time savings. While value of working time savings are based on the augmented wage rate (wage rate plus extra employment related costs such as taxes and compulsory contribution), the value of non-working time savings are based on the willingness to pay for the travel time saved to transfer to other activities including leisure.

A recently completed study in Bangladesh adapts models developed for industrialised countries for use in developing countries and finds evidence of significant time savings for rural travellers (I. T. Transport, 2002a). Although the study findings are country and area specific, they may be used as a guide for rural travel time saving values in developing countries. If no empirical study results are available for the area concerned, the following values may be used as guidance:

• Working VoT (economic)	70-80% of the average wage rate in the area
• Non-working VoT for an average traveller (economic)	50-60% of the average wage rate in the area

Note: if the model requires a single time saving value then the weighted average value should be used. For example, if the ratio of working and non-working trips is 20:80, the wage rate is w currency units/hour, the average working time saving value is 75% of w and the average non-working time saving value is 50% of w then the weighted average value of time should be equal to 0.55w (0.2*w*0.75+0.8*w*0.5).

I. T. Transport (2002a) and Gwilliam (1997) provide further guidance on VoT.

2.7. Economic life of a road

Economic appraisal models require input on the economic life of the road. An assumption about the economic life of the project has influence on the net economic value of the investment. The longer the economic life of the road, the higher the costs (added yearly maintenance cost) and benefits (added road users' cost savings). The costs and benefits in the later life of the project do not form substantial portion of the project's net benefit due to the discounting of costs and benefits. However, the assumption concerning economic life of the project may be crucial for accept/reject decision of a marginal project.

Guidance

It is difficult to provide guidance on the length of economic life of a road project. The economic life of the project may vary from 6-15 years depending on the type of interventions (e.g. the potential economic life of a road that is subjected to spot improvements will be substantially less than the same road subjected to full rehabilitation). Therefore, it is best to conduct sensitivity tests with different values of economic life of the road to make a decision.

2.8. Non-consideration of all feasible options

Project appraisers are often asked to look at pre-selected options to determine whether they should be accepted or rejected. If all the mutually exclusive feasible options (all road projects and type of intervention) have not been included in the appraisal, at best a second-best option may be selected and at worst wrong road selection decisions made.

Guidance

While conducting economic appraisal take into consideration all possible options and decide the best option from them. Table 3 shows an example from a donor assisted road project in Uganda. The analysis included testing of three mutually exclusive options (spot improvement, full re-gravelling and full rehabilitation) for an investment decision. If spot improvement only had been considered, Road # 4 would have been rejected (EIRR < 12% and NPV <0) and the rest would have been accepted for spot improvement when full re-gravelling is obviously the better option. Section 2.12 elaborates the criteria for choosing the best option.

Table 3 - Testing different options in roads' appraisal

Road Name	**NPV (million USD)** / **NPV/Economic Agency Cost**			**EIRR**			**Selected Option**
	SI	FRG	FR	SI	FRG	FR	
Road # 1	0.404	0.793	0.368	27%	31%	20%	FRG
	0.191	0.401	0.139				
Road # 2	0.006	0.069	-0.122	13%	18%	8%	FRG
	0.010	0.109	-0.138				
Road # 3	0.211	0.481	0.364	25%	36%	28%	FRG
	0.210	0.556	0.328				
Road # 4	-0.086	0.114	-0.271	7%	16%	8%	FRG
	-0.061	0.083	-0.147				
Road # 5	0.185	0.615	0.424	19%	31%	25%	FRG
	0.112	0.435	0.236				
Road # 6	1.778	2.080	1.907	80%	71%	58%	FRG
	1.154	1.498	1.221				

Note: SI = Spot improvement; FRG=Full re-gravelling; FR=Full rehabilitation; Discount rate = 12%; Road names are deliberately not mentioned

In many cases it may be unrealistic to consider all mutually exclusive feasible options because of time and resource limitations. In such cases, an initial rough appraisal of realistic feasible options should be carried out to eliminate serious mistakes.

2.9. Wrong representation of economic costs

The input requirements for appraisal models (e.g. RED or HDM-4) are economic values rather than financial values. Economic values represent the true costs or benefits to the economy. Economic values differ from financial values because of market price distortions. Taxes and subsidies distort the prices of resources, goods and services. They are transfer payments and do not represent the resource cost of a good. The existence of unemployment and underemployment are often associated with labour market distortions and therefore adjustment of the cost the labour input is necessary. I

Guidance

Economic values are calculated through the process of shadow pricing. They can be calculated using a world price numeraire (border price) or a domestic price numeraire. Asian Development Bank (1997) and World Bank (1996) provide details of shadow pricing. Whether a world price or a domestic price numeraire is used, it should be used consistently. Table 4 shows the basis of economic valuation of project inputs and outputs and Table 5 presents the adjustment rules for conversions to domestic and world price numeraires.

Table 4 - Basis of economic valuation of project inputs and outputs

	Incremental	**Non-incremental**
Output	Adjusted demand price or willingness to pay	Adjusted supply price or opportunity cost
Input	Adjusted supply price or opportunity cost	Adjusted demand price or willingness to pay

Note: **Incremental output** – when the project produces additional supplies compared with the without project case; **non-incremental output** – when the project output substitutes for alternative forms of supply; **incremental input** – when the production is expanded to make additional provision for project input (non-traded items) or when provision for additional imports is made for imported items and a provision for increased production is made for exportable items; **non-incremental input** – when the project inputs are competed away from other uses.

Table 5 - Specific Conversion Factors

Item	**Adjustments**	
	Domestic price numeraire	**World price numeraire**
Traded goods	SERF	1.0
Labour	Opportunity cost of surplus labour	Opportunity cost of surplus labour*SCF
Scarce labour	Opportunity cost of scarce labour	Opportunity cost of scarce labour*SCF
Taxes/subsidies	0	0
Non-traded goods	1.0	SCF

Note: SCF – Standard Conversion Factor; SERF – Shadow Exchange Rate Factor

2.10. Choice of discount rate

In an economic appraisal the discount rate is used to determine the present value of future costs and benefits. Choice of discount rate is important in an appraisal as an accept/reject decision of an investment depends on the choice of the discount rate. For example, while the net present value (NPV) of an investment may be positive when discounted using 12% discount rate, the NPV may be negative when discounted using a discount rate greater than 12%; therefore, the investment decisions will be opposite in these two cases. Usually, road appraisal models provide default value of discount rate of 12%.

Guidance

Use a 12% discount rate unless otherwise advised. Fujimura and Weiss (2000), ADB (1997) and World Bank (1996) discuss different aspects of the discount rate.

2.11. Roughness values

Road roughness (before and after the proposed improvement) is one of the most crucial inputs in road appraisal models. The road roughness is used in the calculation of users' benefits. All models require initial road roughness input. While some models calculate future roughness using predefined relationships (e.g. HDM-4), other models require an estimate of average "with project" roughness input. In the case of rural roads pre-intervention roughness values are rarely available.

Guidance

Check for roughness values from the concerned road agency. Although it is rare it is worth checking as some agencies collect roughness data routinely. If such data are not available then estimate the roughness subjectively using the guidance provided by Archondo-Callao (1999) as summarised in Table 6. However, estimation of post-investment roughness is more difficult as the roughness will vary over the life of the road due to deterioration of surface conditions or due to maintenance interventions (e.g. periodic maintenance). I. T. Transport (2002b) reports an approach for estimation of post-improvement roughness (Table 7).

Table 6 - Table for Subjective Evaluation of Road Roughness

Roughness (IRI)	**Comfortable riding speed**	**Other (depression, corrugation, pothole etc.)**
3.5 to 4.5	Comfortable riding up to 80-100 km/h	Negligible depression and no potholes
7.5 to 9.0	Up to 70-80 km/hr	Frequent shallow to moderate depressions or shallow potholes with moderate corrugation
11.5 to 13.0	Up to 50 km/hr	Frequent moderate transverse depressions or occasional deep depressions or potholes with strong corrugations
16.0 to 17.5	Up to 30-40 km/hr	Frequent deep transverse depressions and/or potholes or occasional very deep depressions with other shallow depressions. Not possible to avoid the depressions while driving.
20.0 to 22.0	Up to 20-30 km/hr. Speeds higher than 40-50 km would cause extreme discomfort.	Highly frequent deep depressions and/or potholes and occasional very deep depressions

Note: IRI=International Roughness Index

Table 7 - Estimation of post-improvement roughness (IRI)

	Spot Improvement	**Full re-gravelling**	**Rehabilitation**
Yr. 1	6	5	5
Yr. 2	7	6	6
Yr. 3	8	7	7
Yr. 4	9*	8	8
Yr. 5	6	9*	9*
Yr. 6	7	5	5
Yr. 7	8	6	6
Yr. 8	9	7	7
Average	7.5	6.6	6.6

Note: * Year of periodic maintenance;

2.12. Wrong decision criteria

The appraisal model outputs include indicators like economic internal rate of return (EIRR), NPV, benefit/cost ratio (B/C ratio), ratio of NPV to capital costs, first year rate of return and so on. However, the analyst may face difficulty in choosing the appropriate indicator for an investment decision and a wrong investment decision makes the efforts made in data collection and analysis useless.

Guidance

Table 8 summarises the criteria to be used in investment decision making.

Table 8 - Investment decision criteria

Row		NPV	EIRR	B/C Ratio
1	Accept/Reject	>0	>r	NPV/K ratio>0
2	Mutually exclusive projects or alternatives without fund constraint	Highest NPV	Highest Incremental EIRR	Highest incremental B/C ratio
3	Mutually exclusive projects or alternatives with fund constraint	not suitable	Not suitable	Highest NPV/K ratio
4	Deferment	$(r*K-B_1)/(1+r)>0$	$(B_1/(1+r))/K>r$	Not suitable

Note: r=discount rate; NPV=Net Present Value, K=Capital cost; B_1= First year's benefits;

Explanation of Table 8:

Row 1: Explains the accept/reject decision of an investment. An investment should only be considered if it satisfies any of the following criteria: (i) NPV is greater than zero; (ii) EIRR greater than discount rate (r); and (iii) NPV to capital cost ratio is greater than zero.

Row 2: Applicable to mutually exclusive projects (alternatives) without any fund constraints (i.e. there exist no apparent funding limitations and therefore, the project size is not an issue). Between the mutually exclusive options (e.g. full rehabilitation option vs. spot improvement option of a rural road) an option that satisfies the following should be selected: (i) highest NPV; (ii) highest incremental EIRR; and (iii) highest incremental B/C ratio. The following table provides an example of calculation of incremental EIRR in the case of two mutually exclusive options. In this case option B is better than option A as B gives the highest NPV and the incremental NPV is higher than the discount rate.

	Benefits in different years								
	Yr. 0	**Yr. 1**	**Yr. 2**	**Yr. 3**	**Yr. 4**	**Yr. 5**	**Yr. 6**	**NPV**	**EIRR**
A	-10,000	3,000	3,000	3,000	3,000	3,000	3,000	2,334	19.90%
B	-14,000	4,500	4,500	4,500	4,500	4,500	4,500	4,501	22.70%
B-A	-4,000	1,500	1,500	1,500	1,500	1,500	1,500	2,167	29.50%

Note: NPV at 12% discount rate; row B-A represent the incremental benefits

Row 3: Applicable for mutually exclusive projects (alternatives) with fund constraints (i.e. funding limitations exist and therefore, the project size is an issue). In such a case the alternative with highest NPV to capital costs should be selected. If an alternative is selected on the basis of the NPV, the decision may be biased towards the larger alternatives.

Row 4: Provides decision criteria on deferment of an investment. If one of the two criteria is satisfied then the investment can be deferred.

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