RURAL TRANSPORT
TRAINING MATERIALS

Module 2: Planning, Design, Appraisal and Implementation

Rural Road Economic Appraisal Methodology

Session: 2.3
Part 1

Presentation: 2.3a

The World Bank | TRL | DFID Department for International Development | itt Reducing Poverty by Enabling Access | theIDLgroup | SSATP Africa Transport Policy Program

The Training Modules

Module1. Policies and Strategies

This Module

Module 2. Planning, Design, Appraisal and Implementation

Module 3. Management and Financing

Module 4. Rural Mobility

Module 5. Social and Environmental Issues

Module 2. Planning, Design, Appraisal and Implementation

Session 2.1 Participatory rural planning process

Session 2.2 Design of rural transport infrastructure

This session

Session 2.3 Rural road economic appraisal methodology

Session 2.4 Labour-based works methodology

Session 2.5 Small scale contractor development

Session 2.6 Community Participation in Rural Transport Infrastructure

Session 2.7 Participatory Survey Techniques for Rural Transport

1. Introduction

Learning Objectives

By the end of the session participants will be able to:

- Analyse the role of economic appraisal methods to establish priorities for RTI interventions
- Describe how to carry out screening and ranking using a variety of methods
  - targeting poor communities and eliminating low priority links from consideration for investment
  - multi-criteria analysis (MCA), cost-effectiveness analysis (CEA), cost-benefit analysis (CBA)
- Explain how to extend the CBA framework for RTI

Session Overview

- Rationale for economic appraisal
- Participatory Planning Approach
- Screening
- Ranking
- Extending the CBA framework for RTI

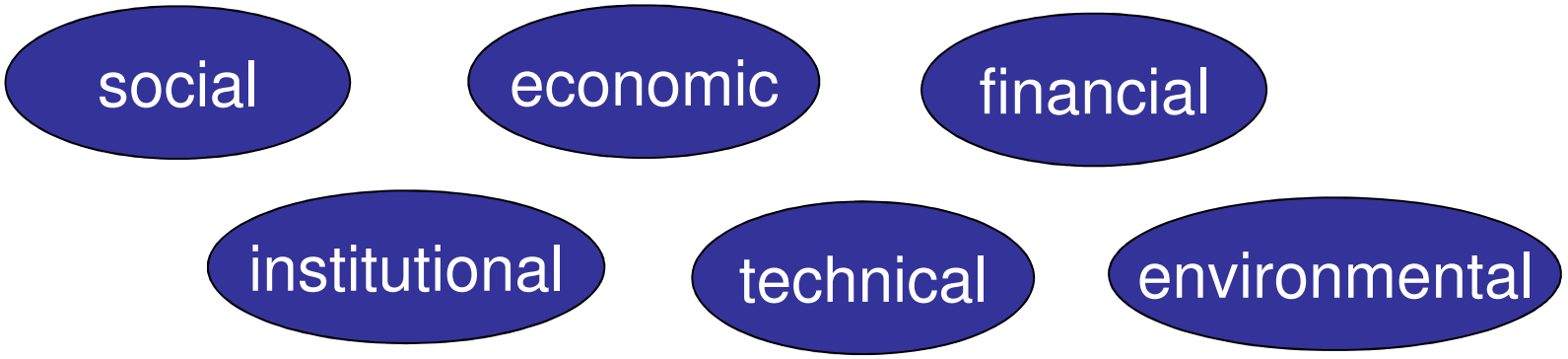
2. Rationale for economic appraisal

- The provision of motorable basic access roads (below 50 VPD) is constrained by
  - available resources - maintenance & capital budgets
- Affordability depends on:
  - local population's capacity to maintain their own basic access infrastructure over the long-term
- Determining affordability depends on the complex relationship between
  - local capacity, available skills, income levels, population density, geographic conditions, and political will

Appraising RTI: *Basic Access* approach

A basic access intervention is the **least-cost** (total life-cycle cost) intervention for ensuring **reliable**, **all-season passability** for the locally prevailing means of transport.

- Project appraisal of a planned *Basic Access* intervention is the analysis & assessment of these issues:



Basic Access approach recognises ….

- Local communities are the main stakeholders and users of RTI
- Their participation is essential
  - in preparation and implementation of investment programmes
  - enhances local ownership and commitment
  - fosters better accountability and management
  - greater sustainability

Appraisal Methods
an overview

1. Participatory Planning Approach
2. Screening
3. Ranking
   A. Multi-criteria analysis (MCA)
   B. Cost-effectiveness analysis (CEA)
   C. Cost-benefit analysis (CBA)
4. Extending the CBA Framework for RTI

3. Participatory Planning Approach

- Decentralised framework for the provision of local services calls for a participatory RTI process
  - Start with consultations at community and local government level
  - Iterative and simultaneous ‘bottom-up’ and ‘top-down’ approaches

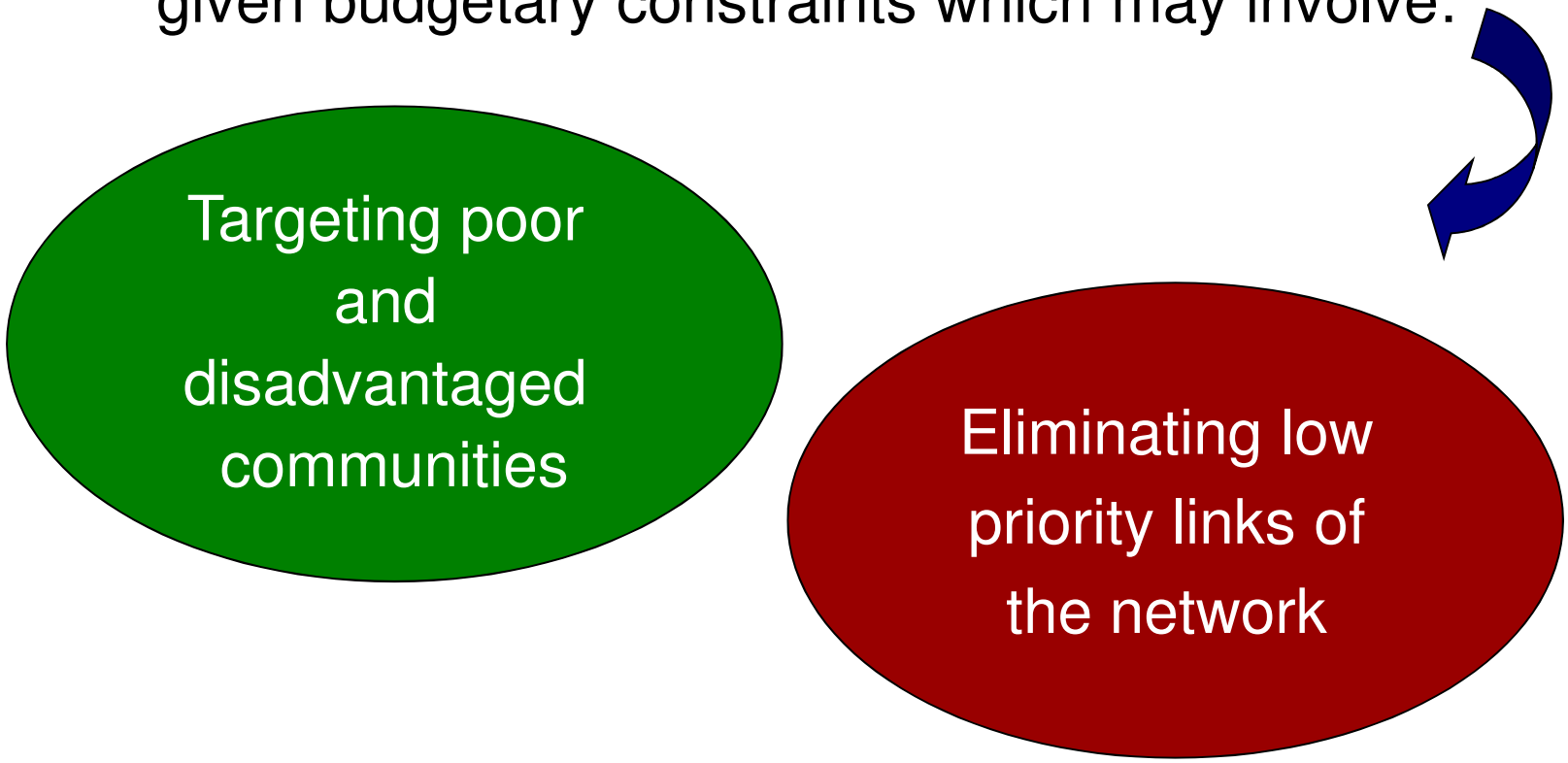
A key tool is the ‘as is’ plan

- A local government/community transport plan
  - local engineers or consultants and communities, conduct a low-cost inventory and condition survey of the local transport network
  - plus economic, social and demographic information
- Stakeholders can cooperatively decide upon desired improvements to the RTI network
  - taking into account objectives and available resources

But! Participation cannot replace the **economic** selection process, due to:
‘wish list’ phenomenon and available resources

4. Screening

Screening decreases the number of investment alternatives given budgetary constraints which may involve:



- Has been adapted for the selection of districts, communities, and municipalities on the basis of poverty criteria
  - economic standing and potential
  - social development (literacy and health statistics)
- **China**
  - 1st stage: poverty-based pre-screening was used to identify 'priority counties'
  - 2nd and 3rd stage screening process to identify specific road sections and corresponding design standards

China: Road Improvement for Poverty Alleviation (RIPA)

1st stage – 'priority counties' criteria:

- average income per capita
- number of the 'very poor' per 10,000 population
- value of agriculture production
- value of mineral production
- social development indicators (literacy rate, health workers per thousand population, access to clean drinking water)

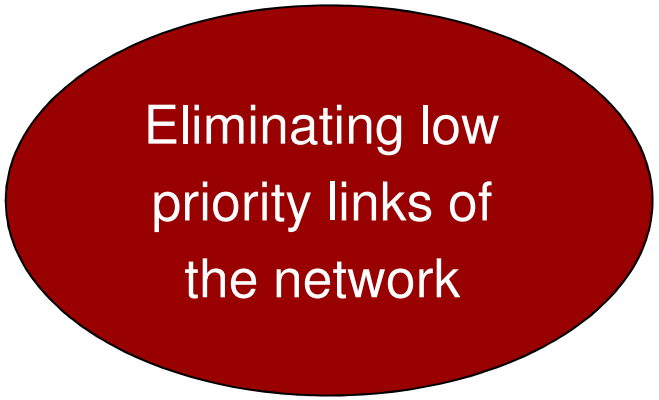
2nd stage – cost effectiveness criteria:

- continuity of the system
- maximisation of the population served
- connectivity to as many settlements as possible
  - ➢ then the proposed investment cost is divided by population served

China: Road Improvement for Poverty Alleviation (RIPA)

3rd stage:

- analysis of the economic and social benefits of road systems being considered
- review of motorisation trends
  - ... to guide the selection of proper road class and road engineering design that would meet the future needs of motorised and non-motorised traffic



- Elimination based on agreed criteria
- **India, Andhra Pradesh**
  - each village would have only **one** link (the shortest one) upgraded to basic access standard
  - this reduced the road network that was considered for interventions
    - ... from about 5000 km. to 3000 km. per district

Poverty based screening

Group Activity

Based on the experiences from China:

what are the advantages and potential problems with poverty-based pre-screening?

5. Ranking Methods

Multi-criteria analysis (MCA)

Cost-effectiveness analysis (CEA)

Cost-benefit analysis (CBA)

Multi-criteria analysis (MCA)

- Criteria: based on their perceived importance, weights (points) given to:
  - traffic level
  - proximity to health and educational facilities
  - agricultural assets receive weights (points).
- Each road link is allocated the number of points corresponding to the fulfilment of the particular criteria
- The sum of the points provides a rank for each investment option

MCA – what potential as a *participatory* planning method?

For MCA to be a participatory planning method, the weights and points must be allocated in a **participatory & transparent** way –

indicators are both economic and subjective!

But!

- MCA tends to be applied by consultants or planners in isolation without consultation with stakeholders
- The outcome of the MCA methodology is often:
  - non-transparent
    - ➢ especially if too many factors are considered and a complicated formula applied

Cost-effectiveness analysis (CEA)

- A subset of the MCA
- CEA compares the cost of interventions with their intended impacts
- Widely used to appraise investments in the social sector, less so in transport
- Justification for use in transport sector
  - increased focus on the poverty and social impacts of transport investments

When is CEA used?

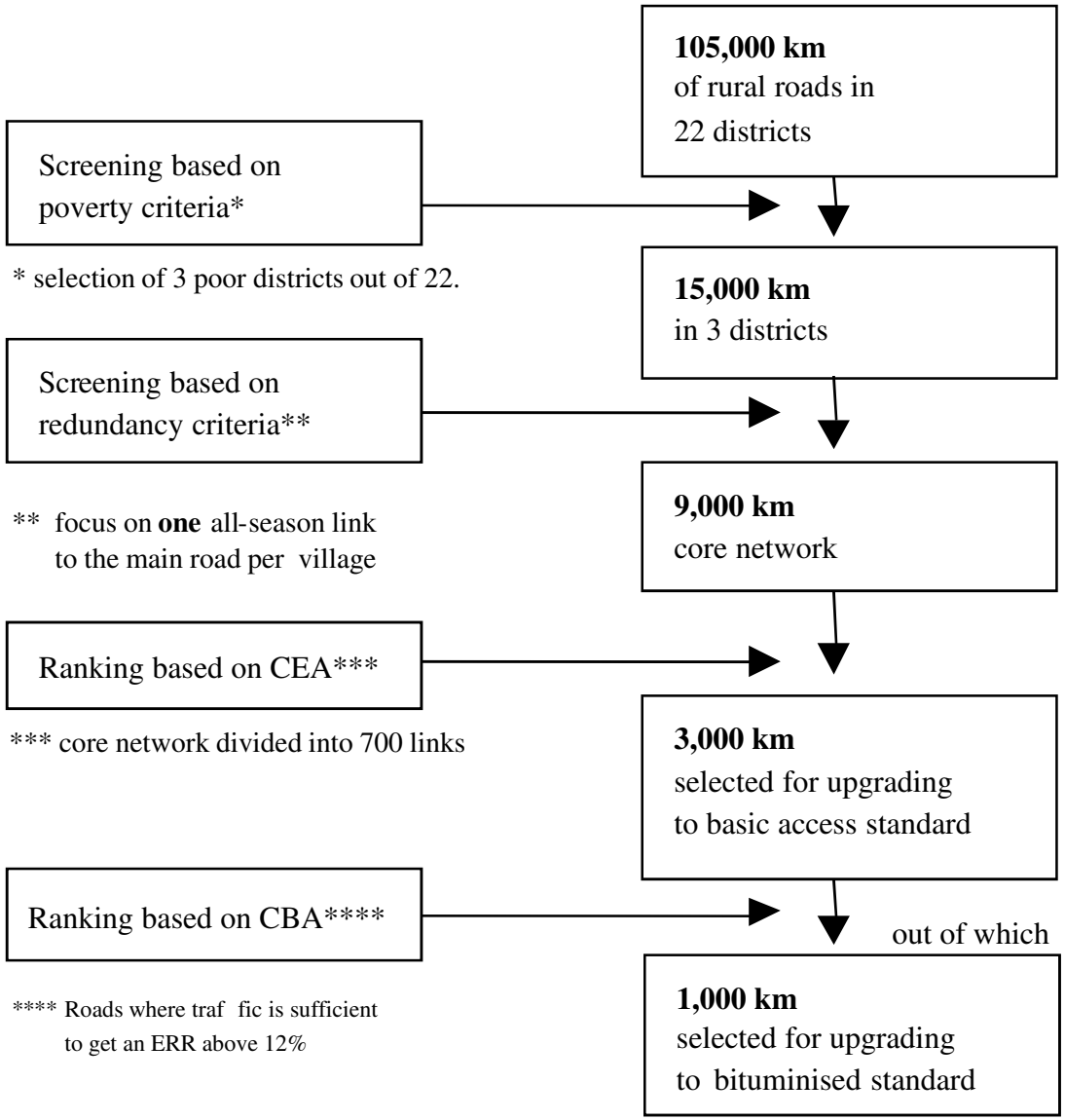
- Operational policies of the World Bank allow the use of CEA where:
  - benefits cannot be measured in monetary terms or
  - where measurement is difficult
- Conditions for use of CEA:
  - objectives of the intervention clearly stated and are part of a wider programme of objectives (e.g. poverty alleviation)
  - the intervention represents the least-cost way of attaining the stated objectives

Rural Roads Component of the Andhra Pradesh Economic Restructuring Project

CEA used to rank individual links of a 'core network' selected on the basis of screening criteria

$$\text{Cost-effectiveness indicator of link} = \frac{\text{Cost of upgrading of link to basic access standard}}{\text{Population served by link}}$$

Applying the Basic Access Approach: Rural road component of the Andhra Pradesh Economic Restructuring Project



Thresholds for Cost-Effectiveness (CEA)

- There are none!
- With CBA projects are deemed ‘uneconomic’ when their ERR (economic rate of return) falls below 10% - 12%
- For CEA the criteria for determining ‘opportunity cost’ thresholds when ranking on the basis of cost-effectiveness
  - is left to policy makers

Sample Study to Indicate Economic Viability

- Use cost-benefit analysis (CBA) to complement the CEA method
  - sample study based on 1 or 2 roads project area
- If the sample study establishes that
  - a per-capita threshold of investment meets the prescribed economic rate of return for the sample link
    - … then **all** links above the threshold are likely to be viable
- This approach provides a good economic basis for applying the CEA method to a broad RTI investment programme

Cost-benefit analysis (CBA)

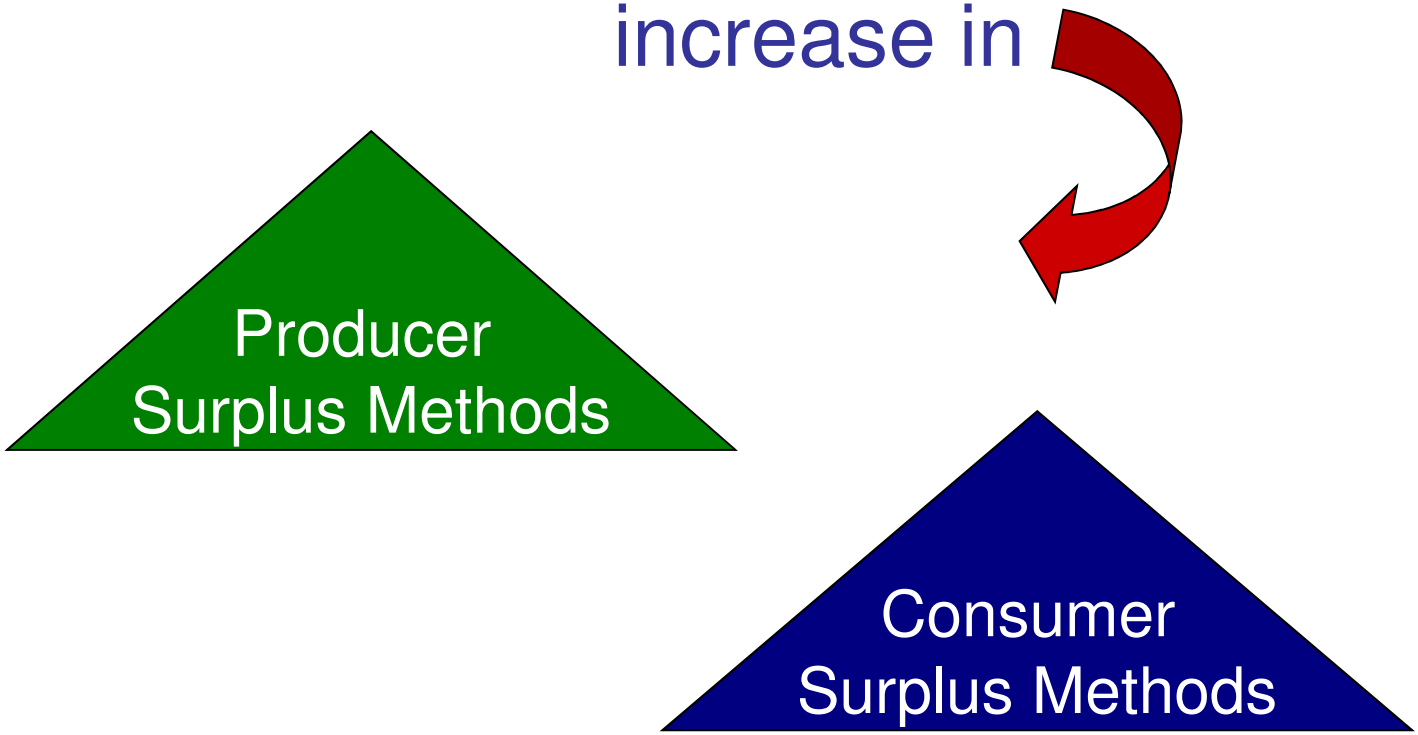
- Accounting of all the real costs and benefits associated with a (road) project:
  - users and non-users
  - the road agency
- Where the impact on non-users is negligible, a CBA of road alternatives focuses on:
  - trade-offs between total life-cycle costs of infrastructure (capital and maintenance), and
  - user costs and benefits (operating cost of the primarily vehicle and time savings)

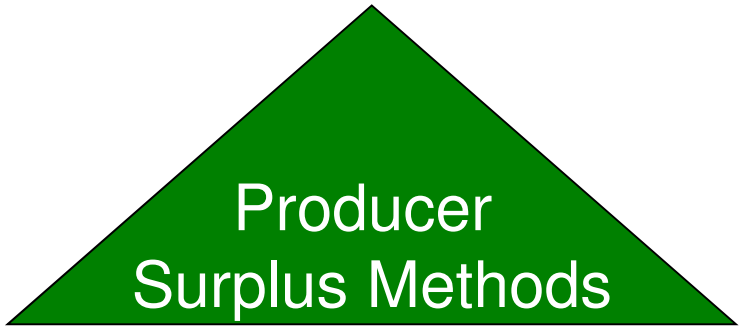
CBA

- The outcome of CBA permits ranking of
  - alternative interventions on a particular link based on the net present value (NPV)
- If there are several different but independent links (and there is a fixed capital budget), base the ranking on:
  - the net present value per financial investment outlay ratio (NPV/INV), or
  - net present value per kilometre (NPV/KM)
    - … if road infrastructure costs (capital & maintenance) are the same for all links

CBA

The benefit from cost savings for transport users can be considered as an increase in





- Transport cost reductions lower producers' input and output costs
  - result in higher net income for producers
- Assumptions made on:
  - impact of transport investments on local agricultural productivity and output
    - … which are difficult to assess, particularly where interventions are expected to open up new areas
    - … and adequate production data may be difficult to compile
- Application of the method reduced in recent years:
  - RTI investments are increasingly focused on existing networks
  - put more emphasis on social rather than economic objectives

- Benefits result if savings accrue to the users as a *reduction in transport costs or charges.*
- Reliable for higher-volume roads (>200 VPD)
- But! application to low-volume roads has problems:
  - small magnitude of user benefits
  - stronger influence of the *environment* rather than traffic on infrastructure deterioration
- If traffic levels 50 - 200 VPD
  - a customised approach can be used - Roads Economic Decision Model (RED)

Roads Economic Decision Model (RED)

a consumer surplus model

- 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 statistical risk analysis
- RED simplifies the economic evaluation process

RED addresses 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)

- e.g. those related to non-motorised traffic, social service delivery, and environmental impacts, if they are computed separately

h) presents the results with the capacity for sensitivity, switching values and statistical risk analyses

RED

can be downloaded free of charge at

http://www.worldbank.org/html/fpd/transport/roads/tools.htm

But! for traffic levels below 50 VPD ...

- The *consumer surplus approach* is NOT recommended, because:
  - main benefits are not from savings in motor vehicle operating costs, but ….
    - relate to the provision of *access* itself
  - the benefits of access are difficult to quantify
    - traffic typically constitutes non-motorised vehicles, animal transport, walking and headloading

This calls for special adaptations & extensions to the traditional CBA

6. Extending the CBA Framework for RTI and low-volume roads

- Principles of CBA remain the same
- Methods of analysis are modified to account for the special features of RTI
- The modified methods can be used for
  - 'pilot' or 'sample' CBA to supplement CEA
  - a low-volume road that presents a major investment
  - a new access option to a given area
  - a proposed upgrading to a higher than basic access level

Enhancements of CBA include:

A. Better assessment of the cost of interrupted access
B. Estimating operating cost savings of NMT
C. Savings due to mode changes (from NMT to motorised transport)
D. Improved valuation of time savings
E. Valuation of social benefits from improved access to schools and health centres

A. Better assessment of the cost of interrupted access

- Passability during the rainy season
- Seasonal changes in transport quality
  - local socio-economic impact e.g. higher goods prices, lost productivity, or decreased social travel
  - impact on particular activities
    - agriculture, marketing, travel for jobs & related wage earnings, school attendance & consequent decline in quality of education, health visits, etc
- Collect information through a local survey/ other participatory processes
- Examine the costs associated with
  - alternative (longer) routes (increase transport cost and time)
  - substitutes for transport (migration, storage)
  - lost opportunities and income

B. Estimating operating cost savings of NMT

- A recent addition to project evaluations
- Rickshaw operators in Bangladesh
  - provide an example of how to estimate operating costs
  - the links between road surfaces and operating costs
  - justification for investment in black-topping roads

Assessing the cost of interrupted access

Group Activity

Using the case of rickshaw operators in Bangladesh:

A. *Explain the rationale for road investment in black-topping (asphalt) even though the VPD is less than 50.*

B. *What are the true operating costs for rickshaw operators?*

C. *How are with- and without-project costs best estimated? Why?*

Bangladesh rickshaw operators

For project analysis, use

- charges made by the rickshaw-van operators on different types of road conditions
  - reflect the true cost variations
    - greater exertion, time, additional food for higher level of effort & energy needed for rougher roads (fares can be 2x)

Human pulled vehicles need smooth surfaces **even more** than motor vehicles

- road investments in black-topping could be justified when heavy NMT traffic exists
  - even if VPD 50 per day

C. Savings due to mode changes from NMT to motorised transport

Cost reduction can be **ten** fold

Studies in Ghana & elsewhere:

- Head porterage takes 2 person-days to move 1 ton/km., using
  - average load size, walking speed per hour, & time for the return trip (without load)
  - minimum wage rate of $2.00 - $2.50/ton/km. (= proxy for the resource costs and time & effort)
  - ➢ reflects actual market charges for such operations
  - ➢ but not productive time lost

Studies in Balochistan (Pakistan), Nepal, Bhutan: using mules

- actual cost is $ 3-4/ton/km.
  - ➢ compared to $0.20/ton/km. for truck operating costs on low-volume roads (after road construction or improvement)

D. Improved valuation of time savings

- It is critical to understand the impact of improvements in infrastructure on
  - journey times
    - and therefore on productive time saved
    - … including those associated with NMT and transit time of freight
- Valuing time in transport operations is controversial!
- Currently no universally accepted methods for determining a 'value of time'
  - but some general guidance

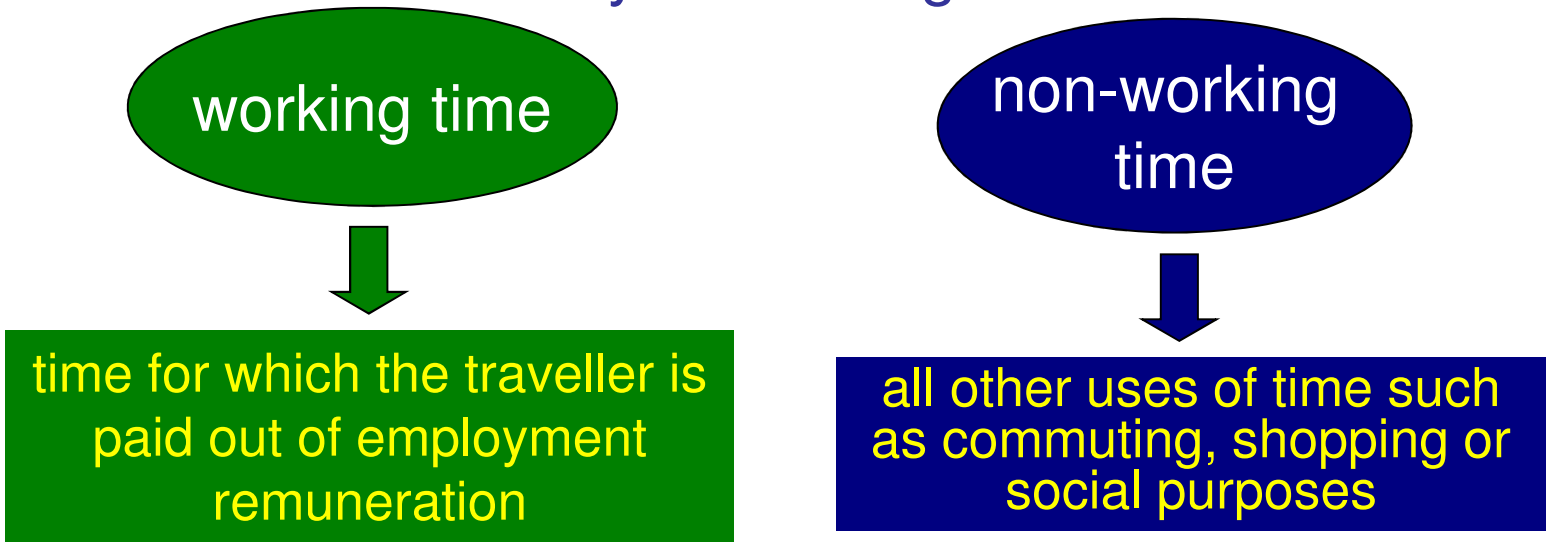
Valuing ‘Journey Time Saving’

Investigations have focused on:

- *Conventional* journeys of people by road
  - reflects traditional arguments of transport economics
  - the use of resource assessments of value, or inferring resource values from the behaviour of travellers
  - ignored trips on foot and by other NMT

The problem with conventional investigations

Journeys are categorised:



These categories are appropriate to the economic & social structures of *developed* countries

…. **not** rural household members who are:

- predominantly **self-employed**
- engaged in **multi-purpose/ simultaneous task trips**
  - ➢ especially **women** - often the dominant transporters at the household level

Another problem ...

- Assumption by most transport economics literature
  - majority of the rural population are in non-wage employment
  - considered to be travelling in non-working time
    - so ascribed a zero value
- This does not make sense!
  - in resource or behavioural terms
- Walking journeys consume energy and time
  - valuable resources in rural subsistence households
  - the behaviour of such societies indicates that they place a relatively **high value** on their time

Key points when collecting data on the value of time ...

- Estimate values which can be applied to particular modes of travel
  - bus versus bicycle travel
- Stated time values can change with
  - overall journey length
  - income level
- Time required for walking, waiting, or transfer
  - valued differently than specific travel time (on or in vehicles)
  - should be reported separately where possible
  - if not possible to obtain local values for travel time

The valuation of time savings from transport improvements in developing countries

Where it is not possible to derive values locally, use the following bases: W = wage rate per hour; H =household income per hour

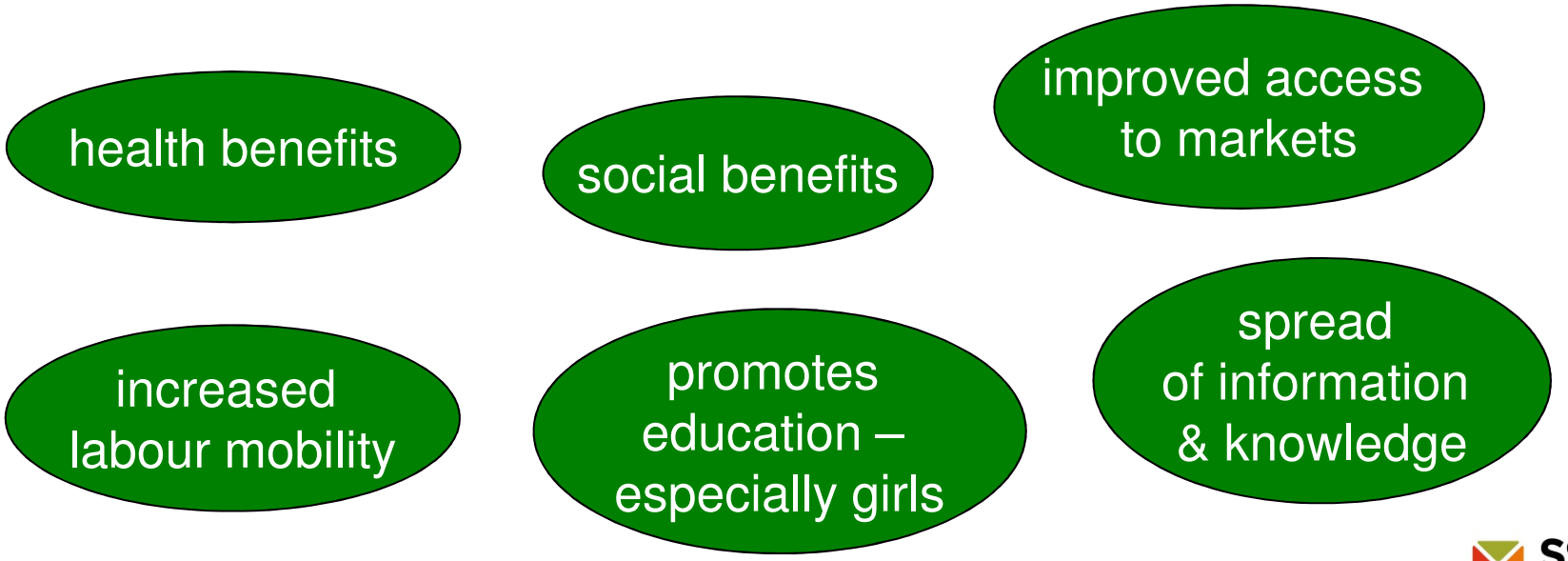
Trip Purpose	Rule	Value
Work trip	Cost to employer	1.33 w
Business	Cost to employer	1.33 w
Commuting and Other non-work	Empirically Observed value	0.3 H (adult) 0.15 H (child)
Walking/waiting	Empirically Observed value	1.5 x value for trip Purpose
Freight/ PublicTransport	Resource cost Approach	Vehicle time cost+ driver age cost+ occupants time
Source: Gwilliam 1997		

E. Valuation of social benefits from improved access to schools and health centres

It is often argued that the most important impacts of rural infrastructure improvements are:

- changes in the pattern of personal mobility
- increased social travel

Improved rural access provides:



A study in Bangladesh …

- Villages with road access, compared with villages without access, fared better:
  - farm-gate price of produce
  - fertiliser use
  - land under irrigation
  - household income
  - income per acre of field crops
  - wage income of landless labour
  - percentage of employed women

Access, Income, and Education in Bhutan

	'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%

A common approach for quantifying social benefits

- Use a sample case as guidance for
  - assessing similar benefits from other road improvements (ie. access to health and education) in similar areas or regions in the same country
  - usual transport cost savings can be estimated separately
- Care must be taken to ensure that there is no double-counting of benefits in the process

For example in the Bhutan case study …..

- Education benefits 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
  - other health savings from better access to health centres
- Approach involves considerable field data collection & analysis

- Other important approaches for assessment of benefits from rural road access improvements:
  - estimation of mule-haulage costs in the without-project situation
  - use of a 40-year life assumption for the road
    - … defined as a well-designed and erosion-protected mountain road with a gravel surface and expected good maintenance

Concluding Remarks

- Priorities of an RTI intervention requires a selection process consisting of a combination of screening and ranking
- Screening
  - targeting of disadvantaged communities based on poverty indexes
  - or by eliminating low-priority links from the list according to agreed-on criteria
- Ranking
  - multi-criteria analysis (MCA)
  - cost-effectiveness analysis (CEA)
  - cost-benefit analysis (CBA)

Concluding Remarks

- MCA
  - only recommended if cost criteria are included
  - … and if the criteria are few, relevant, and have been determined in a participatory way
- CEA
  - determine threshold value using sample CBA on selected links
- CBA
  - use standard if VPD 50 – 200
  - If VPD <50 – use Roads Economic Decision Model (RED)