HIGHWAY ENGINEERING
SAB2832

EVALUATION BASED ON ECONOMIC CRITERIA

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INTRODUCTION

- Practice of engineering involve many choices among alternative designs, procedures, plans, and methods
- Question – will the benefit of the project worth the cost? (Will it pay?)
- Basic questions and issues – what approach to be taken, what data are needed, what analytical techniques to be used.
- Questions by General John J. Carty (chief engineer NY Tel Co):
  1. *Why do this at all?*
  2. *Why do it now?*
  3. *Why do it this way?*

OBJECTIVES OF ECONOMIC EVALUATION

- What information is needed for project selection?
- General objective – to furnish the appropriate information about the outcome of each alternative so that the selection can be made
- Some of the specific objectives in carrying out economic evaluation are:
  1. *To decide whether the scheme under consideration is worth investment at all*
  2. *To rank the schemes competing for scarce resources in order of priority*
  3. *To compare and select the most economic scheme*
  4. *To assist in phasing the program*

BASIC PRINCIPLES

- Economic evaluation involves choice between alternatives – do nothing & improvements >> select the most attractive
- All past actions are irrelevant – only consider future flow of costs and benefits
- Viewpoint of the nation as a whole – not to any subset i.e. highway agencies, truck or buses operators
- Should take place within a set of established criteria – i.e. minimum attractive rate of return, interest rate etc.
- Should not be misunderstood with financial analysis

EVALUATION BASED ON ECONOMIC CRITERIA

- To consider economic worth of improvement : calculate improvement cost, compare with do nothing
- Two approaches:

1. *Compare diff in cost and diff in benefit → select project if net increase in benefit > net increase in cost*
2. *Consider total cost each alternatives, including user and facility, → select project with lowest total cost*

- Need to identify elements of cost:

1. *facility costs – construction, maintenance, operation*
2. *user costs – travel time, accidents, voc*

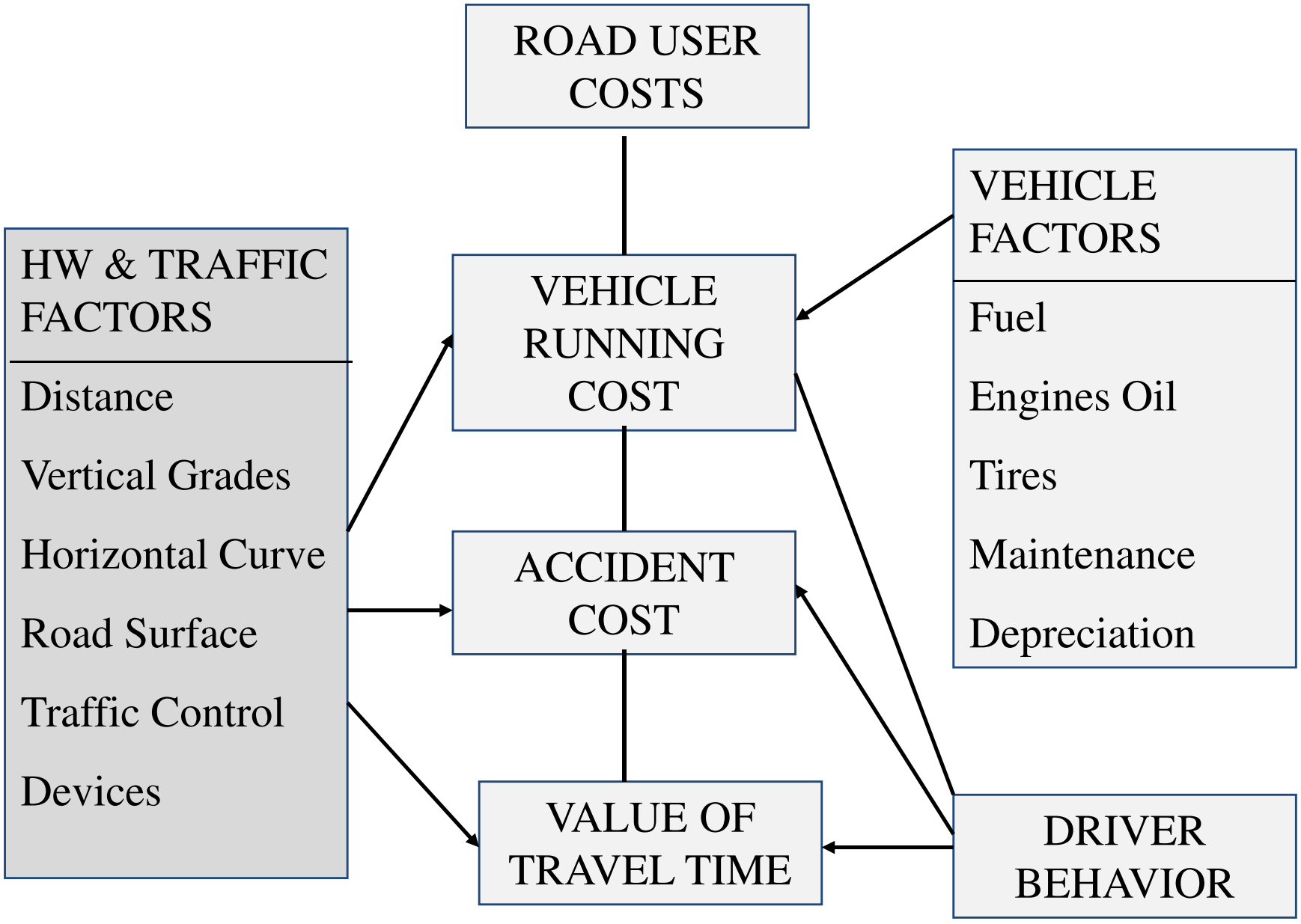
Facility Costs

- Two components – first (design, row, constr.) and continuing (annual maint., operation and admin)
- Cost common to both project excluded - since interested in diff
- Estimate salvage value at end of service life

Road User Costs

- Includes – voc, travel time, and accidents
- Sometimes referred as benefits due to reduction in user cost
- Road user cost factors –

1. *VOC – significant items since improvement result in major cost reduction (fuel, lubricant, tires, parts, maintenance, depreciation, toll, road tax, insurance, interest)*
2. *Travel time – increase speed → reduce travel time, how to convert?? (time value? passenger, good, vehicle)*
3. *Accident costs – need to estimate number and type of accidents → fatality, injuries, property damage, injury-related acc valued from insurance data, human life??*
4. *Society – environment, land value, discomfort & inconvenience*


ROAD USER COSTS
VEHICLE FACTORS
Fuel
Engines Oil
Tires
Maintenance
Depreciation
HW & TRAFFIC FACTORS
Distance
Vertical Grades
Horizontal Curve
Road Surface
Traffic Control
Devices
VEHICLE RUNNING COST
ACCIDENT COST
VALUE OF TRAVEL TIME
DRIVER BEHAVIOR

Benefit from Highway Scheme

- Represent the difference in cost with new facility compare to the old facility.
- Can be grouped into, benefit to:
  1. *Existing traffic, by reducing road user cost*
  2. *Generated traffic*
  3. *Diverted traffic from other routes and modes*
  4. *Traffic operating on other routes and modes via reduction of traffic by new facility*

Time Value of Money

- Fundamental premise on which all economic evaluation methods rest is that money earns over a period of time
- RM100 today will be worth RM672.75 at the end of 20 years if invested at 10% compound interest rate
- Also, RM672.75 which might become due after 20 years from today is worth RM100 at present, assuming same interest rate
- Therefore, need to devaluing future benefits and cost to present time to determine present worth
- Process of calculating PW of future known as "discounting" and interest rate used called "discount" rate

ECONOMIC EVALUATION METHODS

Four methods – PW, EUAC, BCR, ROR

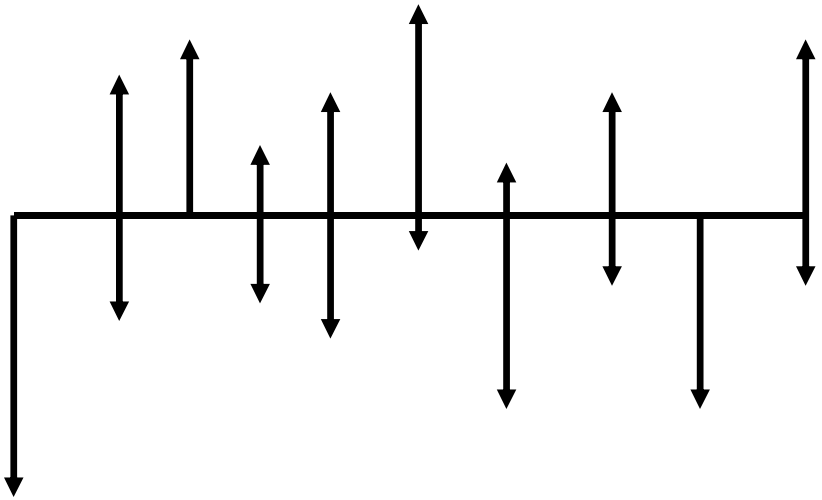
- All will produce same results but just a matter of convenience
- Cash flow diagram – time (horizontal), money (vertical) to depict cost and revenue that will occur over lifetime of a project
- Equations:

$$P = F\left[\frac{1}{(1+n)^n}\right]$$

$$A = F\left[\frac{i}{(1+i))^n - 1}\right]$$

$$P = A\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$$

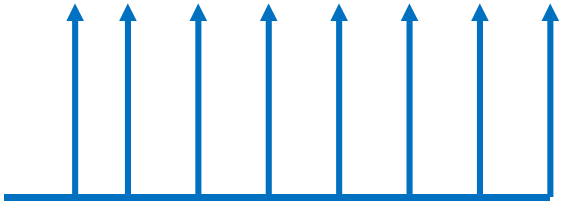
Cash Flow Diagram



Actual flow

Present

Future



Annual

Net Present Worth

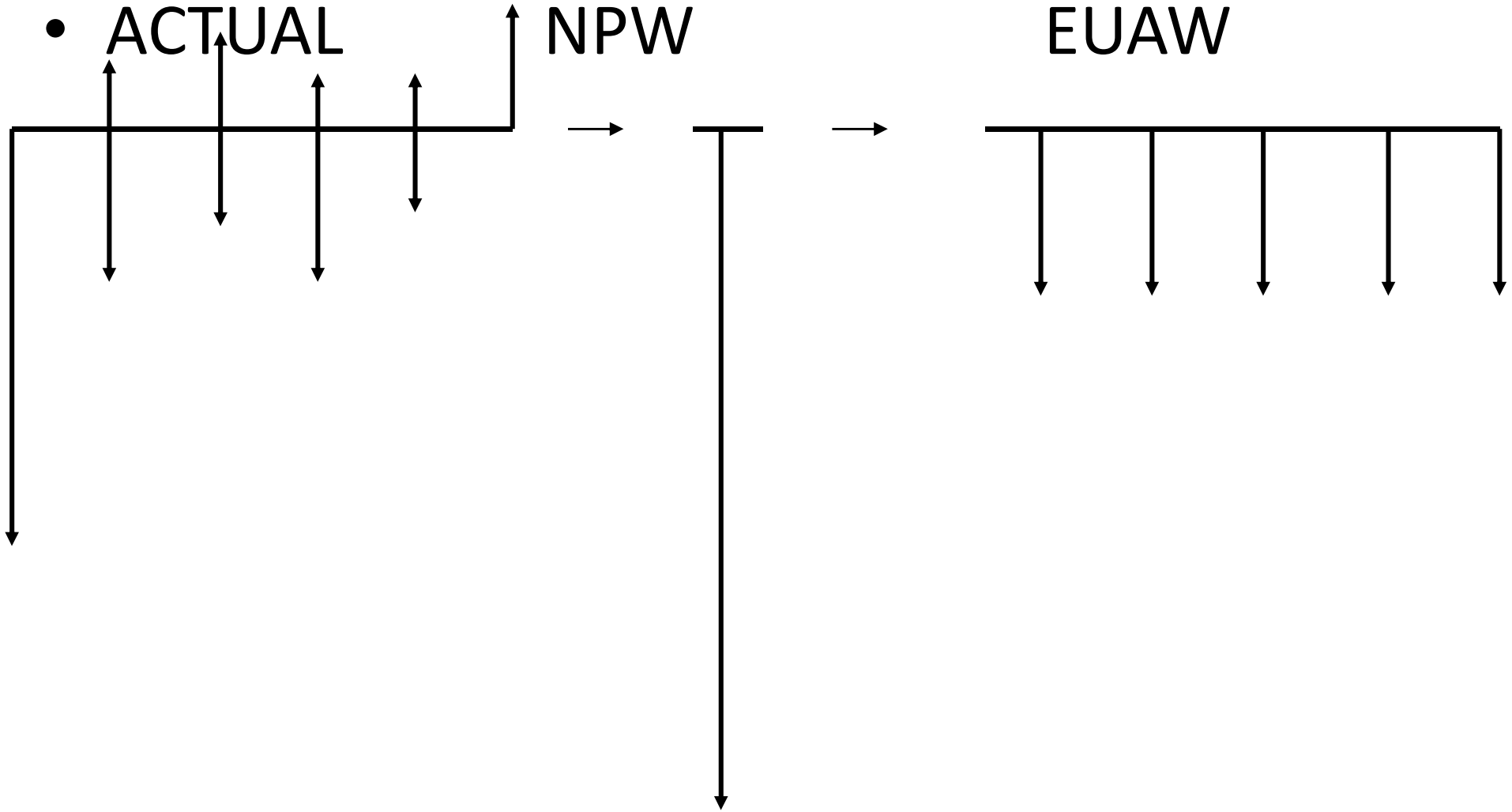
- PW – the most straight forward since represent current value
- NPW – present worth of both cost and benefit (net)
- Discount rate (i) used to convert money to particular time → depends on risk and economic conditions
- Use cash flow diagram to depict costs and revenues
- Select project with highest NPW

Equal Uniform Annual Worth

- EUAW – convert cash flow to a series of equal annual amount
- EUAW = NPW (A/P, i, N)
- Relation between actual, NPW and EUAW
- Select project with highest EUAW

CASH FLOW

- ACTUAL NPW EUAW



Benefit Cost Ratio

- BCR – ratio of PW of net benefits to PW net costs
- BCR used to show extend to which investment will result in benefit to society
- Need to do comparison to determine added benefit with added investment
- $BCR_{2/1} = (B2 - B1) / (C2 - C1)$
- BCR ≥ 1, the higher cost alternative economically attractive, if < 1 discard higher cost alternative
- Steps:
  1. *Convert cost and benefit to PW or EUAW*
  2. *Rank in ascending order of capital cost, including do-nothing*
  3. *Incremental BCR calculated, retaining the project with BCR ≥ 1*
  4. *Selected project is the highest capital cost with BCR ≥ 1*

Internal Rate of Return

- ROR – determines the interest rate at which NPW of increase in benefit compare to increase in cost equals 0.
- If ROR > interest rate (minimum attractive rate of return), the higher priced project retained, and vice-versa.
- The steps involved similar to BCR

- ***Comments:***

- NPW & EUAW – simplest to understand and apply (equal economic life)
- BCR - less info, carefully applied to produce right answer
- ROR – req. more calculation, but gives more info

REFERENCES

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