Public Transport Project Evaluation (short)

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New Zealand Transport Agency
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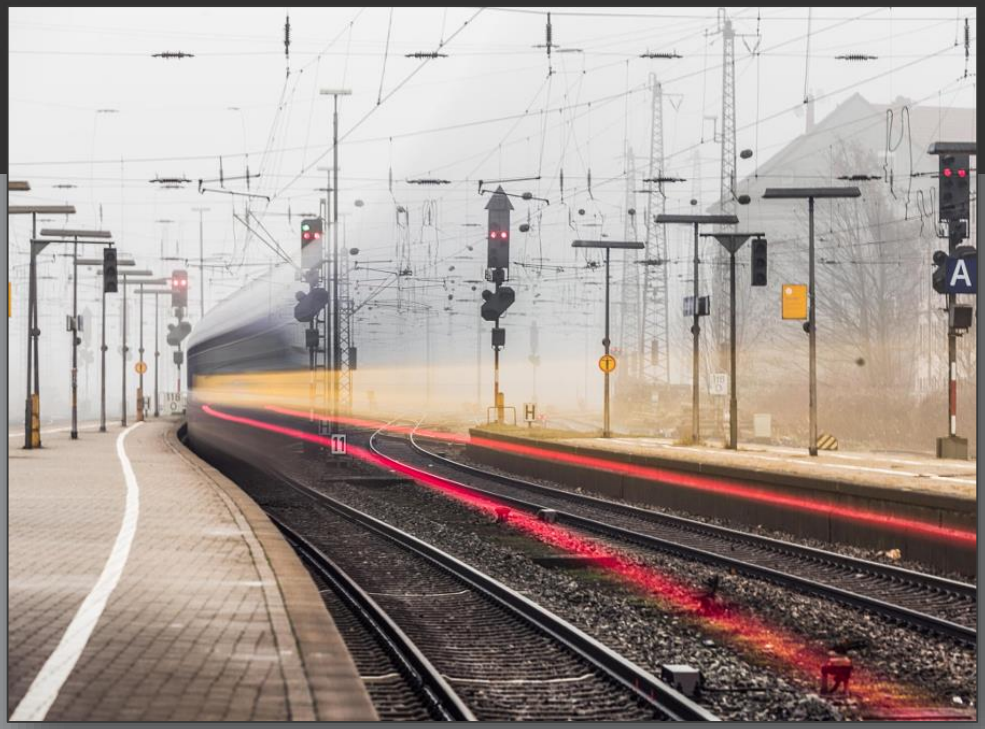
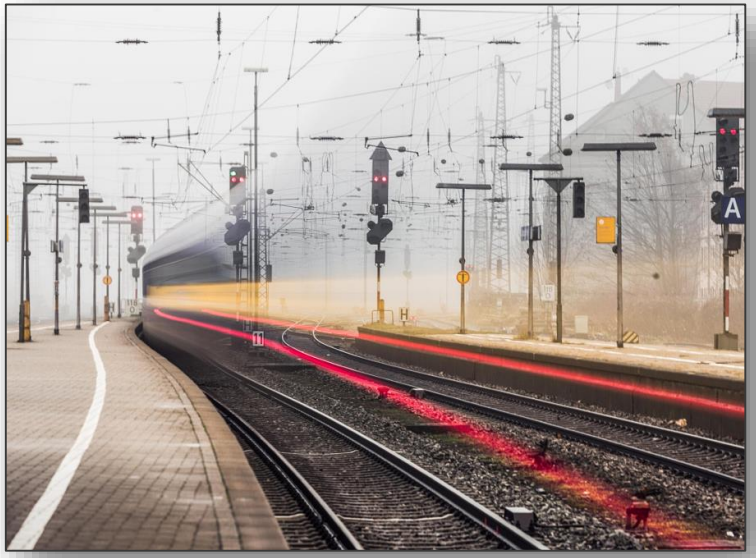


Agenda

1. Introduction
2. Costing
3. User/ Non User Benefits
4. Cost Benefit Analysis



This session aims to provide tools to undertake public transport project appraisal

- Emphasis is on readily to use ‘raw’ approaches rather than rocket science. I apologise now to any economists in the audience. We will be using English not ‘econobable’.
- The approaches explained broadly fall under the ‘cost benefit analysis’ methodology based on the Australian National Guidelines

There is a whole science and industry behind the approaches we will cover. This course is an introduction to this world.

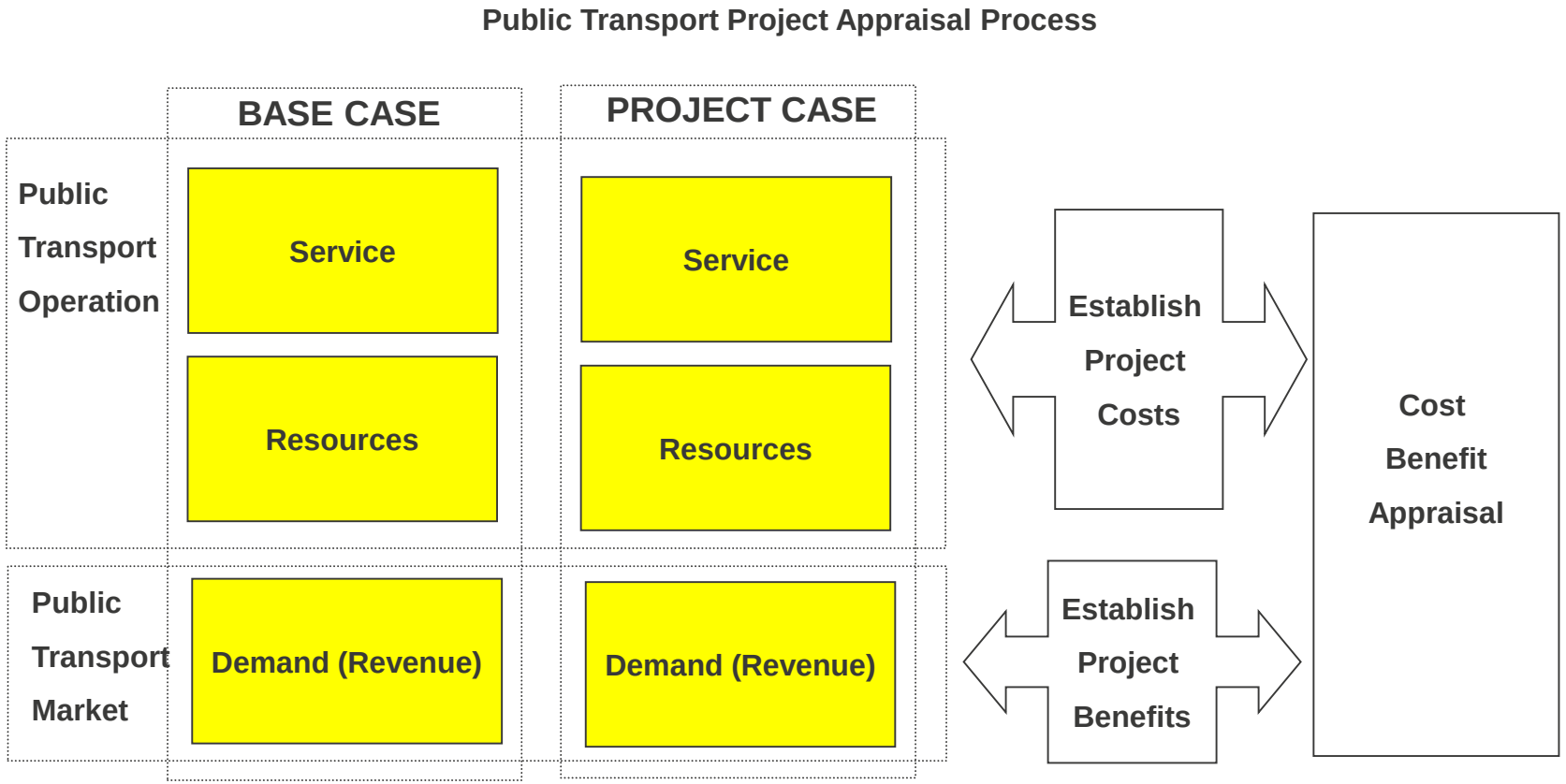
There are two ways of viewing an investment appraisal – from a financial and an economic viewpoint

Types of Public Transport Project Appraisal

Financial	Economic
• **Considers the direct costs and revenues which will incurred** • **This is usually the actual costs and revenues which will be the 'cost to Government'. However this can be undertaken as a cost to a private operator. In this case it is very much a business investment appraisal.** • **From a public transport perspective it considers:** – Financial capital costs (including any taxes) – Financial operating costs (including any taxes) – Potential revenue from the farebox – Other potential revenues e.g. advertising revenue or from developer contributions	• **An appraisal from the point of view of the project impacts on the community as a whole** • **Considers the wider economic and environmental impacts of public transport projects. It places a monetary value on the benefits which were at one point considered to be the rationale for public transport provision** • **From a public transport perspective it considers:** – Economic capital costs (excluding taxes) – Economic operating costs (excluding taxes) – Benefits to public transport users, usually in travel time terms valued in dollars using a value of time – Benefits to non users such as road traffic as a result of congestion relief, reduced road accidents, reduced vehicle operating costs, environmental benefits (noise emissions) – Can include farebox revenue (a producer surplus)

In both financial and economic appraisals all costs and benefits are estimated in comparable monetary terms

The process of investment appraisal involves establishing project costs and benefits for both the operation and also the market



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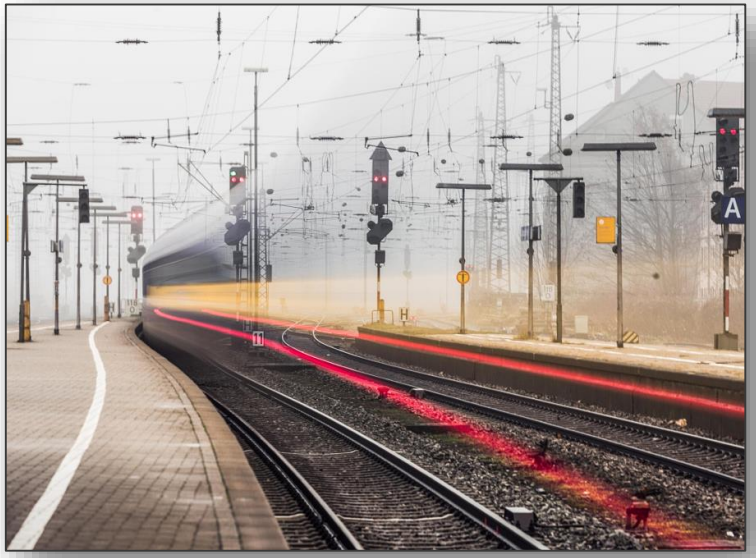


Key costing principles:

- Marginal costs attributable to the project:
  - For example when building a new rail line, will freight traffic use the line? Clearly the benefits to freight will need to be considered
  - It is important not to exclude any costs. A proper appraisal is strict in its adherence to this principle
- All of life costing
  - Full life of the assets (30 years evaluation period), Bus life=20 years
- All costs included
  - Overheads (head office staff)

There are two main types of public transport project costs; capital and operating

Types of Public Transport Costs

Capital	Operations
• Costs of providing fixed infrastructure such as tracks, stations, busway right of way, tunnels, road layout changes for transit priority etc • Costs for new public transport vehicles i.e. new buses, trams and trains • One off payment with fixed infrastructure usually at the beginning of the project life	• Costs of operating vehicles and crew to enable the service to be supplied • Includes: – Vehicle operating costs; fuel, tyres, maintenance costs – Crew costs; wages and on costs – Overhead costs; depot costs, management and administration • Costs occur every year the project is in operation

To estimate (large) fixed capital costs a specific engineering study for the project is usually required – some 'loose' rules of thumb can be used but should be applied wisely

- For a large railway project, the fixed capital costing need to establish the types of structures and their associated costs to enable the project to be realised
- This is a very location specific issue. For example a railway in built up areas may need to be operated underground. The costs of tunneling vary considerably according to sub-soil geology
- There are some very broad rules of thumb which can be used:

Broad Fixed Capital Costs – Rail Rights of Way ($M per track km – 2 way – 2002)

Light Rail	Heavy Rail
$3.8M	$2.6M

Note: Does not include stations. Surface design without cuttings or tunnels. Includes Track and overhead.

Tram costs are for on street operation in a reserved right of way in a heavily developed area.

Heavy Rail Station	Tunneling
$5.0M	$40M/km

More is known about public transport vehicle costs. Here are some typical values from Australian evaluations.

Typical Public Transport Vehicle Costs ($M, 2002) and lifespan to renewal

Light Rail Vehicle

$3.0M (30 years)

Heavy Rail Set

$12.0M (30 years)

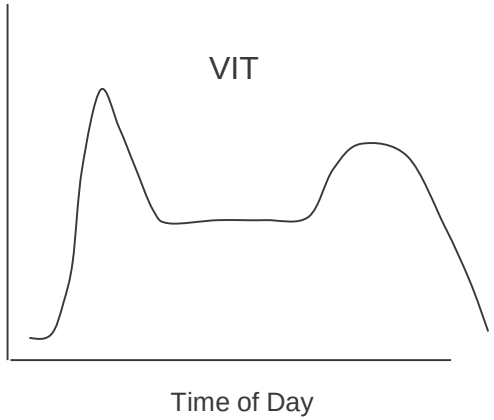
Note: Typical Melbourne 6 car set

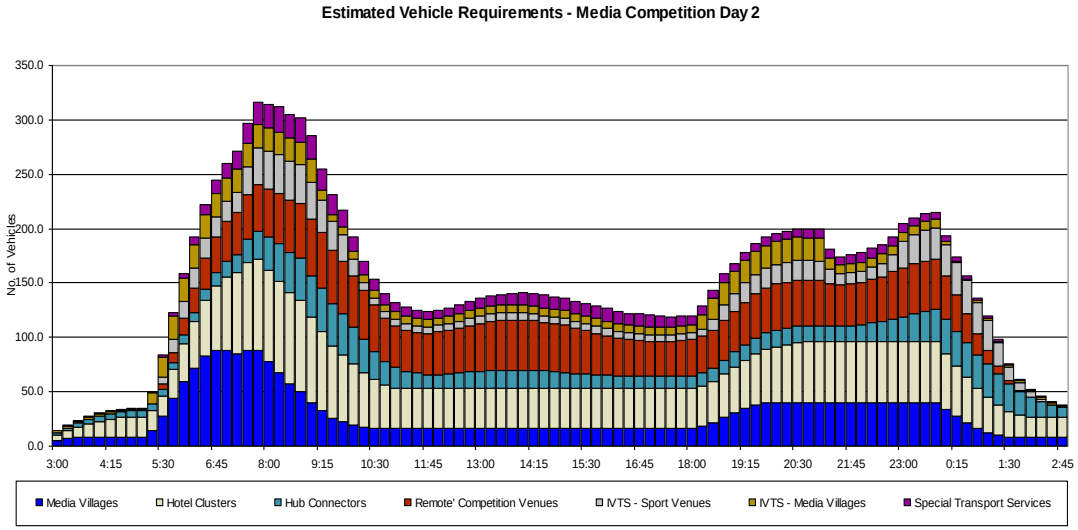
Low Floor Standard Bus

$0.335M (15 years)

The best Public Transport operating costing approach uses the 'Adelaide' model – it has proven a very good way of representing marginal costs of operating additional services.

- The Adelaide costing model was developed by Travers Morgan (1978, 1980)
- It has withstood a range of international assessment and is now considered world best practice
- In particular it emphasises the problem of peak resource allocation common to public transport systems internationally

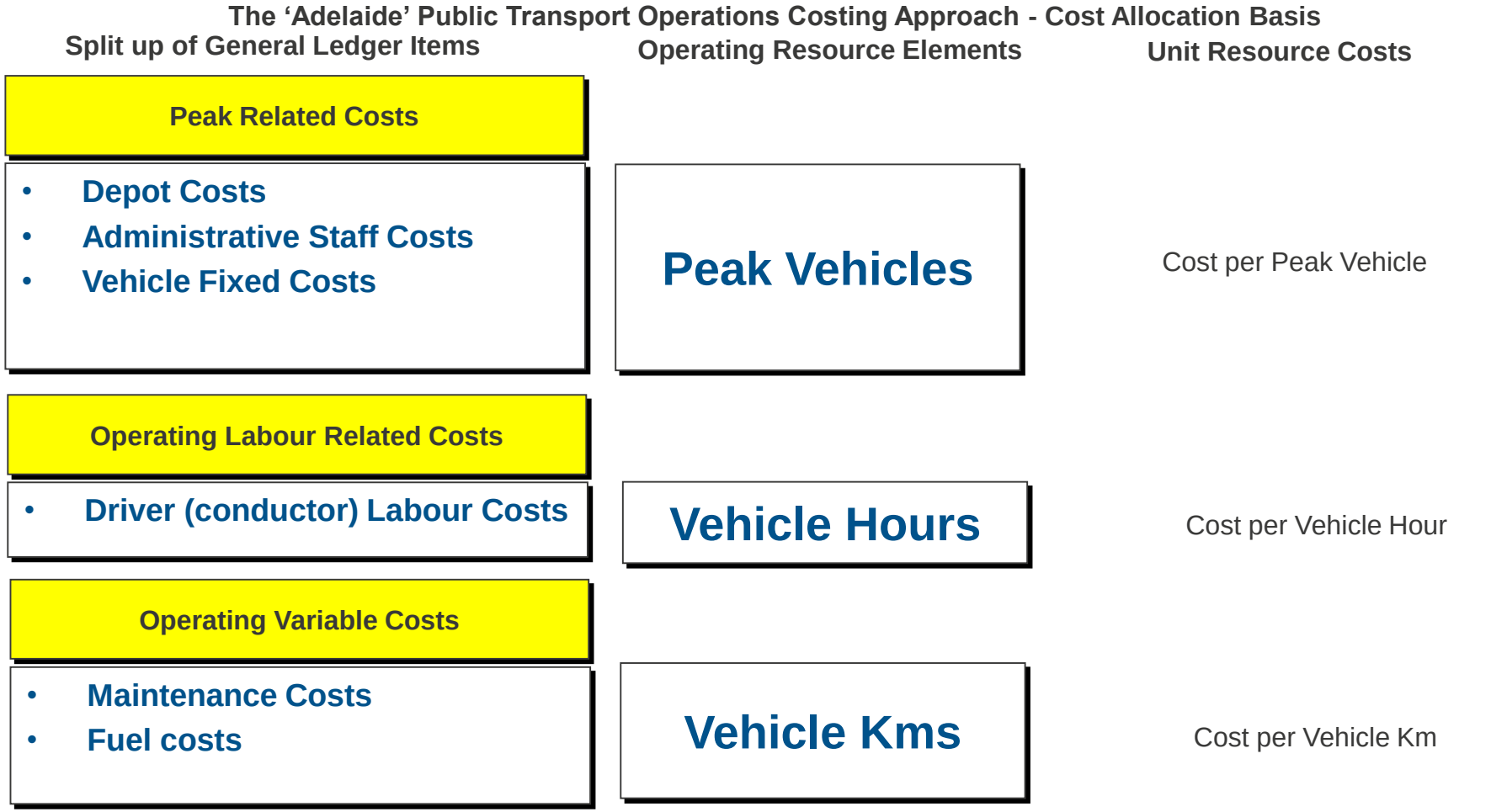




R Travers Morgan Pty Ltd (1978) *Adelaide bus costing study*, prepared for the Director General of Transport, South Australia January 1978

R Travers Morgan Pty Ltd (1980) *Adelaide rail costing study*, prepared for the Director General of Transport, South Australia June 1980

The approach splits costs into peak related, crew related and operating. These are then associated with Peak Vcles, Vcle Hours and Vcle Kms



EXAMPLE – BUS COSTING (INCLUDING VEHICLE CAPITAL) Total costs are $263.7M p.a.

The 'Adelaide' Public Transport Operations Costing Approach - Cost Allocation Basis

Split up of General Ledger Items	Operating Resource Elements	Unit Resource Costs
Peak Related Costs		
• Depot Costs • Administrative Staff Costs • Vehicle Fixed Costs **$110.4m**	**Peak Vehicles = 1,150**	Cost per Peak Vehicle ($21,000+ $75,000) =**$96,000**
Operating Labour Related Costs		
• Driver (conductor) Labour Costs **$97.5m**	**Vehicle Hours=3.9m**	Cost per Vehicle Hour **$25.00**
Operating Variable Costs		
• Maintenance Costs • Fuel costs **$55.8m**	**Vehicle Kms=93m**	Cost per Vehicle Km **$0.60**

EXAMPLE APPLICATION – BUS COSTING (INCLUDING VEHICLE CAPITAL)

PROBLEM

- **A new bus service is to be introduced**
- **The resources required to operate the service are:**
  - Peak Buses = 10
  - Bus Hours = 33.900 p.a.
  - Bus Km = 808,700 p.a.
- **What will it cost to operate annually?**

Answer

	Resources	Unit Cost	Total Cost p.a.
Peak Buses =	**10**	**$96,000**	**$ 960,000**
Bus Hours =	**33.900**	**$25.00**	**$ 847,500**
Bus Km =	**808,700**	**$0.60**	**$ 485,220**
		Total	$2,292,720

Unit Resource Costs

Cost per Peak Vehicle

($21,000+ $75,000)

=**$96,000**

Cost per Vehicle Hour

$25.00

Cost per Vehicle Km

$0.60

Some Example Transit Operating Unit Costs are provided

Bus	Tram/Light Rail	Heavy Rail
• Cost per Peak Vehicle – ($21,000+ $75,000[1]) – **$96,000** • Cost per Vehicle Hour – **$25.00** • Cost per Vehicle Km – **$0.60**	• Cost per Peak Vehicle – **$26,000** • Cost per Vehicle Hour – **$50.00** • Cost per Vehicle Km – **$1.40** • Cost per Track Km – **$19,000**	• Cost per Peak Vehicle – **$97,000** • Cost per Vehicle (Set) Hour – **$73.00** • Cost per Vehicle (Set) Km – **$6.44** • Cost per Track Km – **$65,000** • Cost per Station – **$240,000**

Note: [1]Includes reccurrent funding of vehicle replacement

All unit costs quoted have no status. They represent possible order of magnitude industry values. For application in actual evaluations a full costing analysis should be undertaken to identify real unit costs

An important methodological tip – how to work out operating resources – THE SERVICE LEVEL SPREADSHEET

TRANSIT SERVICE LEVEL SPREADSHEET

				Weekday								Saturday						Sunday					
				Service Span			Service Counts					Service Span			Service Counts			Service Span			Service Counts		
Route No.	Route Name	Direction	Route Length	Start	Finish	Total Hours	Pre Peak (<6:59)	AM Peak (7:00-8:59)	Inter Peak (9:00-14:59)	PM Peak (15:00-17:59)	Evening (>18:00)	Start	Finish	Total Hours	Morning (<11:59)	Afternoon (12:00 17:59)	Evening (>18:00)	Start	Finish	Total Hours	Morning (<11:59)	Afternoon (12:00 17:59)	Evening (>18:00)
999	Monash University to Paradise	To Monash	13.3	5:00	19:00	14:00	1	6	6	9	4	9:35	15:22	5:47	2	3		9:35	15:22	5:47	2	3	
		To Paradise	13.3	5:30	18:40	13:10	1	4	6	9	4	10:40	15:05	4:25	1	3		10:40	15:05	4:25	1	3	

ASSUMPTIONS Dead Running = 5% Layover = 5 Mins Average Speed= 22.88 kph

Annualisation = 251 Saturdays
52 Saturdays
52 Sundays
10 Sundays for Public Holdays

Vehicle Trips		
Weekday	Saturday	Sunday
50	9	9

VKMs/Day								
Weekday	Saturday	Sunday	Total/Week	Annual V/KMs	Peak Trip Time	AM Peak Headway	Round Trip Time	Peak Vehicles
700	126	126	3,752	190,081	35	20	75	3.75

Resources

Peak Buses =	**3.75**
Vkms p.a. =	**190,081**
Vhrs p.a. =	**8,307**

Key Formulae

- Peak Vehicles = Route Trip Time/Headway
- Route Trip Time = running time +layover
- Annualisation Factors
- Inclusion of dead running in Kms

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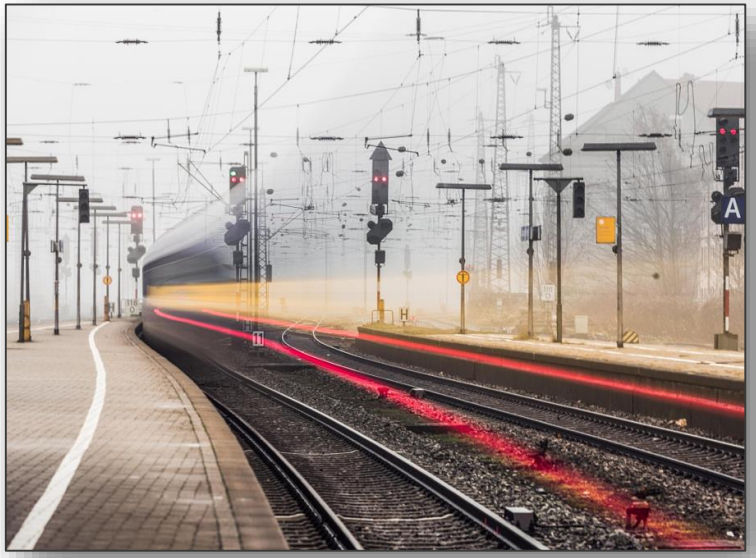


Impact assessment considers benefits and dis-benefits to USERS, NEW USERS and NON USERS of a project

- Users = Existing Public Transport Travelers
- New Users = Public Transport Travelers encouraged onto transit by the project
- Non Users = wider benefits to society as a result of mainly new users who were car drivers deciding to use public transport (e.g. road congestion relief, environmental benefits)
- A benefit concerns a winner and how much they win
- A dis-benefit concerns a loser and how much they lose

As with costs, impact assessment is undertaken in equivalent monetary terms

USER Benefits are the travel time and amenity benefits for existing public transport travelers – The generalised cost modelling identified in the demand forecasting course is the main basis for estimating impacts

	Actual Time (mins)	Perceptual Weightings[2]	Percieved Time (mins)	Total Generalised Cost ($)
Access Walk	5 Mins	2.0	10 Mins	
Expected Wait	10 Mins	2.0	20 Mins	
Unexpected Wait	1 Mins	5.0	5 Mins	
In-Vehicle Travel 1	10 Mins	1.0	10 Mins	
Transfer Time [1]	8 Mins	2.0 plus a 10 min transfer penalty	26 Mins	Apply a Value of Time of $10.00/hour[3] (16.67c/ minute)
In-Vehicle Travel 2	5 Mins	1.0	5 Mins	
Egress Walk	5 Mins	2.0	10 Mins	
Total Time	44 Mins		86 Mins	$14.33
			Fare	$ 1.84
				$ 16.18

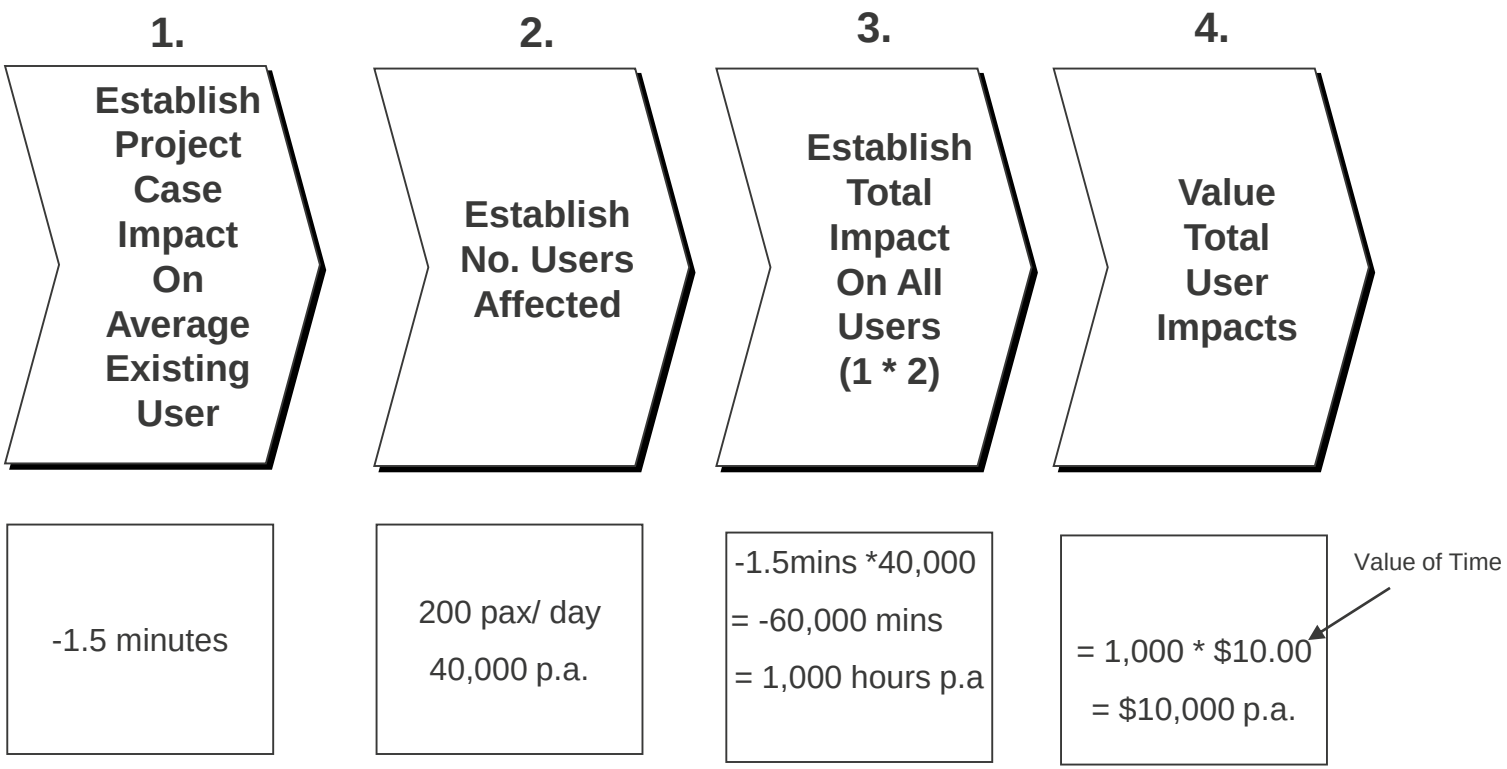
Note: [1]Includes a walk and wait

[2]See TransFund NZ June 2000

[3]June 2004 DoI Guideline on economic, social and environmental cost-benefit analysis 2005

USER benefit assessment involves a simple multiplicative process to value benefits annually

Process of User Benefit Assessment



All elements in the generalised cost model can be used to assess EXISTING USER benefits ranging from new services to seats on stations

GENERALISED TRAVEL TIME

TRANSFER PENALTIES

MODE SPECIFIC FACTORS

SOFT VARIABLES

TABLE E3 : BUS SOFT VARIABLES - BUS STOP ATTRIBUTES

ATTRIBUTE	VALUATION			
			IVT Minutes	% Fare
	Value	Currency		
Information at Home				
Timetables at home	5.5	UK, pence per journey 1997 prices	1.0	
Maps at home	3.9	UK, pence per journey 1997 prices	0.7	
Phone service	2.8	UK, pence per journey 1997 prices	0.5	
Customised local information at home	2.0	UK, pence per journey 1997 prices	0.4	
Bus Stop Infrastructure				
Basic shelter with roof and end panels	5.6	UK, pence per journey 1997 prices	1.0	
Basic shelter with roof only	4.5	UK, pence per journey 1997 prices	0.8	
Lighting	3.1	UK, pence per journey 1997 prices	0.5	
Moulded seats at stop	3.4	UK, pence per journey 1997 prices	0.6	
Flip seats at stop	2.2	UK, pence per journey 1997 prices	0.4	
Bench seats at stop	0.9	UK, pence per journey 1997 prices	0.2	
Payphone at stop	3.8	UK, pence per journey 1997 prices	0.7	
Bus Stop Environment				
Dirty bus stop	-11.8	UK, pence per journey 1997 prices	-2.1	
Information at Bus Stop				
Guaranteed customised local information at stop	9.9	UK, pence per journey 1997 prices	1.7	
Countdown to next bus arrival	9.0	UK, pence per journey 1997 prices	1.6	
Guaranteed current information at stop	8.8	UK, pence per journey 1997 prices	1.5	
Boarding				
Compulsory stop versus request	1.7	UK, pence per journey 1997 prices	0.3	
Bus pulls in close to kerb	5.8	UK, pence per journey 1997 prices	1.0	
Externally shown route number and line diagram	2.8	UK, pence per journey 1997 prices	0.5	
Low bus entry versus high steps	2.4	UK, pence per journey 1997 prices	0.4	
Split steps versus high steps	-0.3	UK, pence per journey 1997 prices	-0.1	
Notes:				
Steer Davies and Gleave cited in London Transport (1997) "Business Case Development Manual", LT Corporate Planning				
All valuations based on maximum improvement (i.e. poorest condition to perfect condition),				
Monetary values converted using recommended value of time (i.e. 5.7 pence per minute 1997 prices)				

It is a key part of the appraisal that ‘user perceptions’ of values are included since this represents how they would value a project

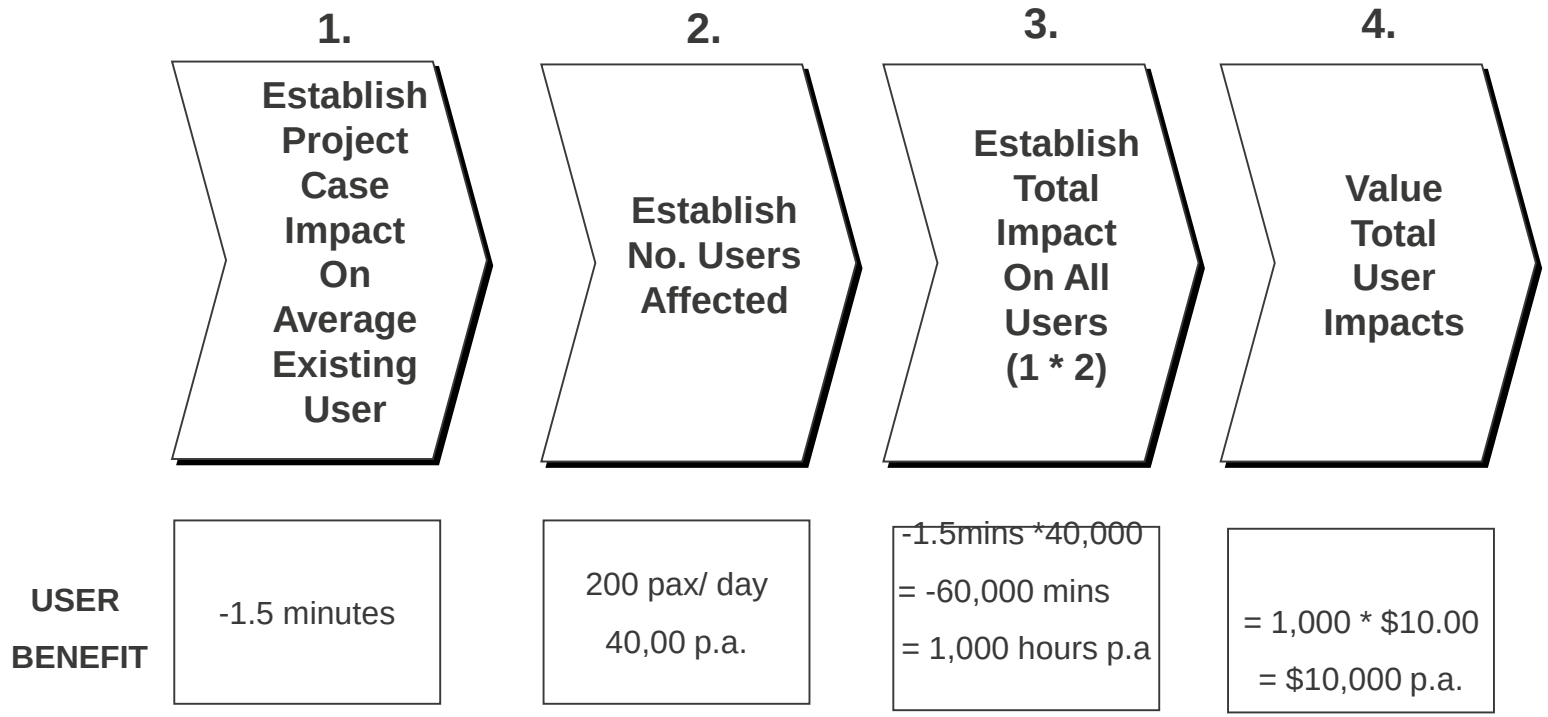
The first step to assessing NEW USER impacts is a demand forecast

- Refer to the work in the Demand Forecasting Course Module
- Key approaches are:
  - Benchmarking
  - Elasticities
  - Generalised Cost Modelling
- The later approach has the obvious beauty that the generalised costs you use for demand forecasting can also be the ones you use for user impact assessment (this is a major reason behind the use of transport models)

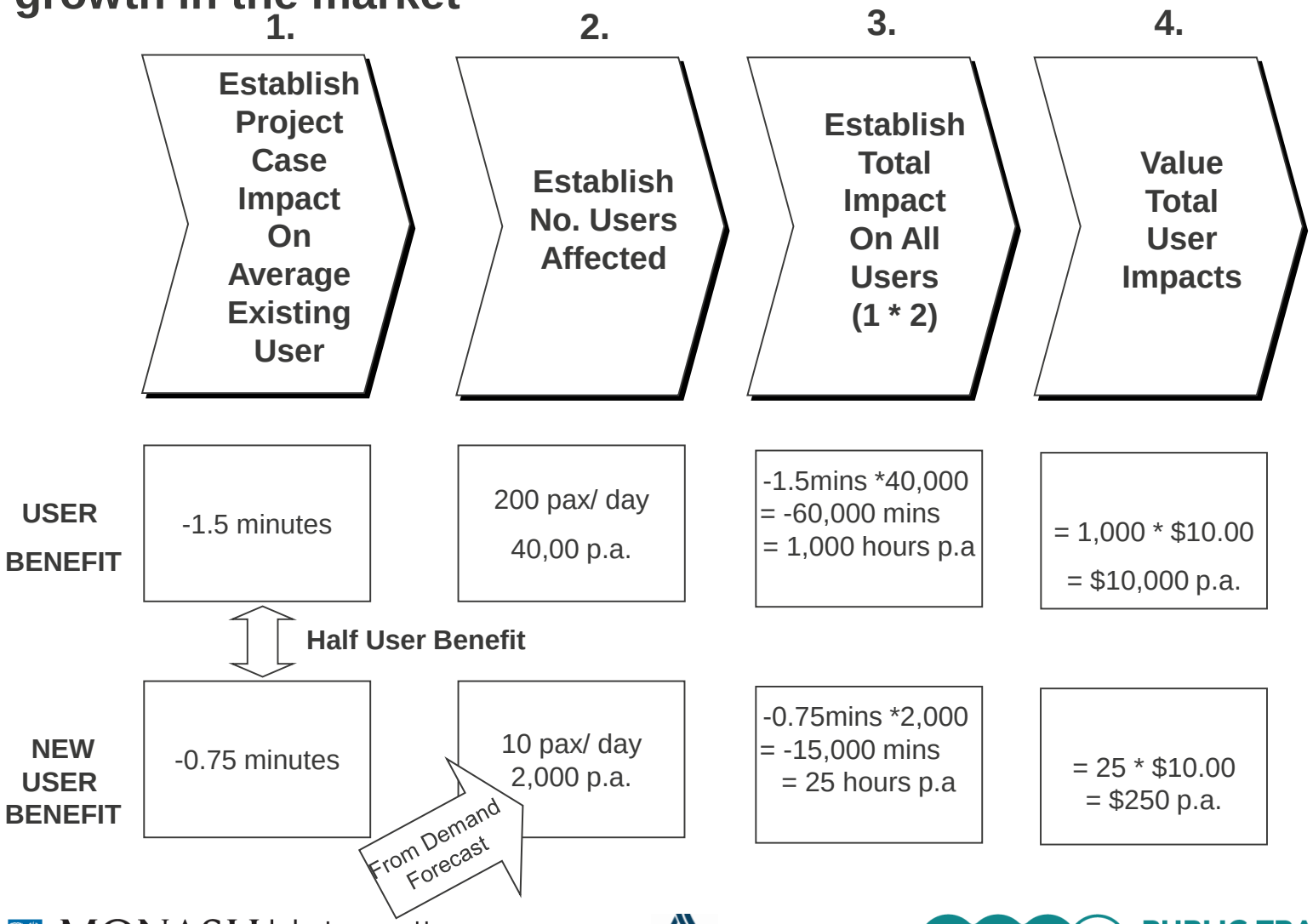
NEW USER impacts are half USER impacts using the ‘Rule of a Half’ (termed the consumer surplus by economist)

- The rule of a half is a rational way to determine the value of new user benefits
- One problem we have with new users is that we do not know what their travel time was for the travel they made before they used public transport
- However we can use the following logic:
  - The maximum value of their benefit must be the same size of benefit as that to existing users (or they would already be using PT and hence wouldn’t be new to it)
  - The minimum benefit must be just very slightly above zero
  - The ‘rule of a half’ says therefore take half the existing user benefit

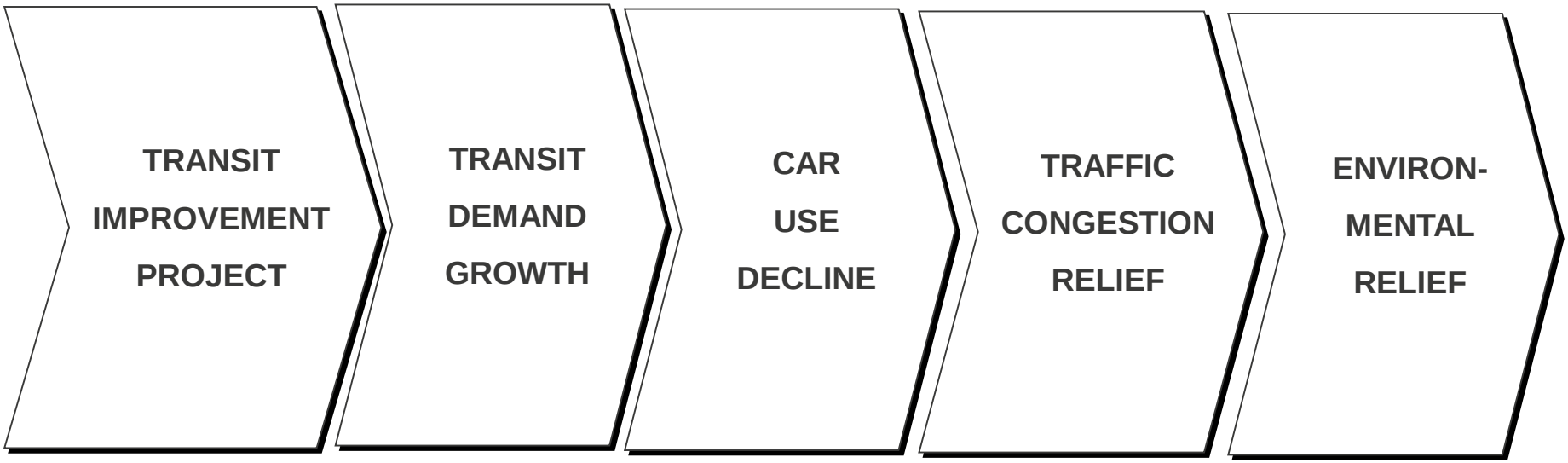
So while USER benefits are assessed as follows:



NEW USER benefits use half the value of USER benefit applied to the growth in the market



NON USER benefits represent the wider benefits to society resulting less car use and the resulting congestion and environmental relief



- Road User Travel Time Savings
- Reduced Road Accidents
- Reduced Car Operating/ Ownership Costs
- Less Noise Emissions
- Less Vehicle Emissions

At one time estimating the size of these impacts was a major challenge. However thanks to DoI and Stanley et al we can use the following values.

Unit Values for Non User Benefit Estimation

Road User Benefits[1]	c / vkm
Heavily congested roads	
•peak	96
•off peak	17
Moderately congested roads	
•peak	64
•off peak	17
Lightly congested roads	17

Environmental Benefits	Value
•Reduced greenhouse gas emissions •Reduced air pollution	1.4 c/vkm

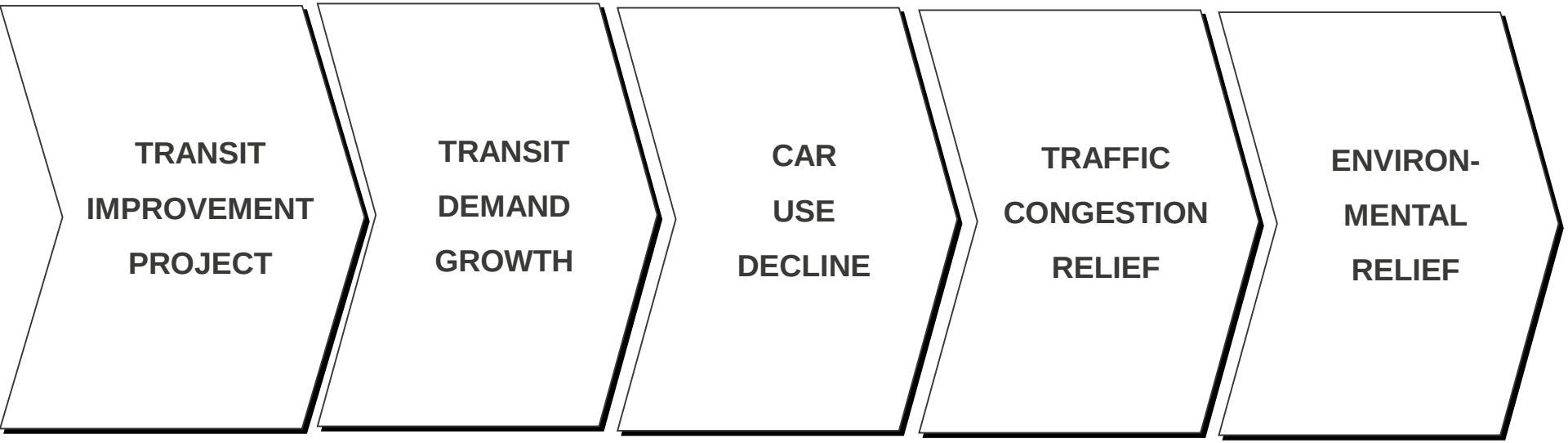
Assumed Share of New Users who used to be Car Drivers	Value
• Estimated share of new transit users who used to be car drivers	50%

[1]Based on Stanley and Ogden plus internal review by Ashley (2001)

Sourced from Victorian DoI Guideline on economic, social and environmental cost-benefit analysis

June 2004 values

The process of estimating NON USER impacts is a relatively simple one



	40 people/day 8,000 p.a.	8,000 * 50% = 4,000 Factored by car trip length (10km) = 40,000 vkms	= Vkms * $0.96 = 40,000 * $0.96 = $38,400	= Vkms * $0.014 = 40,000 * $0.014 = $560

Total Impact = $38,960 p.a.

One other element of project benefit impacts is usually sometimes included in the economic appraisal – FAREBOX REVENUE GROWTH

- It is sometime assumed that this would be double counting of benefits
- Farebox revenue growth is certainly a major input to the financial evaluation
- The rationale for its inclusion in the economic appraisal is that it is seen as a ‘producer surplus’ (an economic term)

SUMMARY OF KEY POINTS - USER/ NON-USER IMPACT APPRAISAL

Existing User Benefits	• Existing public transport users who receive a benefit from the project	• Value Benefit (TGC) • Identify passengers affected • Value total benefit
New User Benefits	• Public transport users encouraged onto transit as a result of the project	• Do demand forecast • Take HALF user benefit • Value total benefit
Non User Benefits	• Benefits to people not using public transport • Congestion and environmental relief	• Use demand forecast • Factor by 50% for car drivers • Factor by road car travel distance • Multiply by Congestion Relief Factor (e.g. 90c/km • Multiply by Environmental Relief factor (1.3c/vkm)
Fare Box Revenue Growth	• Increase in fare revenue	• Do demand forecast • Factor by average fare

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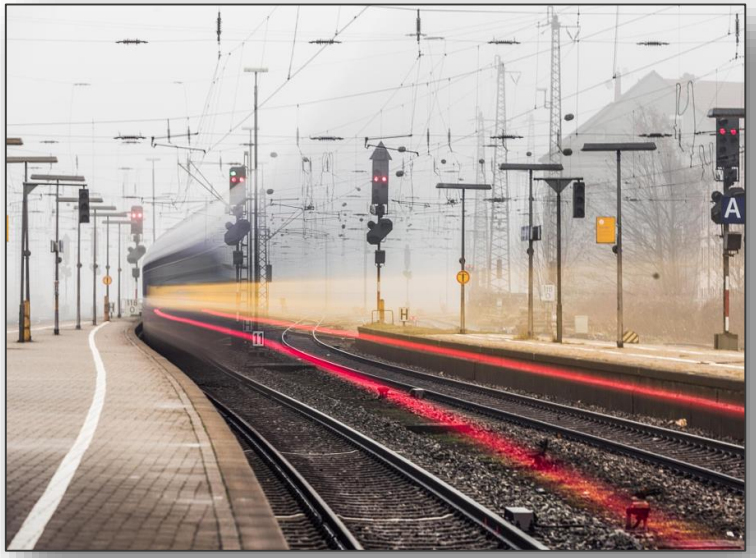
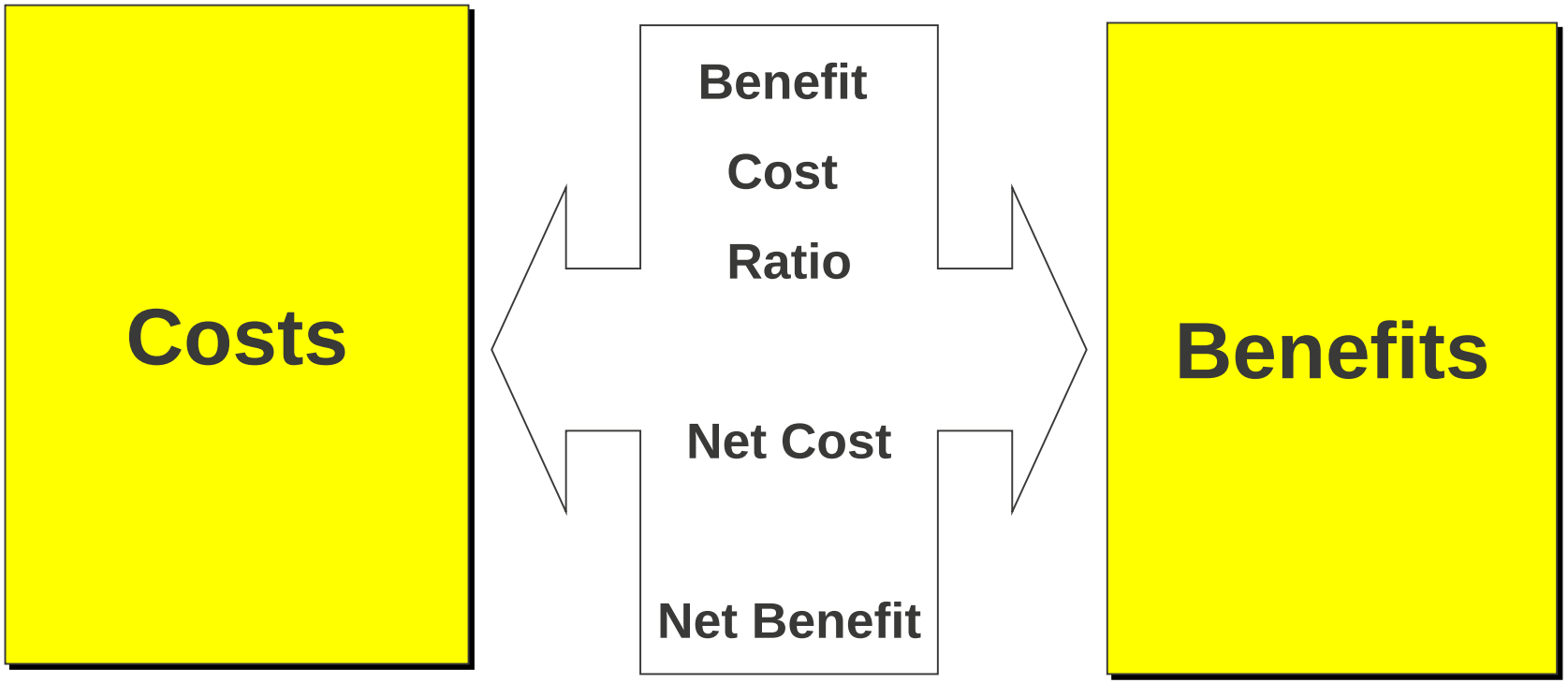


Cost Benefit Analysis is the simple comparison of Costs vs Benefits



CBA Analysis is usually done using a DISCOUNT CASH FLOW Chart

	Costs ($M)			Benefits ($M)					Net Impact
Year	Capital	Operating	Total	User	New User	Non User	Farebox	Total	
1	22.5		22.5						-22.5
2	13.4		13.4						-13.4
3	2.1		2.1						-2.1
4		1.1	1.1	1	0.1	0.3	0.6	2.0	0.9
5		1.1	1.1	1	0.1	0.3	0.6	2.0	0.9
6		1.1	1.1	1	0.1	0.3	0.6	2.0	0.9
7		1.1	1.1	1	0.1	0.3	0.6	2.0	0.9

The Excel Net Present Value Function is used to 'value' cost elements over time

- Discount Cash Flow (DCF) analysis is a simple listing of the relevent costs and benefits in a time stream over the life of the evaluation (typically 30 years)
- The Net Present Value (NPV) Function calculates the current value of a future investment and income stream using a Discount Rate. Current discount rates used in Victoria is usually 6%.
- Essentially it brings a stream of values going into the future to a single number to represent the value of that stream

Excel Function Syntax:

NPV(**rate**,**value2**,value3, ...) + value 1 *[the value of the first year of the discount stream is not discounted]*

Over a 30 year horizon the following values emerge – The NPV of the project is -26M with a BCR of 0.48

	Costs ($M)			Benefits ($M)					Net Impact
Year	Capital	Operating	Total	User	New User	Non User	Farebox	Total	
1	22.5		22.5						-22.5
2	13.4		13.4						-13.4
3	2.1		2.1						-2.1
4		1.1	1.1	1	0.1	0.3	0.6	2.0	0.9
5		1.1	1.1	1	0.1	0.3	0.6	2.0	0.9
6		1.1	1.1	1	0.1	0.3	0.6	2.0	0.9
30		1.1	1.1	1	0.1	0.3	0.6	2.0	0.9
NPV (DR 6% $M)	37.0	13.1	50.1	11.9	1.2	3.6	7.2	23.9	-26.3

Important Reference

- Australian Transport Council (2006) 'National Guidelines for Transport System Management in Australia – 4 Urban Transport'
- Available for free download at:

http://www.atcouncil.gov.au/documents/NGTSM.aspx

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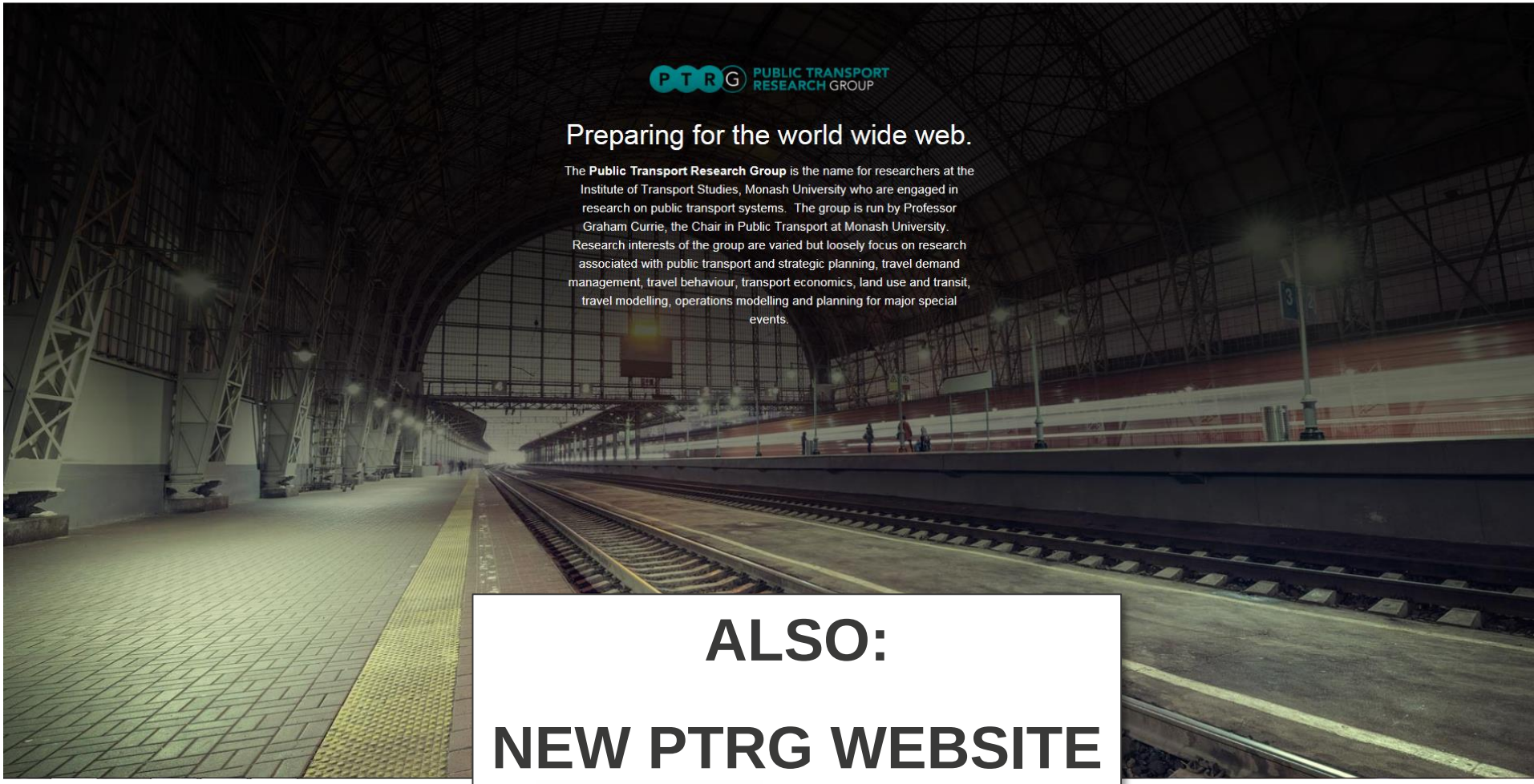
2025=PTx2

Showcase Award Winner



ALSO:

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