Traditional Cost Benefit Analysis (CBA)

ENGGEN 403 - Lecture 7

Marc Lewis

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This Week

2	22 Jul	Challenges & Systems Thinking	Stakeholders at Systems Level	Systems Level Innovation	Personal Goal Settings (Review)
3	29 Jul	Traditional CBA	Societal Considerations	GDP and Govt. Spending	Quiz 1
4	5 Aug	Social CBA	Guest Speaker: Dame Prof Juliet Gerrard	Meet the Team	Lecture Participation Team Canvas

Reminders

- Quiz week 3
  - Opens Thursday 1pm - closes Friday 10pm

Learning Outcomes

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By the end of this session, students should be able to:

1. Define and explain the concepts of cost benefit analysis, time value of money, discounted costs and benefits, and risk.
2. Estimate high-level costs for systems-level projects
3. Define financial metrics (NPV, CBR and IRR) and how they are used to influence decision making.
4. Demonstrate how the cost benefit analysis is reported and communicated to the government.
5. Report complicated project information in an easily digestible and understandable format.

Agenda

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1. Financial Case
2. ENGGEN 303 vs ENGGEN 403
3. Steps to cost benefit analysis

Cases: - Auckland Light Rail, Marine Parade Redevelopment

VS

Better Business Case Introduction

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Better Business Case Introduction

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ENGGEN 303	ENGGEN 403
Problem space	**Strategic case** • Project background/Introduction • Problem statements • Users/stakeholders • Requirements and CSFs **Economic Case**

Solution space	• Options
	• Long list options assessment
	  • DFVS
	  • Problem statements and CSFs
	• Shortlisted options
	Financial Case
	• Economic and social impact assessment of at least 2 shortlisted options
	• Preferred way forward

Implementation plan	**Management Case** • Project scope • Project plan

The Financial Case

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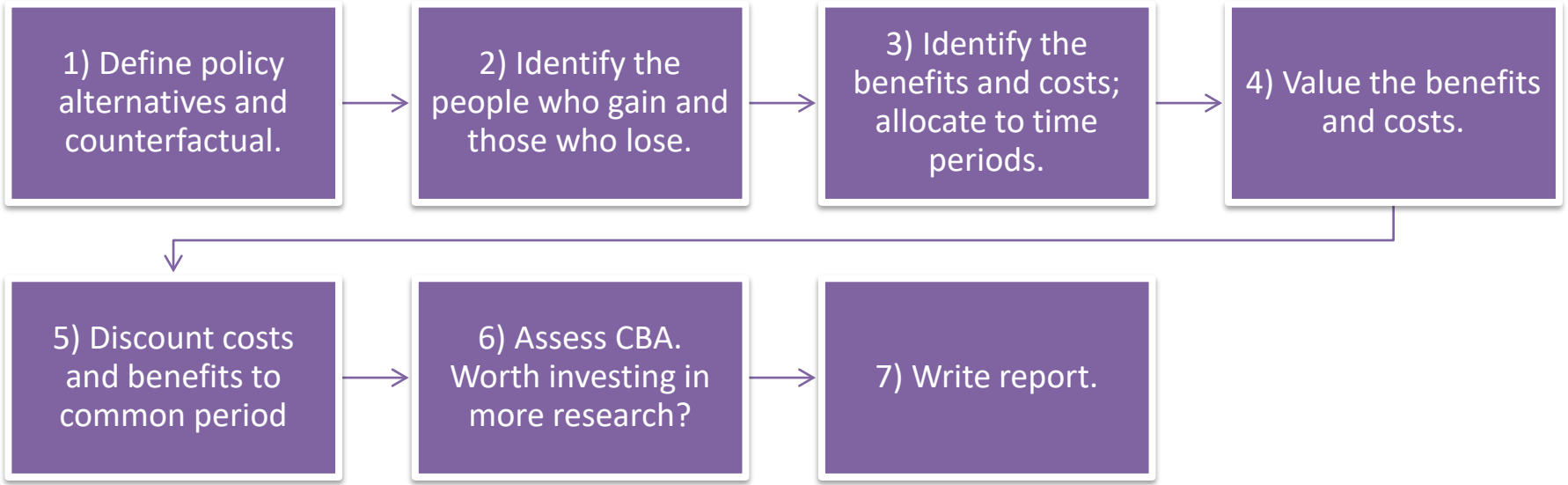
Once you have completed the options assessment and have your shortlisted options, you must now assess the **Financial Case** for your shortlist. This is done through a high-level cost benefit analysis.

At the national (systems) level the steps for the CBA are:



303 Financials Recap

In 303 you learnt about Discounted Cash flow and Cost benefit analysis for a single project/product.

- Income (revenue)
- Expenses (costs)

Systems level projects…

- Generate economic benefits (covered today)
- Generate social benefits (monetised and non-monetised (covered in detail next week)
- Capital costs (capex), ongoing costs (opex)

303 CBA Recap

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Cash Flow Forecast

Year	0	1	2	3	4	5
Cash opening balance	**0.00**	**-409,667.00**	**-256,274.30**	**-25,970.90**	**281,243.20**	**665,368.00**
Cashflows from Customers	**0.00**	**619,500.00**	**774,375.00**	**929,250.00**	**1,084,125.00**	**1,239,000.00**
Parking Service Fee	0.00	547,500.00	684,375.00	821,250.00	958,125.00	1,095,000.00
Monthly Fees	0.00	72,000.00	90,000.00	108,000.00	126,000.00	144,000.00
Cashflows paid to Supplier	**-261,000.00**	**-326,250.00**	**-391,500.00**	**-456,750.00**	**-522,000.00**	**-587,250.00**
Materials	-40,000.00	-50,000.00	-60,000.00	-70,000.00	-80,000.00	-90,000.00
Labour	-90,000.00	-112,500.00	-135,000.00	-157,500.00	-180,000.00	-202,500.00
Software Development	-50,000.00	-62,500.00	-75,000.00	-87,500.00	-100,000.00	-112,500.00
Azure cloud services	-1,000.00	-1,250.00	-1,500.00	-1,750.00	-2,000.00	-2,250.00
sensor installation cost	-80,000.00	-100,000.00	-120,000.00	-140,000.00	-160,000.00	-180,000.00
Cashflows for Operating Ac	**-127,143.00**	**-139,857.30**	**-152,571.60**	**-165,285.90**	**-178,000.20**	**-190,714.50**
Administration	-46,463.00	-51,109.30	-55,755.60	-60,401.90	-65,048.20	-69,694.50
Marketing	-24,780.00	-27,258.00	-29,736.00	-32,214.00	-34,692.00	-37,170.00
Propety and Plant	-10,000.00	-11,000.00	-12,000.00	-13,000.00	-14,000.00	-15,000.00
admin labour	-45,000.00	-49,500.00	-54,000.00	-58,500.00	-63,000.00	-67,500.00
Insurance	-600.00	-660.00	-720.00	-780.00	-840.00	-900.00
Maintenance and repairs	-300.00	-330.00	-360.00	-390.00	-420.00	-450.00
Tax (28% on profit)						
Cashflows from Investment	**-21,524.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Installation service vehicle	-10,000.00	0.00	0.00	0.00	0.00	0.00
Soldering Kit	-100.00	0.00	0.00	0.00	0.00	0.00
Computers and hardware	-5,000.00	0.00	0.00	0.00	0.00	0.00
office furniture	-500	0	0	0	0	0
office supplies	-924	0	0	0	0	0
tools and safety gear	-5000	0	0	0	0	0
Discount Rate (Hurdle Rate	**15%**					
Net Cash Flow	**-409,667.00**	**153,392.70**	**230,303.40**	**307,214.10**	**384,124.80**	**461,035.50**
Closing balance	**-409,667.00**	**-256,274.30**	**-25,970.90**	**281,243.20**	**665,368.00**	**1,126,403.50**

403 Cost Benefit Analysis

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Cost Benefit Analysis

Year	0	1	2	3	4	15
Opening Balance	**0.00**	**11,000,000.00**	**11,150,000.00**	**11,150,000.00**	**11,150,000.00**	**11,150,000.00**
Costs	**11,000,000.00**	**150,000.00**	**0.00**	**0.00**	**0.00**	**0.00**
Capital Costs						
Aotea station						
Professional Fees	1,000,000	150,000.00				
Property Acquisition	10,000,000.00					
Construction	100,000,000					
Ongoing costs						
lifecycle costs						
operation and maintenance						
Benefits	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Fares generates						
Travel time saved						

Rather than individual cash flows, high level costs and benefits

Step 1. Identifying the Counterfactual

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Example: Bridge over river

Suppose that the bridge costs $20 million, and that it will save travellers $25 million worth of travel time and vehicle operating costs, in present value terms. The bridge would appear to have benefits that exceed the costs. The net present value (NPV) of the bridge is $5 million.

But suppose that in the absence of a bridge being built, there is every expectation that a private ferry operator will start business. The cost is $10 million in present value terms, and the social benefits are $20 million in present value terms. The ferry operation has an NPV of $10 million.

Compared with the ferry operation, a bridge would cost $10 million more, and would produce $5 million more benefits. Against this counterfactual, the bridge has an NPV of –$5 million.

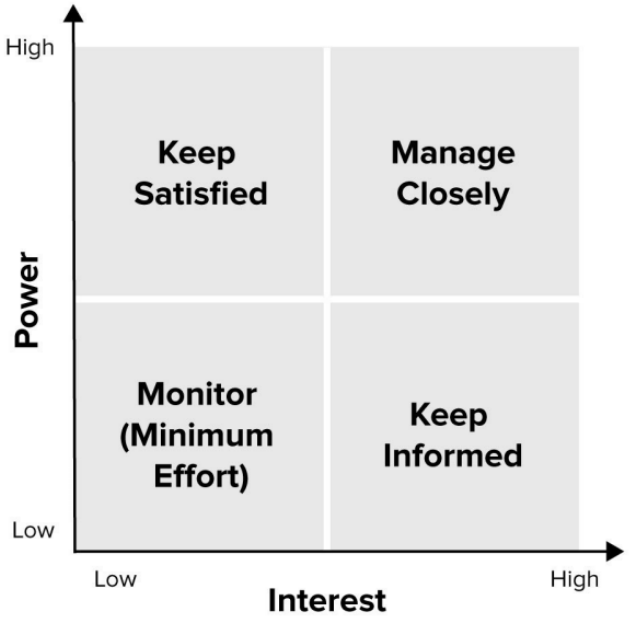
Against the “no bridge, no ferry” counterfactual, the bridge would seem worthwhile. But against the “ferry” counterfactual, the bridge is not.

Equivalently, the ferry could be presented to decision-makers as an alternative to the bridge. This would still show the ferry to be the better option, despite the fact that the bridge has greater total benefits.

Step 2. Identify who gains and who loses

You have already done this in your stakeholder analysis.

Refer to Amanda's lecture.



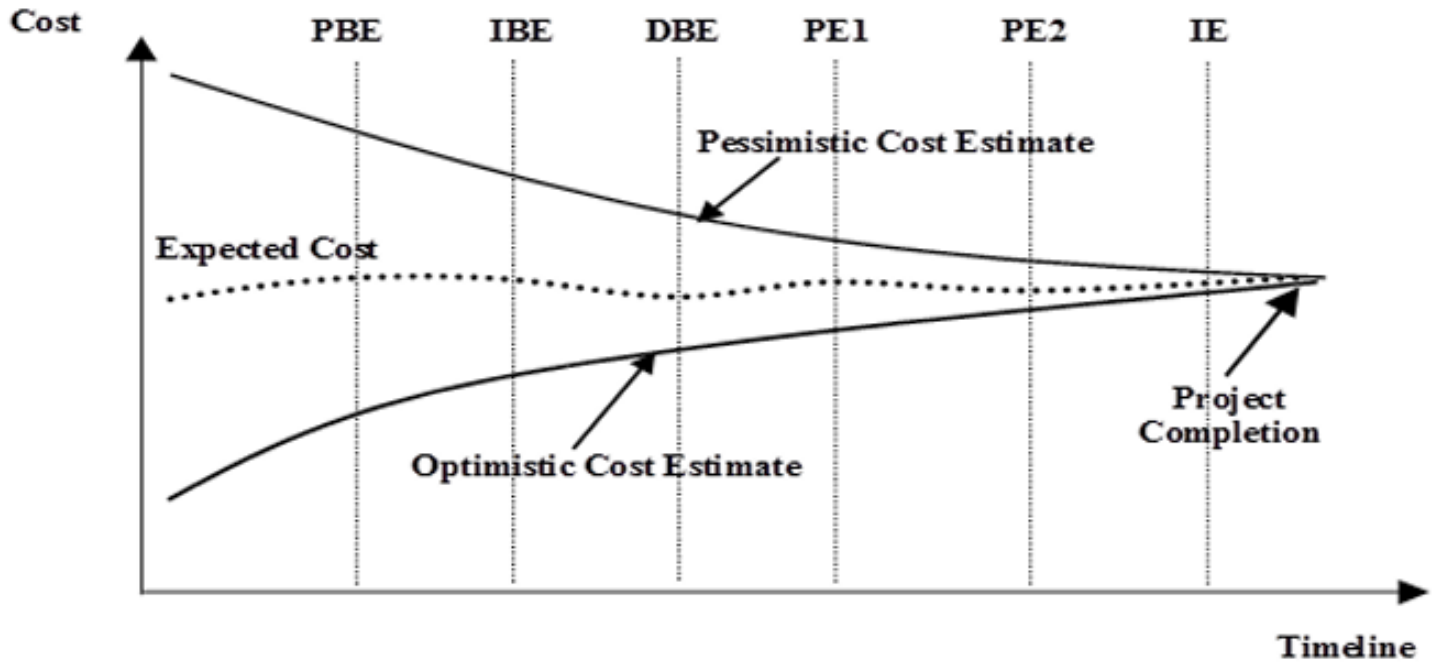
Activity / Stakeholder	
Prime Minister / Minister of Energy	DEPARTMENT OF THE PRIME MINISTER AND CABINET
MBIE	MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
Iwi and land owners	Te Rūnanga o NGĀI TAHU; NGAPUHI
Energy companies	Mercury; Meridian
Engineering firms	SIEMENS Gamesa; Vestas
Energy users / customers	

Step 3. Identify Benefits and Costs

You will need to determine the costs and benefits for your systems projects. These should be measured through observable consequences (impacts) on people.

- Can be in terms of **money** but can also be **intangible.**
    - Both must be **measurable.**
    - Only those directly related to the project
    - Should include costs and benefits that are avoided due to the decisions being made about the project.
  - Don't consider depreciation or interest (double counting)
  - Transfer payments for welfare are net neutral (do not include)
  - Do not include any capital gains
- Need to identify the time-period for analysis (10-15 years).

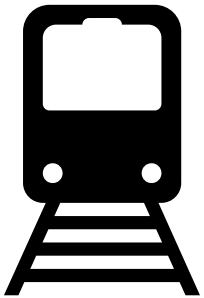
High level costings



Taken from: NZTA Cost Estimation Manual

Auckland Light Rail

Auckland
LIGHT RAIL
Bringing us closer



Costs – Auckland Light Rail

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Capital costs

Capital costs have been developed to a Class 5 estimate (reflecting an estimated accuracy range of -40% to +70%). The capital cost estimates consider the delivery of all aspects of the infrastructure, stops/stations , and facilities required during the delivery phase of the Project. The costs have been disaggregated into "Core" (relating to the core transport solution in the

e.g. Professional Services, property acquisition, Construction, Client and delivery costs etc.

Ongoing costs

A summary of the ongoing costs is presented below, with the detailed operating and maintenance (O&M) cost plan report included in Appendix 15. While a number of inputs and assumptions have been made (detailed in Appendix 15), the two main assumptions in relation to ongoing costs are:

- the Delivery Entity oversees the Project in its entirety, including post service commencement
- service delivery is outsourced to a private provider that has O&M responsibilities for a fully vertically integrated rail line.

e.g. Operating and maintenance cost, lifecycle costs

Costs – Auckland Light Rail

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Significant cost items

The most significant items within this cost estimate for Tunnelled light rail, making up over 80 percent of the total, are as follows:

- 43 percent tunnels

City Centre to Māngere Rapid Transit Indicative Business Case **Page 144**

Commercially sensitive – Do not distribute

- 12 percent retaining wall structures to stops/stations and cuttings etc
- 10 percent rail systems and trackwork
- 10 percent stations and stops
- 5 percent bridges / viaducts

Costs – Auckland Light Rail

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Table 12: Economic Costs

	Light Rail	Light Metro	Tunnelled Light Rail
Unescalated (P50) Capital Cost (M)	$7,312	$12,773	$11,410
Escalated (P50) Capital Cost (M)	$9,047	$16,291	$14,601
Unescalated OPEX (M pa[55])	$105	$115	$120
Economic NPV (M)	**$7,141**	**$11,196**	**$10,362**

Report Summary in body of report

Full cost benefit analysis in appendix

Looking for High-level report

Cost Estimation resources

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- https://www.nzta.govt.nz/assets/resources/cost-estimation-manual/docs/sm014-appendix-c-estimate-summary-reporting-forms.xlsx
- https://www.nzta.govt.nz/planning-and-investment/learning-and-resources/business-case-approach-guidance/the-five-case-model/financial-case/ (tools at the bottom of page)
- https://at.govt.nz/media/1991939/auckland-transport-guide-to-cost-estimation.pdf
- https://www.nzta.govt.nz/assets/resources/cost-estimation-manual/docs/cost-estimation-manual-sm014.pdf
- https://www.treasury.govt.nz/publications/guide/cbax-spreadsheet-model (more next week)
- Remember BOTTOM UP vs TOP DOWN

Benefits

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3 Description of Benefits

Monetary: Benefits that are measurable in monetary terms: financial or cash releasing, such as avoided costs or efficiency savings

Non-monetary: Benefits that are not measurable in monetary terms. These can either be quantifiable, such as reduced customer complaints, or qualitative, such as improved health outcomes. Qualitative benefits may be observed but not easily measured. Narrative and level of change identified.

Need model/framework/tool/way for measuring monetary benefits (Lecture 12)

- Waka Kotahi NZ Transport Agency's Monetised benefits and costs manual (MBCM)

Will need to discuss non-monetary benefits as well (lecture 11)

Quantitative	**Qualitative**
Project emissions estimation tool (PEET)	Living Standards Framework – 4 capitals
Living Standards Framework – indicators	He Ara Wairora
CBAX	

Benefits – Auckland Light Rail

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Table 13: Economic Benefits

	Light Rail	Light Metro	Tunnelled Light Rail
Traditional transport benefits (NPV) (M)	$3,747	$6,063	$5,278
Wider economic benefits (NPV) (M)	$3,989	$6,988	$5,760
Total benefits (NPV) (M)	$7,736	$13,051	$11,038

More detail on modelling benefits and costs next week

Step 4. Value the Benefits and Costs

Benefits should be measured in terms of 'willingness to pay', and costs should reflect opportunity costs.

For systems week:

- Values can be expressed as point values (will not be carrying out sensitivity analysis nor modelling for CI.
- The evaluation period should be 'whole of life'.

In practice:

- Values should be adjusted for **risk**.
- Values should be expressed in terms of ranges.
- Benefits and costs should be measured in real terms, i.e. net of inflation.
- Multiplier effects should be ignored, unless there is high unemployment.

Risk – Auckland Light Rail

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FINANCIAL RISKS

The Project is complex, and the scale of investment carries several inherent risks. A project risk register has been developed, which details all the identified design, construction, and operating risks. The potential impact of these risks has been assessed and quantified and was used as an input into the risk pricing for the Project. The key financial risks include:

- **Cost estimation risks:** The size, scale, and uncertainty over final scope of the Project means that there are several inherent risks associated with the cost estimates that have been prepared. This includes estimates for indexation (e.g. base interest rate, construction escalation, foreign exchange for various scope components (e.g. rolling stock)). Appropriate levels of risk and contingency have been included at this stage of the Project, commensurate with the level of information and detail available.

Risk – Auckland Light Rail

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- **Unknown utility and geotechnical risks:** These unknown risks are not currently sufficiently understood to appropriately quantify and price. Leveraging partner, including Mana Whenua matauranga and experience, information and recent experience and completing geotechnical surveys and utility identification works as part of an early works package (or even during the DBC) will be used to better understand these risks.
- **Funding revenue estimates:** The revenue expected from the different funding sources will be estimated at the next phase. Estimates will be predicated on a number of underlying assumptions. There is a risk that these assumptions are optimistic, reducing actual revenue potential from each source.
- **Implementation risks:** There is a risk that some of the potential funding tools will be challenging to implement and/or may require legislative change (e.g. utilising the rating powers under the Urban Development Act 2020). This will be explored in more detail in the DBC.
- **Announcement risk:** There is a risk that the ability to utilise some of the funding tools to their potential is undermined by the timing of certain announcements. This is particularly relevant in relation to some value uplift capture tools, where announcements of route or station location, for example, can lock in uplift at the time of that announcement. This means that the portion of uplift cannot be captured in the future unless the funding strategy is confirmed in advance.
- **Farebox revenue:** Operating costs for the Project are likely to be predominantly fixed in relation to the timetabled services. If patronage is lower than forecast, then there is a risk that farebox revenue is therefore lower than expected, which would increase the operating funding gap.

Sensitivity analysis

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Economic sensitivity tests

For a project of this size there is uncertainty with the forecast costs and benefits. Estimates in this IBC phase are made with the best information available at that time. To understand the sensitivity to the economic performance of the preferred option to some of the key assumptions, a series of sensitivity tests has been undertaken, including:

- Low land use test – assumed uplift in density does not occur
- Test different Do Minimum – assumed higher land use
- Different base case –assumed land use change occurs regardless of the Project
- 3 percent discount rate – both benefits and costs are discounted with a 3 percent discount rate
- 5 percent discount rate - both benefits and costs are discounted with a 5 percent discount rate
- Increased cost by 20 percent - capital cost and opex increases by 20 percent
- Benefits increase by 20 percent
- Slower benefits ramp up – opening year benefits are achieved over a 5 year ramp up period instead of 2 years as assumed in the base

Sensitivity analysis

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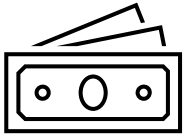
Option	Traditional Benefits total	Wider Economic Total	Benefits TOTAL	NPV costs	BCR without WEBS	BCR with WEBS
Preferred option – Tunnelled Light Rail	$5,278M	$5,760M	$11,038M	$10,362M	0.5	1.1
Test - Low land use	$4,025M	$5,760M	$9,785M	$10,362M	0.4	0.9
Test - Different Do minimum	$4,856M	$5,760M	$10,616M	$10,362M	0.5	1.0
Test - 3 % discount rate	$6,907M	$5,760M	$12,667M	$11,429M	0.6	1.1
Test - 5 % discount rate	$3,586M	$5,760M	$9,346M	$9,488M	0.4	1.0
Test - increased cost by 20%	$5,278M	$5,760M	$11,038M	$12,434M	0.4	0.9
Test - increase benefits by 20%	$6,333M	$5,760M	$12,093M	$10,362M	0.6	1.2
Slower benefits ramp up (5 years instead of 2)	$4,780M	$5,760M	$10,540M	$10,362M	0.5	1.0
Reduction in wider costs	$5,278M	$5,760M	$11,038M	$9,826M	0.2	1.2
Increase in Value of CO2 reductions	$5,343M	$5,760M	$10,952M	$10,362M	0.5	1.1
Rule of a half on all PT / Traffic benefits	$4,926M	$5,760M	$10,687M	$10,362M	0.5	1.0

You may think about reporting a couple of alternative scenarios

Step 5. Discount Benefits and Costs

Because these projects are very large and can span several years to several decades the **Time value of Money** becomes very important.
You must **discount** the costs and benefits to today's value.

Recap 303
If you had the option of having $1000 dollars **now** or 1 year into the **future** which would you pick?



The Time Value of Money Recap

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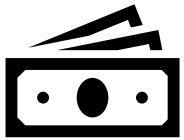
You should take the money **now!**

Because you can put it into a savings account and earn **interest** (say 8%) from the bank.



Period (n)	0	1	2	3	4	5	n
Present Value (PV)	$1000	$1080	$1166.40	$1259.71	$1360.49	$1469.32	
Interest rate (r)	0.08	0.08	0.08	0.08	0.08	0.08	r = 0.08
Future Value (FV)	1000 + 1000 x 0.08	1080 + 1080 x 0.08	1166.4+ 1166.4 x 0.08	1259.71 +1259.7 1*0.08	1360.49 + 1360.49 *0.08	1469.32 + 1469.32 *0.08	$FV_n = PV_0(1+r)^n$

The Time Value of Money Recap

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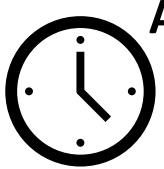
But what if you want to make more than 8%?
Maybe we decide to invest in something…

Think about benefit and costs on a national level, still need to discount

How much return will you get in the future, and what does that benefit look like in today's money.

This is otherwise known as the **DISCOUNT RATE.**

Any future benefit must be discounted back to today's value.



Calculating the Discount factor

The real opportunity cost of capital has been calculated using a version of the tax-adjusted capital asset pricing model (CAPM). The formula is as follows[3]:

WACC[4] (real) = [(1 + WACCn) / (1 + i)] -1

Where:

WACCn = [RFR x (1 -Tc) + (Ep x β_a)] / (1 - Te)

WACCn is the nominal weighted average cost of capital and β_a is the asset beta[5]. The other variables and their assumed values are as follows:

Tc (corporate tax rate) = 30%

Te (effective tax rate) = 20%

Ep (equity risk premium) = 7%

RFR (risk free rate) = 6.4%

i (inflation rate) = 3%

The derived values for WACC (real) are:

β_a (asset beta)	WACC (real)[6]	Applications
0.42	6.0%	Buildings
0.67	8.0%	Default
0.65	8.0%	Infrastructure
0.82	9.5%	Technology

The Discount rate at the Government level represents an opportunity cost

A lot goes into calculating these discount factors see how the treasury has determined public sector discount rates here. You don't need to worry about calculating this in systems, simply use an appropriate rate found here (4-6% common)

Public Sector discount rates

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Category	Rate
Default rate (for projects that are difficult to categorise including regulatory proposals, and most social sector projects):	5.0% p.a.
General purpose office and accommodation buildings	5.0% p.a.
Infrastructure and special purpose (single-use) buildings: • Water and energy • Prisons • Hospitals • Hospital energy plants • Road and other transport projects	5.0% p.a.
Telecommunications, media and technology , IT and equipment, Knowledge economy (R&D)	6.0% p.a.

Economic Metrics

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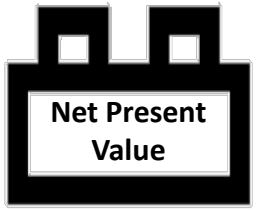
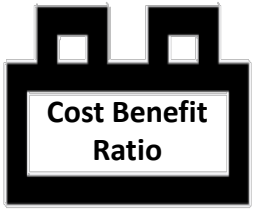
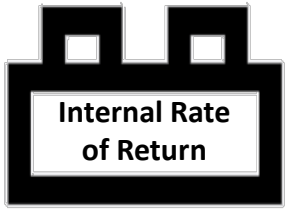
Now you understand discount rates, can calculate some economic metrics to judge the economic viability of your solutions.



The difference between the present value of benefits and costs



The ratio of present costs to benefits



The rate of return for a project at NPV=0

Used to make informed decisions

Economic Metrics

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The Net Present value:

$$\mathrm{NPV} = \left(\sum_{n=1}^{n} \frac{Undiscounted\ Benfit - Undiscounted\ Cost}{(1+r)^n}\right)$$

r = discount rate
n = time period

NPV>0 – Accept project
NPV<0 – Reject project

Cost Benefit Ratio:

$$\mathrm{CBR} = \frac{PV_{benefits}}{PV_{total\ cost}}$$

Cannot use one of these in isolation to determine go/No-go

CBR>1: Accept project
CBR<1: Reject project

Modified Internal Rate of Return:

$$0 = \left(\sum_{n=1}^{n} \frac{Undiscounted\ Benfit - Undiscounted\ Cost}{(1+r)^n}\right)$$

IRR>0 – Accept project
IRR<0 – Reject project

Economic Metrics Recap

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The Net Present value:

- Avoid double counting of benefits and costs

Cost Benefit Ratio:

Negative costs and dis-benefits

- Cost savings are a benefit (not to be subtracted from costs)
- Dis-benefits are a cost (not to be subtracted from benefits)

Modified Internal Rate of Return:

- Uses a Reinvestment rate
- Assumed to be () will be built into model

Step 6. Assess the CBA

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Is it worth pursuing the cost benefit analysis?

- Can be back of the envelope or very involved-research that can cost over $1 million.
- A mini-CBA of the CBA should be carried out
- Is proportional to the size of the project.
- Value of carrying out the CBA must **NOT** exceed the potential value of the project.
- Who carries it out?
    - Policy advisors – Treasury, consultants
    - Decision makers (Government)
        - Often lack the capability thus seek externally

Step 7. Write the Report

How should these values be presented?

- Use a summary cost benefits table. (refer to pg 41: *Guide to social cost benefit analysis*).
- Use a summary economic metrics table.
- Should have ranges or confidence intervals rather than point estimates (in practice)
- Appropriate accuracy. NOT to the nearest dollar!
    - Tens of thousands? Hundreds of thousands Millions?
- If monetary costs outweigh monetary benefits but there are large intangible benefits, this MUST be highlighted to the reader in the summary.
- Should provide the intuition behind the result (tone, feeling).
- Sources and assumptions must be reported.

Marine Parade Redevelopment

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Cost/benefits summary table– Marine Parade redevelopment

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Table 1: Short-listed options

$millions	Short-listed Options			
	Option 1 -Status Quo Marineland vacant	Option 1a -Status Quo Marineland with Animals	Options 2 & 3	Option 6 - Preferred Way Forward
Analysis period (Years)	30	30	30	30
Capital costs	$0.50	$0.50	$5.17	$7.24
Whole of life costs	$3.32	$17.18	$11.07	$14.58
Cost Benefit Analysis				
Net Present Value benefits	$2.12	$2.18	$2.12	$4.39
Net Present Value costs	$1.38	$7.09	$6.59	$8.83
Overall NPV for project	$0.74	-$4.92	-$4.47	-$4.43
Value of construction activity to economy	$1.50	$1.50	$15.52	$21.73

Assumptions – Marine Parade Redevelopment

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- Costs and revenues have been inflated at 2% p.a.
- Capital costs include the initial capital investment for new developments plus any asset renewal requirements for all options. An annual allowance of $20,000 has been allowed for new skate ramps and facilities;
- Depreciation has been estimated based on an assessment of the economic lives of assets as outlined in the project cost estimates. Asset lives range from 10 years for equipment and pumps, to 50 years for hard landscaping, buildings and permanent structures;
- Operational costs have been included for existing facilities and an allowance has been made for the cost of new facilities based on data obtained from Council officers and the Napier Skating Trust. While some estimates may take the lower end of a possible range, costs for the operation of similar facilities such as the water play area at the Napier Aquatic Centre have been used wherever possible;
- An allowance has been made for enhanced revenue for the lease of the upgraded facilities. This may be a combination of revenue from commercial tenants or from a community group, in which case the revenue represents the opportunity cost or potential subsidy provided through discounted rent;
- At this stage it is assumed that any new facilities will be operated by the Council rather than external entities. Therefore indicative ROC and revenues are included for options (except Option 1 - status quo which has a contract with an external party). This may be reviewed once the detailed design is complete; however modelling of an internally operated facility allows for the greatest transparency in cost allocation;
- Allowance may be made for replacing 92 car parking spaces within the CBD at a cost of $1.15m, depending on the outcome of the NCC Parking Review. No allowance has been included for revenue from the potential changes to carpark locations or maintenance costs, which is a conservative view given the more attractive location of the proposed CBD car parks. Based on data from the Council's existing facilities, the projected revenues should exceed the annual maintenance costs;

All assumptions for both the general analysis and financial analysis should be listed!

Limitations of the Cost Benefit Analysis

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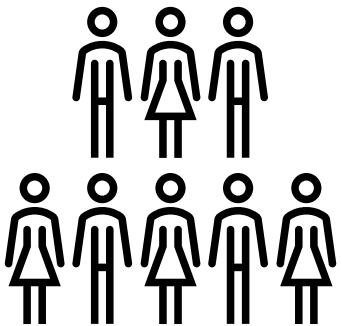
- Benefits can be difficult to monetise (more on this next week).
- Gives money terms to things that different people may value differently e.g. equity. These should be highlighted to decision makers.
- Costs and benefits can be hard to measure, especially intangibles and social considerations (Reza's lecture tomorrow).
- Assumes perfect competition.
- Based on uncertain forecasts.
- Are the assumptions valid?



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