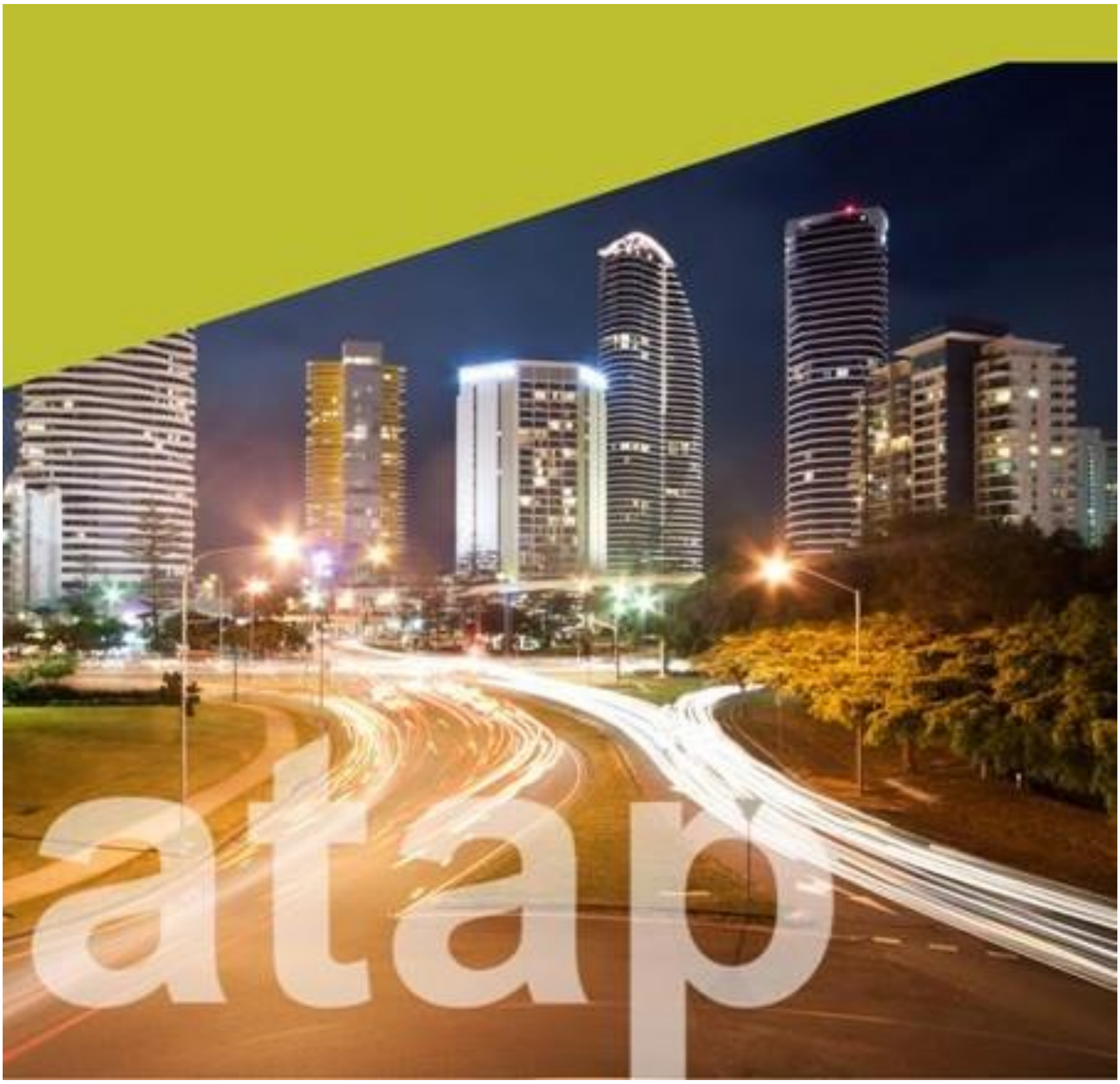
INFRASTRUCTURE AND TRANSPORT MINISTERS

Australian Transport Assessment and Planning Guidelines

Worked Example: W3 Freight Rail
3.1 A dedicated urban freight railway

August 2021



ISBN 978-1-922521-36-1

August 2021

The contributions of the following people in the development of this report are acknowledged:

Cardno: Andrew Malowiecki

ATAP project team: Mark Harvey, Paul Stanley, Peter Tisato

Reviewers of drafts

Members of the ATAP Steering Committee: Mark Harvey, Andreas Bleich, Belinda Sachse and Paula Stagg (Australian Government), Atiqur Rahman, Paul Stanley and David Tucker (Infrastructure Australia), Alban Pinz (QLD), Robert Smith and Matthew Jones (NSW), Justinieta Balberona (ACT), Ed McGeehan (VIC), Arun Kendall (TAS), Scott Cooper and Aaron Bell (SA), Des Lock (WA), Brett Clifford (NT), Sandy Fong (NZ), Richard Delplace (Austroads), Peter Tisato (Technical Coordinator).

Contact us

This publication was prepared by the Australian Transport Assessment and Planning (ATAP) Steering Committee and approved by the Transport and Infrastructure Senior Officials' Committee. The Committees cannot accept responsibility for any consequences arising from the use of this information. Readers should rely on their own skill and judgment when applying any information or analysis to particular issues or circumstances.

ATAP Steering Committee Secretariat

Australian Transport Assessment and Planning Guidelines

Department of Infrastructure, Transport, Regional Development and Communications

GPO Box 594

Canberra ACT 2601

Australia

Email: atap@infrastructure.gov.au

Website: atap.gov.au

Contents

Figures

Tables

1. Problem description

Increasing urban congestion and especially in port precincts and the corridors to ‘off-port’ (inland intermodal terminals) substantially increase land-based logistics costs in the Australian economy for exporters and importers, manufacturers and consumers. Generally, rail is uncompetitive with road over very short distances and lacks the flexibility to offer direct door-to-door services. However, road-based hauls are increasingly compromised by urban traffic congestion and contribute significantly to congestion problems in particular precincts at particular times of the day.

One rail solution is to use shuttle trains connecting ports with inland terminals and using these inland hubs as the points of pick-up and delivery for a door-to-door service. The service is not as seamless as the single truck-based solution but has some appeal — it reduces road congestion generally and at the port, decreases the amount of on-street truck parking at the port as loads are waiting to be processed, and takes some heavy transport off urban streets. There are some older underutilised rail lines connecting many of the inland terminals with the port, but signalling and other track improvements must be made to bring them up to an operationally and commercially acceptable standard.

Upgrading such rail corridors may arrest (or perhaps reverse) the decline in rail mode share by offering an improved price-service package. This can be achieved in several ways:

- Improved signalling etc. in selected areas can allow reduced headways and improve corridor operations, resulting in reduced train operating cost.
- Improved infrastructure can improve productivity and efficiency and provide capacity for future growth if required.
- Improved alignments can give better train operating performance potentially improving transit times, reducing damage or product deterioration and improving service quality.

Resulting transfers of freight from road to rail can ease pressure on the road system and potentially reduce road maintenance costs. There can also be gains in terms of improved road safety and reduced environmental externalities.

A worked example of such a situation is considered here. The example assesses the merits of a generic proposal to upgrade an underutilised rail line running through an urban area, resulting in a shift of short–haul freight traffic from road to rail.

For this worked example, it is assumed an existing railway is about 30 kilometres in length from port to the preferred inland terminal. To illustrate the mode shift effect, it is assumed a parallel road is adjacent to the rail corridor and is of similar length.

Please note that this is a simplified worked example to illustrate the application of cost-benefit analysis in a rail freight context. Specific projects will have their own complexities, requiring a fuller assessment of potential benefits and costs, and will require more sophisticated modelling.

2. Options

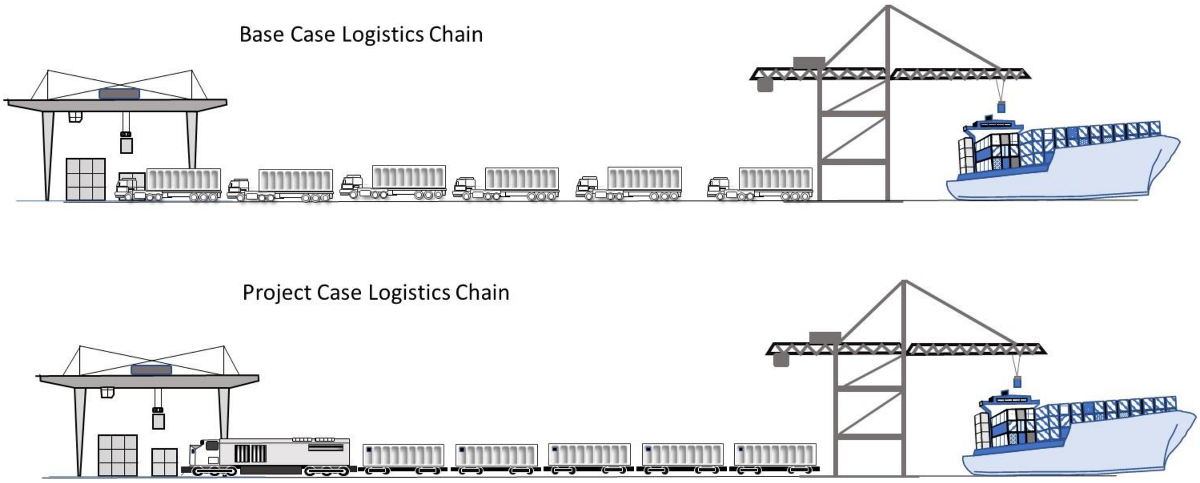
This example examines a single Project Case option compared to the Base Case. For simplicity, it is assumed the freight task in question is 45,000 Twenty Foot Equivalent (TEU) containers annually in each direction. It is assumed there are balanced empty and loaded movements. For simplicity in calculation, and reflecting a long–term move to Forty Foot Equivalent Units (FEUs), the worked example assesses the task in terms of FEUs (rather than TEUs). Thus, the active task in year 1 is 22,500 FEU in each direction. This simplifies calculations because a single FEU is the standard load for a “double slot” container wagon.

The existing arrangements are for road movements from port to an inland hub where the product is either packed or unpacked on-site or transhipped to road for a full door-to-door service involving a pick-up or delivery leg.

The leg between port and terminal is undertaken by road in the Base Case, but switches to being performed by rail in the Project Case.

The logistics options are depicted in Figure 1 below.

Figure 1: Alternative Logistics Chains



Base Case

Do Minimum: The Base Case involves retention of the trucks (six-axle semi-trailers) travelling between port and hub. This will: require expenditure for road repairs; consume critical road capacity (especially during urban peaks) adding to road congestion; and have higher levels of environmental externality and road safety impacts than a rail–based operation.

The branchline will be maintained to its current state without any improvement to the infrastructure and operations. The branchline typically still supports longer hauls — usually over 300 kilometres direct to or from the port. The branchline components such as steel or concrete sleepers, rails and ballast are fit for purpose and are sustainable with conventional maintenance long into the future.[1] There is neither the physical space for significant realignment nor a market need given the few advantages to be gained over such short hauls.

Project Case Option

Urban Freight Line Upgrade: The improvements will consist of some re-rail and re-sleeper work, reinforcement or replacement of multiple culverts, and improved level crossing safety plus major signalling upgrades.

[1] Some of the longer hauls may require rail and track components to be of a higher standard, and this would need to be accounted for in a more detailed assessment.

3. Benefits and costs

Table 1 lists the benefits and costs that have been monetised in this worked example.

Table 1: Monetised benefits and costs

	Monetised
Benefits	
Transport cost savings.	✓
Reduced urban traffic congestion	✓
Environmental externality benefit	✓
Reduced road accidents	✓
Reduced road maintenance	✓
Residual Value	✓
Costs	
Construction costs	✓
Operating and maintenance costs	✓

A more advanced assessment would consider several other items: potentially improved rail rollingstock productivity; net change in road and rail revenue. The increase in rail revenue is more than likely offset by the decrease in truck revenue. The revenue streams are considered to be based on a mark-up on operating costs. In a comprehensive assessment both revenues from both modes should be modelled.

4. Inputs and assumptions

4.1 General

Base year and price year: December 2018. This price year is used so that there is a direct link to the parameter values in ATAP M3.

Real discount rate: 7% for main central analysis, 4% and 10% for sensitivity tests

Construction period: To simplify calculations, the construction phase has been compressed into a single year, 2019. The improved rail line is fully operational by the start of 2020.

Appraisal period: 51 years, consisting of one-year construction and 50 years post construction (recommended in ATAP T2 for rail projects).

Investment cost: The capital costs are $35 million in the Project Case, and $2 million in the Base Case. The Project Case includes no associated road upgrades whereas the Base Case assumes some road upgrades.

Asset (economic) life: Table 2 lists the assets involved in the Base Case and Project Case. The table also shows the estimated economic life of each asset. The economic life of various components is sourced from ATAP M3 TABLE 24. In the Base Case, the economic life of the road assets is shorter than the appraisal period, requiring the road assets to be reinvested at the end of their economic life in year 25.

Table 2: Capital cost ($m)

Item	Cost $m	Economic life (years)	% life remaining at end of appraisal period	Residual value, $m
Base Case				
Road Works	2	25	0%	–
Total	2			–
Project Case				
Trackwork	10	75	33%	3.3
Culverts and structures	10	100	50%	5.0
Signalling and safety	15	50	0%	–
Total	35			8.3

Reinvestment: The economic life of some of the rail asset components exceed the appraisal period, As a result, there will be a residual value, to be included in the last year of the appraisal period.

Residual value methodology: Straight line depreciation method using the following formula:

$$\text{Residual Value (Straight Line Depreciation)} = \text{Capital cost} \times \frac{\text{Asset Life Remaining After Appraisal Period}}{\text{Asset Life}}$$

See ATAP T2, SECTION 3.3 for a general discussion on residual value methods.

Table 2 shows the calculation of residual value.

Growth rate: For simplicity, it is assumed the annual volume of containers to be transported is growing at a constant 2% per year. This is broadly in line with long–term estimates and is consistent with population drivers.

4.2 Logistics simulation

Very sophisticated applications may require specific modelling software, e.g. discrete event simulation but for most cases a simple spreadsheet-based model is sufficient (as with this worked example). The purpose in modelling is to understand the resource requirements.

Import-export (IMEX) containers are year-round markets although there are short-term spikes associated with particular events and market segments, e.g. retail in the build-up to Christmas, seasonal agricultural products. For simplicity, it is assumed traffic volumes are constant all year round. For rail, the task involves 900 trains per year (3 per day x 300 days), each with 25 FEU containers in each direction. This equates to 22,500 semi-trailers with 1 FEU container each or about 75 trucks per day in each direction.

Note that high productivity vehicles (HPVs) may increasingly be used, requiring fewer truck movements for the same FEUs. However, HPVs are restricted on many metro road networks.

Table 3 summarises the key operational inputs for the current example.

Table 3: Logistics supply chain summary

Item	Base Case	Project Case
Transport mode	Truck	Rail
Freight task:		
FEU containers per year	22,500	22,500
Payload per FEU: tonnes	22	22
Total payload: tonnes per year	495,000	495,000
Truck round trips per year	22,500	
Payload per truck: tonnes	22	
Payload per train: tonnes		550
Trains per year		900
Terminal time per round trip	0.5	6
Line haul time per round trip	2.5	1.33
Operating hours per year (terminal + line haul)	67,500	6,600
Operating km per year	1,350,000	54,000
Wagon km per year		1,350,000
NTK per year	14,850,000	14,850,000
GTK per year	42,525,000	49,005,000

4.3 Base Case

Transport **cost per truck trip**

Freight cost per truck trip is calculated by applying the unit time and vehicle operating costs for six-axle semi-trailers from ATAP PV2 **t**o the trip time and distance figures in **Table 3**. The unit costs used are: $51.70 per hour for time cost; $1.20 per truck-km vehicle operating cost. The cost is then annualised based on the number of truck-kms.

4.4 Project Case

Transport cost per train trip

Rail transport costs are calculated by combining the key statistics in **Table 3** with the parameter values in **Table 4**.

Table 4: Summary of rail parameter values

Parameter	Value ($)	Unit	Source	Comment
Locomotive fuel	7.8	per km	M3 Table 26	Standard 3000hp locomotive on flat terrain
Locomotive crew	300	per working hour	M3 Table 24	Adjustment for 2 crew urban only
Locomotive capital cost	670,000	per year	M3 Table 22	Standard 3000hp at 7%
Locomotive Servicing	1.3	per km	M3 Table 28	For running component
Locomotive Servicing	20	per hour	M3 Table 28	For time based component
Wagon capital cost	13,000	per year	M3 Table 23	Double slot container wagon at 7%
Wagon maintenance	70	per 000km	M3 Table 29	Container flat
Overhead	15%		M3 Table 33	Adjusted for just transport costs
Variable track maintenance	2	per 000 GTK	M3 Table 31	Medium range
Routine track maintenance	25,000	per track km pa	M3 Table 30	Secondary line low use

Table 5 summarises the resulting rail transport costs in the Project Case on a per train basis.

Table 5: Estimated train operations costs

Item	Forward Loaded	Return (Empty)	Round Trip
Fuel	234	234	468
Crew	1,100	1,100	2,200
Locomotive Servicing	112	112	225
Wagon Servicing	94	94	188
Locomotive Capital	372	372	744
Wagon Capital	45	45	90
Overhead	196	196	391
Cost per train	2,153	2,153	4,306

The variable track component has been removed from the train operating cost model and is placed within the overall operations and maintenance category. This slightly complicates the calculations going forward if a growth factor is included, but provides for greater transparency in comparing the transport cost of different modes.

Road congestion reduction

The switch of this container traffic from road to rail results in reduction in urban road congestion. The congestion reduction benefit is estimated by applying the marginal cost of congestion (MCC) estimated by TfNSW (2018). Table 21 of TfNSW (2018) reports MCC for various road types for Sydney. The values to use for a given city will depend on the various road types travelled from inland hub to port. For this worked example, a figure of MCC = 15 cents per PCU-km is used, where PCU stands for passenger car unit. This figure is the average value for freeway and outer arterial from TfNSW (2018). A semi-trailer is equivalent to 5 PCUs, so the MCC for a semi-trailer is 15 x 5 = 75 cents per truck-km.

Environmental benefit

The switch of this container traffic from road to rail also results in reduction in environmental externality costs. The pending update of ATAP PV5 reports the environmental externality costs of urban freight transport as follows: truck (HCV) $33 per 1000 tonne-kms; rail $16 per 1000 tonne-kms. A switch of this freight task from road to rail will therefore result in a reduction of external environmental impacts of $17 per 1000 tonne-kms travelled.

It is noted that some noise impacts of rail movements in metropolitan areas would produce negative outcomes that counteract these benefits.

Road safety benefit

The reduction in heavy vehicle movements will produce a reduction in road safety incidents. The safety benefits are based on a road crash cost of $87,000 per million vehicle-kms travelled (TfNSW, 2018, Table 60).

5. Benefit and cost time streams

Annual benefit and cost time streams are shown in **Figure 2** to **Figure 4** and **Table 6**.

Figure 2 Total benefits time stream

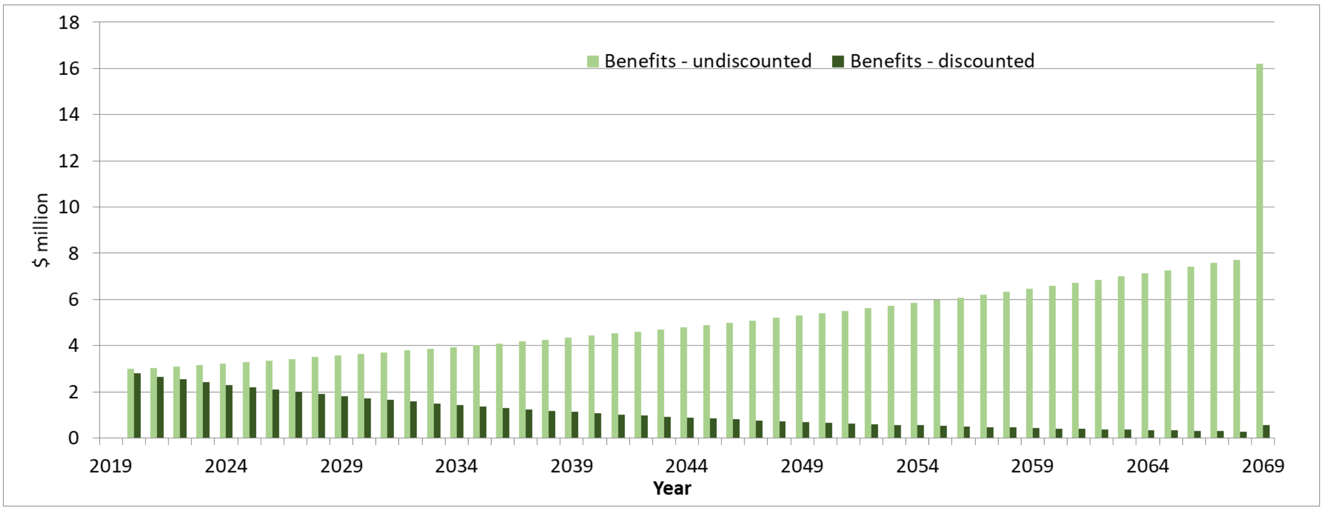


Figure 3 Total cost time streams

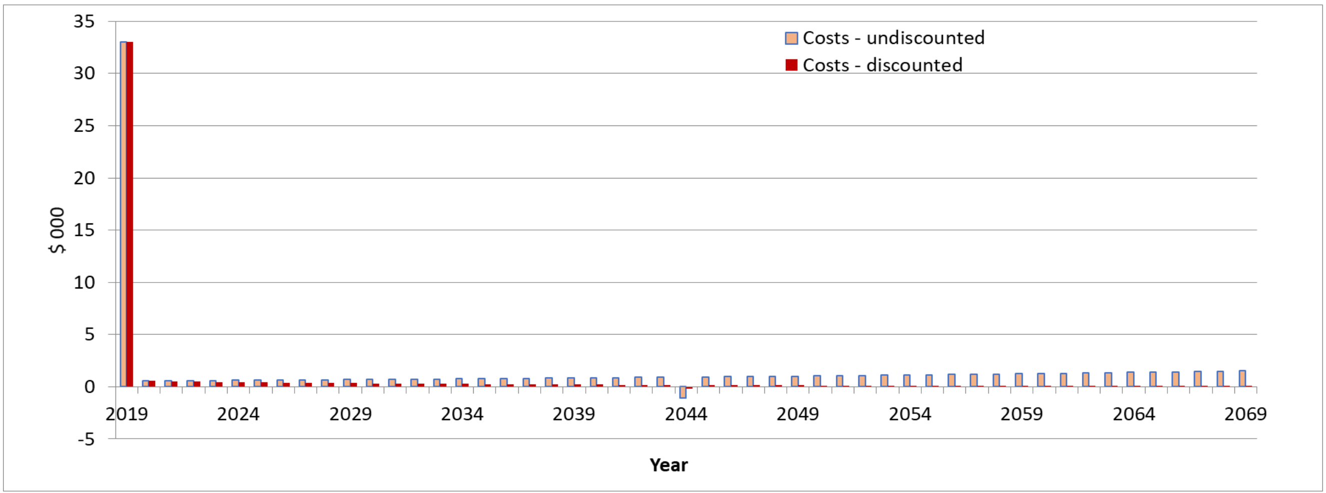


Figure 4 Cumulative discounted net benefit time stream

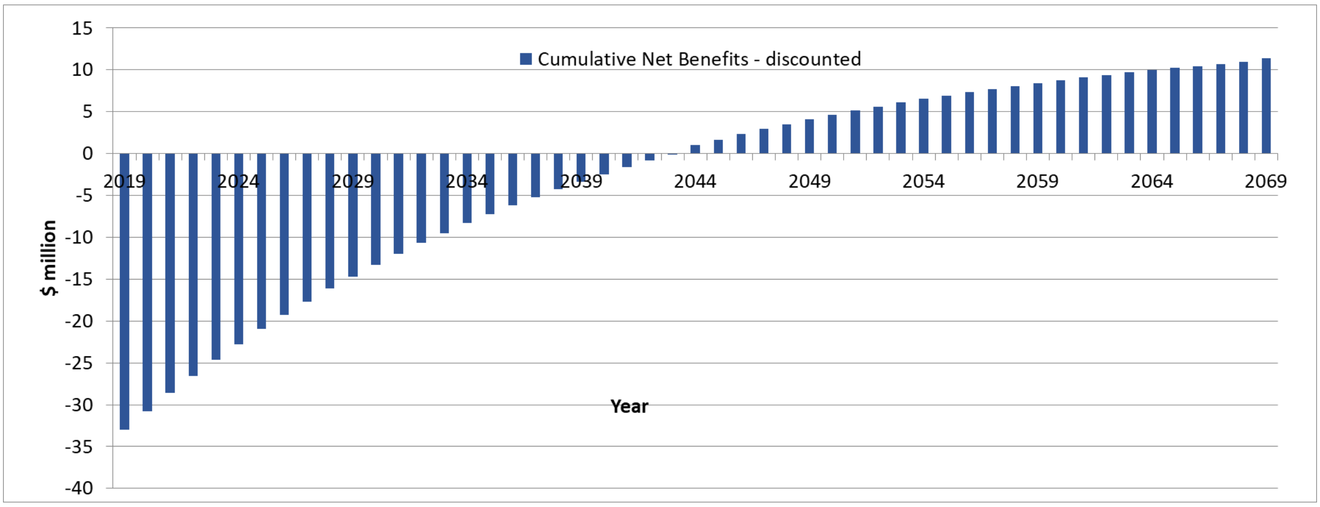


Table 6: Undiscounted benefit and cost time streams ($000)

Year		Base Case	Project Case	Change	Base Case	Project Case	Change	Total cost change	Freight Cost Savings	Congestion Cost Savings	Environmental Externality Benefits	Safety Benefits	Residual Value	Total Benefits	Net Benefit (Benefits - Cost)
0	2019	2	35	33	0.00	0.00	0.00	33.00	0.00	0.00	0.00	0.00	0.00	0.00	-33.00
1	2020				0.26	0.85	0.59	0.59	1.23	1.01	0.62	0.12	0.00	2.98	2.39
2	2021				0.27	0.85	0.59	0.59	1.26	1.03	0.63	0.12	0.00	3.04	2.46
3	2022				0.27	0.87	0.60	0.60	1.28	1.05	0.64	0.12	0.00	3.10	2.51
4	2023				0.28	0.89	0.61	0.61	1.31	1.07	0.66	0.12	0.00	3.17	2.56
5	2024				0.28	0.90	0.62	0.62	1.34	1.10	0.67	0.13	0.00	3.23	2.61
6	2025				0.29	0.92	0.63	0.63	1.36	1.12	0.68	0.13	0.00	3.29	2.66
7	2026				0.29	0.94	0.65	0.65	1.39	1.14	0.70	0.13	0.00	3.36	2.71
8	2027				0.30	0.96	0.66	0.66	1.42	1.16	0.71	0.13	0.00	3.43	2.77
9	2028				0.31	0.98	0.67	0.67	1.45	1.19	0.73	0.14	0.00	3.50	2.82
10	2029				0.31	1.00	0.69	0.69	1.47	1.21	0.74	0.14	0.00	3.57	2.88
11	2030				0.32	1.02	0.70	0.70	1.50	1.23	0.75	0.14	0.00	3.64	2.94
12	2031				0.33	1.04	0.71	0.71	1.53	1.26	0.77	0.15	0.00	3.71	3.00
13	2032				0.33	1.06	0.73	0.73	1.57	1.28	0.79	0.15	0.00	3.78	3.06
14	2033				0.34	1.08	0.74	0.74	1.60	1.31	0.80	0.15	0.00	3.86	3.12
15	2034				0.35	1.10	0.76	0.76	1.63	1.34	0.82	0.15	0.00	3.94	3.18
16	2035				0.35	1.12	0.77	0.77	1.66	1.36	0.83	0.16	0.00	4.02	3.24
17	2036				0.36	1.15	0.79	0.79	1.69	1.39	0.85	0.16	0.00	4.10	3.31
18	2037				0.37	1.17	0.80	0.80	1.73	1.42	0.87	0.16	0.00	4.18	3.37
19	2038				0.37	1.19	0.82	0.82	1.76	1.45	0.88	0.17	0.00	4.26	3.44
20	2039				0.38	1.22	0.84	0.84	1.80	1.48	0.90	0.17	0.00	4.35	3.51
21	2040				0.39	1.24	0.85	0.85	1.83	1.50	0.92	0.17	0.00	4.43	3.58
22	2041				0.40	1.27	0.87	0.87	1.87	1.53	0.94	0.18	0.00	4.52	3.65
23	2042				0.40	1.29	0.89	0.89	1.91	1.57	0.96	0.18	0.00	4.61	3.73
24	2043				0.41	1.32	0.90	0.90	1.95	1.60	0.98	0.19	0.00	4.70	3.80
25	2044	2		-2	0.42	1.34	0.92	-1.08	1.98	1.63	1.00	0.19	0.00	4.80	5.88
26	2045				0.43	1.37	0.94	0.94	2.02	1.66	1.02	0.19	0.00	4.89	3.95
27	2046				0.44	1.40	0.96	0.96	2.07	1.69	1.04	0.20	0.00	4.99	4.03
28	2047				0.45	1.43	0.98	0.98	2.11	1.73	1.06	0.20	0.00	5.09	4.11
29	2048				0.46	1.45	1.00	1.00	2.15	1.76	1.08	0.20	0.00	5.19	4.20
30	2049				0.46	1.48	1.02	1.02	2.19	1.80	1.10	0.21	0.00	5.30	4.28
31	2050				0.47	1.51	1.04	1.04	2.24	1.83	1.12	0.21	0.00	5.40	4.36
32	2051				0.48	1.54	1.06	1.06	2.28	1.87	1.14	0.22	0.00	5.51	4.45

Worked Example: W3 Freight Rail: 3.1 A dedicated urban freight railway

Year		Base Case	Project Case	Change	Base Case	Project Case	Change	Total cost change	Freight Cost Savings	Congestion Cost Savings	Environmental Externality Benefits	Safety Benefits	Residual Value	Total Benefits	Net Benefit (Benefits - Cost)
33	2052				0.49	1.57	1.08	1.08	2.33	1.91	1.17	0.22	0.00	5.62	4.54
34	2053				0.50	1.61	1.10	1.10	2.37	1.95	1.19	0.23	0.00	5.73	4.63
35	2054				0.51	1.64	1.12	1.12	2.42	1.99	1.21	0.23	0.00	5.85	4.72
36	2055				0.52	1.67	1.15	1.15	2.47	2.02	1.24	0.23	0.00	5.97	4.82
37	2056				0.53	1.70	1.17	1.17	2.52	2.07	1.26	0.24	0.00	6.09	4.92
38	2057				0.54	1.74	1.19	1.19	2.57	2.11	1.29	0.24	0.00	6.21	5.01
39	2058				0.56	1.77	1.22	1.22	2.62	2.15	1.31	0.25	0.00	6.33	5.11
40	2059				0.57	1.81	1.24	1.24	2.67	2.19	1.34	0.25	0.00	6.46	5.22
41	2060				0.58	1.84	1.27	1.27	2.72	2.24	1.37	0.26	0.00	6.59	5.32
42	2061				0.59	1.88	1.29	1.29	2.78	2.28	1.39	0.26	0.00	6.72	5.43
43	2062				0.60	1.92	1.32	1.32	2.83	2.33	1.42	0.27	0.00	6.85	5.54
44	2063				0.61	1.96	1.34	1.34	2.89	2.37	1.45	0.28	0.00	6.99	5.65
45	2064				0.63	2.00	1.37	1.37	2.95	2.42	1.48	0.28	0.00	7.13	5.76
46	2065				0.64	2.04	1.40	1.40	3.01	2.47	1.51	0.29	0.00	7.27	5.87
47	2066				0.65	2.08	1.43	1.43	3.07	2.52	1.54	0.29	0.00	7.42	5.99
48	2067				0.66	2.12	1.45	1.45	3.13	2.57	1.57	0.30	0.00	7.57	6.11
49	2068				0.68	2.16	1.48	1.48	3.19	2.62	1.60	0.30	0.00	7.72	6.23
50	2069				0.69	2.20	1.51	1.51	3.26	2.67	1.63	0.31	8.33	16.21	14.69

6. Results summary

Table 7: Benefit and cost results – Central assessment (7% discount rate, input value best estimates)

	Present Value $m
Benefits	
Transport cost savings	22.43
Road congestion cost savings	18.4
Environmental externality benefits	11.25
Safety benefits	2.13
Residual value	0.28
Costs	
Construction costs	32.63
Maintenance and operating costs	10.44
Results	
PVB	54.5
PVOC	10.44
PVIC	32.63
PVC = PVIC + PVOC	43.07
NPV = PVB – PVC	11.42
BCR1 = PVB / PVC	1.27
BCR2 = (PVB – PVOC) / PVIC	1.35
FYRR	7%
Break Even Year	25
EIRR	9%

Table Notes:

1. All benefit and cost components are calculated as the incremental change between Base Case and Project (Option) Case.
2. PV stands for present value; PVB is the PV of economic, social and environmental benefits, includes residual value, and excludes operating and maintenance costs; PVOC is the PV of operating and maintenance costs; PVIC is the PV of investment (i.e. capital) costs.
3. BCR definitions: BCR1 and BCR2 are both used by Australian jurisdictions – see ATAP Part T2 section 10. BCR2 is equivalent to NPVI (the index of investment efficiency) minus 1.
4. The breakeven year is the year in which the sum of the annual discounted benefits becomes equal to the sum of the discounted costs. After that year, the former starts to exceed the latter.

Table 8: Sensitivity testing results

Sensitivity Test	PVB ($m)	PVIC ($m)	PVOC ($m)	NPV ($m)	BCR1	BCR2	FYRR
Central assessment (7% discount rate, input value best estimates)	54.5	32.6	10.4	11.4	1.27	1.35	7%
4% discount rate	93.8	32.2	17.8	43.8	1.87	2.36	7%
10% discount rate	36.5	32.8	7.0	-3.3	0.92	0.90	7%
+20% capital cost	54.6	39.2	10.4	5.0	1.10	1.13	6%
- 20% capital cost	54.4	26.1	10.4	17.9	1.49	1.69	9%
+20% benefits	65.4	32.6	10.4	22.3	1.52	1.68	9%
-20% benefits	43.6	32.6	10.4	0.5	1.01	1.02	5%
+20% volume	65.3	32.6	10.4	22.3	1.52	1.68	9%
-20% volume	43.7	32.6	10.4	0.6	1.01	1.02	5%
+20% transport cost savings	59.0	32.6	10.4	15.9	1.37	1.49	8%
-20% transport cost savings	50.0	32.6	10.4	6.9	1.16	1.21	6%
+20% congestion savings	58.2	32.6	10.4	15.1	1.35	1.46	8%
-20% congestion savings	50.8	32.6	10.4	7.7	1.18	1.24	7%
+20% externality savings	56.7	32.6	10.4	13.7	1.32	1.42	8%
-20% externality savings	52.2	32.6	10.4	9.2	1.21	1.28	7%
+20% operations & maintenance	58.7	32.6	12.5	13.5	1.30	1.41	8%
-20% operations & maintenance	50.3	32.6	8.4	9.3	1.23	1.29	7%
Worst Case	38.1	42.4	13.6	-17.8	0.68	0.58	3%

Note: The worst case scenario is based on costs increasing by 30% and benefits decreasing by 30%.

7. Results discussion

The results in Table 7 and Table 8 show the initiative:

- Is economically justified (NPV>0, BCR>1) in the central analysis (7% discount rate and best estimates for input values), with an NPV of $55 million and a BCR of around 1.3
- Is economically justified in most of the sensitivity cases, except the following cases: 10% discount rate; worst case
- The worst case has a BCR of around 0.6 to 0.7.

Based on the above results, the initiative in this worked example could be seen as having an economic justification. Close attention would need to be paid to refining the benefit and cost estimates to check the viability of the initiative as the funding decision approaches.

It is important to stress again that this is a simplified worked example, so general conclusions about this type of project should not be drawn from the results here.

8. Supporting formulas and calculations

Base Case	Project Case
Truck	Rail
FEU containers per truck = 1 Payload per container = 22 tonnes (t) Payload per truck = 22 t Trucks per year = 22,500 Net tonnes per year = 22,500 x 22 = 495,000 t	Wagons per train = 25 FEU containers per wagon = 1 Payload per container = 22 t Payload per train = 25 x 22 = 550 t 3 trains per day, 6 days per week, 50 weeks per year Trains per year = 3 x 6 x 50 = 900 Net tonnes per year = 550 x 900 = 495,000 t
Tare: 1 truck @ 16 t (prime mover & semi-trailer); 1 container @ 4.5 t Total tare per truck = 16 + 4.5 = 20.5 t Gross mass (to) = 20.5 + 22 = 42.5 t per truck Gross mass (return) = 20.5 t per truck Gross mass (round trip) = 42.5 + 20.5 = 63 t per truck Trip length (one-way) = 30 kms Net tonne kms (NTK) = 495,000 x 30 = 14,850,000 Gross tonne kms (GTK) = 63 x 22,500 x 30 = 42,525,000	Tare: 1 loco @ 120t; 25 wagons @ 16 t = 400 t; 25 FEU containers @ 4.5 t = 113 t Total tare per train = 120 + 400 + 113 = 633 t Gross mass (to) = 633 + 550 = 1,183 t per train Gross mass (return) = 633 t per train Gross mass (round trip) = 1,183 + 633 = 1,815 t per train Trip length (one-way) = 30 kms Net tonne kms (NTK) = 495,000 x 30 = 14,850,000 Gross tonne kms (GTK) = 1,815 x 900 x 30 = 49,005,000
Statistics per round trip: Terminal time = 0.5 hrs Line haul time = 2.5 hrs Total time = 0.5 + 2.5 = 3 hrs Unit time cost = $51.70 per truck-hr Time cost = 3 x 51.70 = $155.10 Distance travelled = 30 x 2 = 60 kms Unit vehicle operating cost = $1.20 per truck-km Vehicle operating cost = 60 x 1.20 = $72 Annual truck round trips = 22,500 Annual time cost = 155.1 x 22,500 = $3.49 m Annual vehicle operating cost = 72 x 22,500 = $1.62m Total cost = 3.49 + 1.62 = $5.11m	Statistics per round trip: Terminal time = 6 hrs Line haul time = 1.33 hrs Total time = 6 + 1.33 = 7.33 hrs Cost components – see Tables 4 and 5 Total cost per train = $4,306 (Table 5) Annual train round trips = 900 Annual train costs = 4,306 x 900 = $3.88m

Detailed benefit calculations are illustrated below for year 2020 (drawing on data in the tables above):

- Transport cost saving = road transport cost – rail transport cost
  = 5.11 – 3.88 = $1.23 million
- Road congestion cost reduction = marginal congestion cost x annual truck-kms
  = 0.75 x 1,350,000 = $1.01 million
- Environmental benefit = environmental cost by road – environmental cost by rail
  where environmental cost = unit environmental cost x annual gross tonne-kms = 0.17 x 1,350,000.
  Road environmental cost = 33 x 42,525,000/1000 = $1.40 million
  Rail environmental cost = 16 x 49,005,000/1000 = $0.78 million.
  So, environmental benefit = 1.40 – 0.78 = $0.62 million

- Road safety benefits = unit crash cost x annual truck-kms
  = 87,000/1,000,000 x 1,350,000 = $0.12 million

References

TfNSW 2018, *Principles and guidelines for economic appraisal of transport investment and initiatives*

INFRASTRUCTURE AND
TRANSPORT MINISTERS