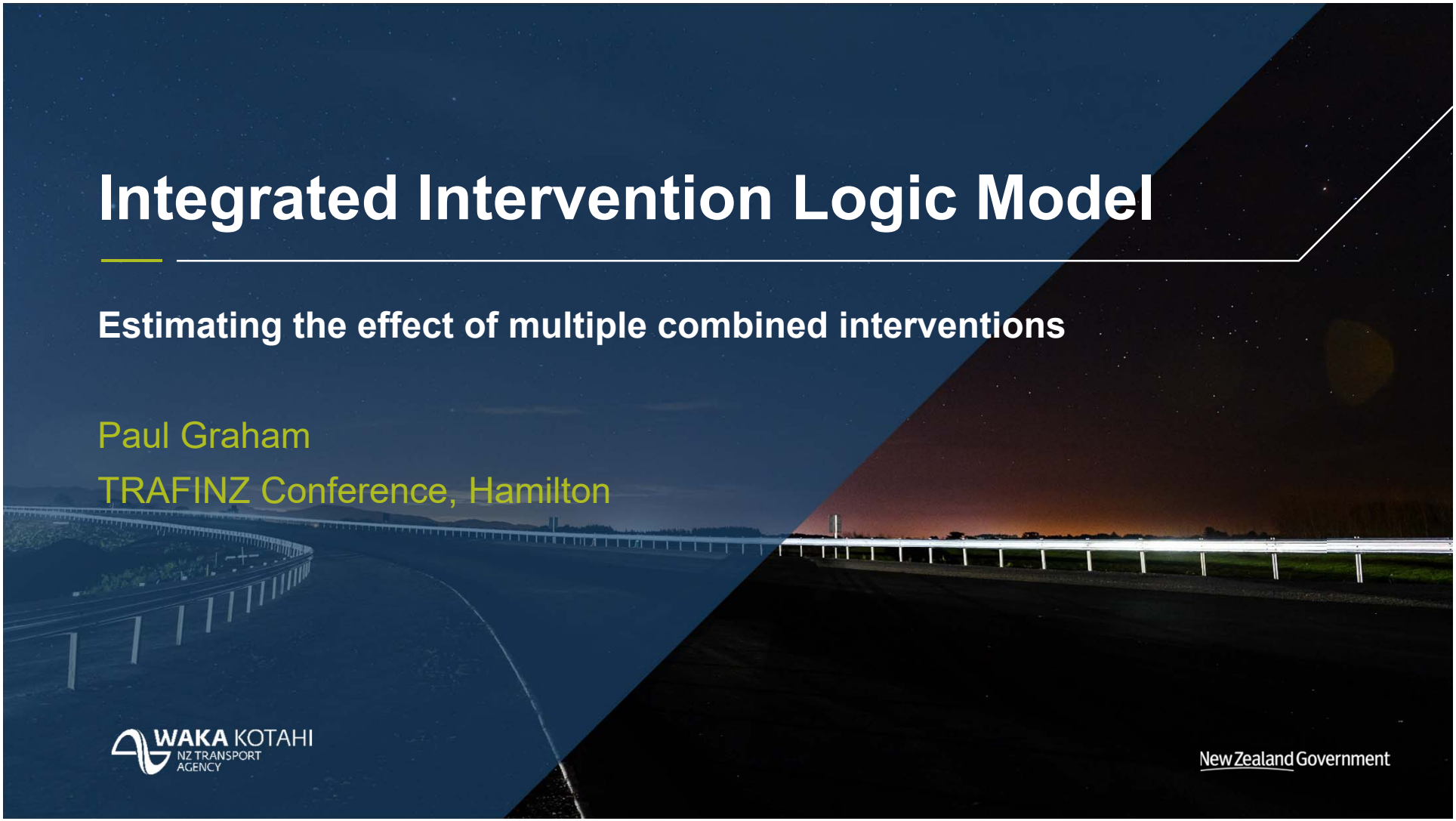

Integrated Intervention Logic Model

Estimating the effect of multiple combined interventions

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TRAFINZ Conference, Hamilton

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New Zealand Government

Integrated Intervention Logic Model (IILM)

The Integrated Intervention Logic Model (IILM) is a tool developed by the NZ Transport Agency (NZTA) in partnership with key road safety stakeholders to inform strategies aimed at improving safety across the network.

The tool uses crash data and evidence-based research and models to estimate reductions in deaths and serious injuries (DSIs) based on a specific dose of each intervention working in synergy. Its purpose is to understand the combined effect of road safety interventions taking a systems-based approach, rather than a more basic model that simply looks at the effectiveness of single interventions. It includes a baseline projection of deaths and serious injuries against which the impacts of the interventions can be estimated. Ten interventions have been modelled to date.

A key objective of the IILM is to give greater assurance that we are investing in the right safety interventions in the right combination and at the right levels. It is more important to look at interventions as a package, rather than individually, as many of the interventions work synergistically. Users select a suite of actions and activities and prescribe the degree of each, and the tool calculates the cost and potential road casualty savings from that combination of interventions. The dependency, union, dominance or independent nature of the interventions are used in determining the combined effect.

The IILM also accounts for changes in effectiveness of an intervention over time dependent on the dose and the projected baseline casualties.

Our problem

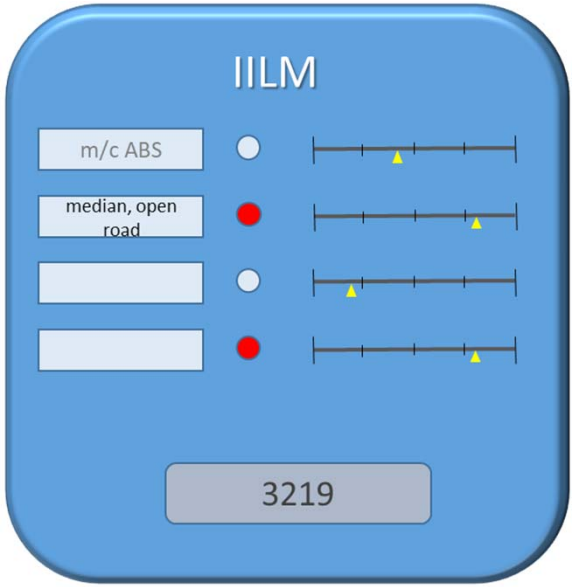
No-one should be killed or seriously injured in a road crash

3,200 deaths and serious injuries per year

We have a suite of effective interventions

On average, one person dies on our roads each day and another seven are seriously injured.

One day, an app



2D example (hypothetical)

Two interventions: reduce alcohol casualties by 25%

reduce run off road casualties by 40%

1000 casualties, 30% from alcohol crashes, 20% from run off road:

casualties from	no alcohol	alcohol	Total
not run off road	560	240	800
run off road	140	60	200
Total	700	300	1000

2D example (hypothetical)

Two interventions: reduce alcohol casualties by 25%

reduce run off road casualties by 40%

Apply run off road intervention (-40%):

casualties from	no alcohol	alcohol	Total
not run off road	560	240	800
run off road	~~140~~ 84	~~60~~ 36	~~200~~ 120
Total	644	276	920

2D example (hypothetical)

Two interventions: reduce alcohol casualties by 25%

reduce run off road casualties by 40%

Apply run off road intervention (-40%):

Apply alcohol intervention (-25%):

casualties from	no alcohol	alcohol	Total
not run off road	560	~~240~~ 180	740
run off road	84	~~36~~ 27	111
Total	644	~~276~~ 207	851

= overall 15% reduction in casualties

2D example (hypothetical)

Two interventions: reduce alcohol casualties by 25% $10M

reduce run off road casualties by 40% $20M

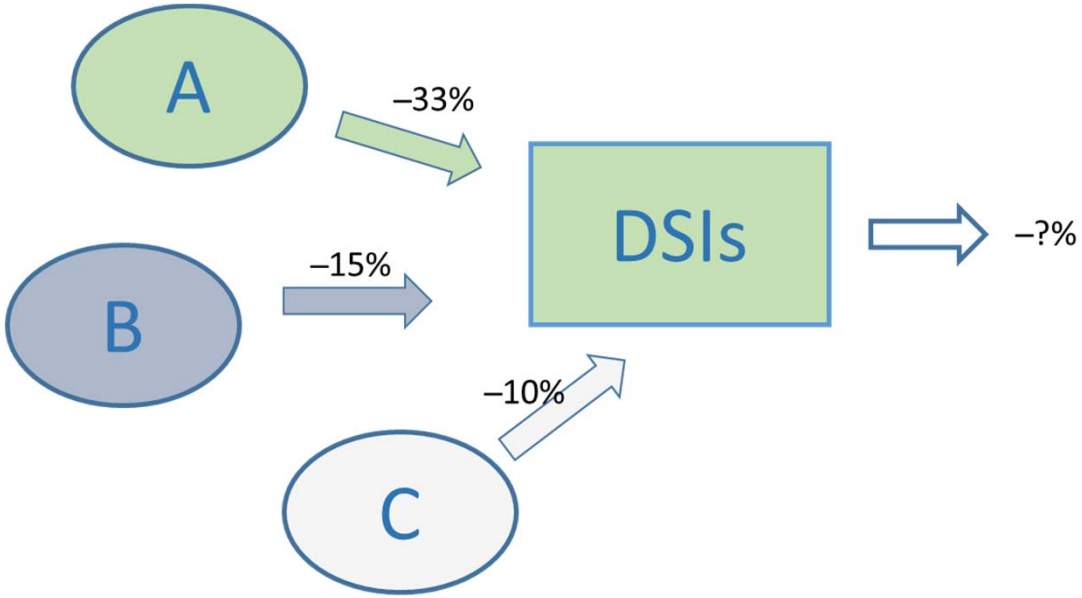
Apply run off road intervention (-40%):

Apply alcohol intervention (-25%):

casualties from	no alcohol	alcohol	Total
not run off road	560	~~240~~ 180	740
run off road	84	~~36~~ 27	111
Total	644	~~276~~ 207	851

= overall 15% reduction in casualties

The next challenge



Estimating the effect of multiple combined interventions:

The four pillars of the Safe System are:

- **Safe roads and roadsides**
- **Safe vehicles**
- **Safe people**
- **Safe speeds**

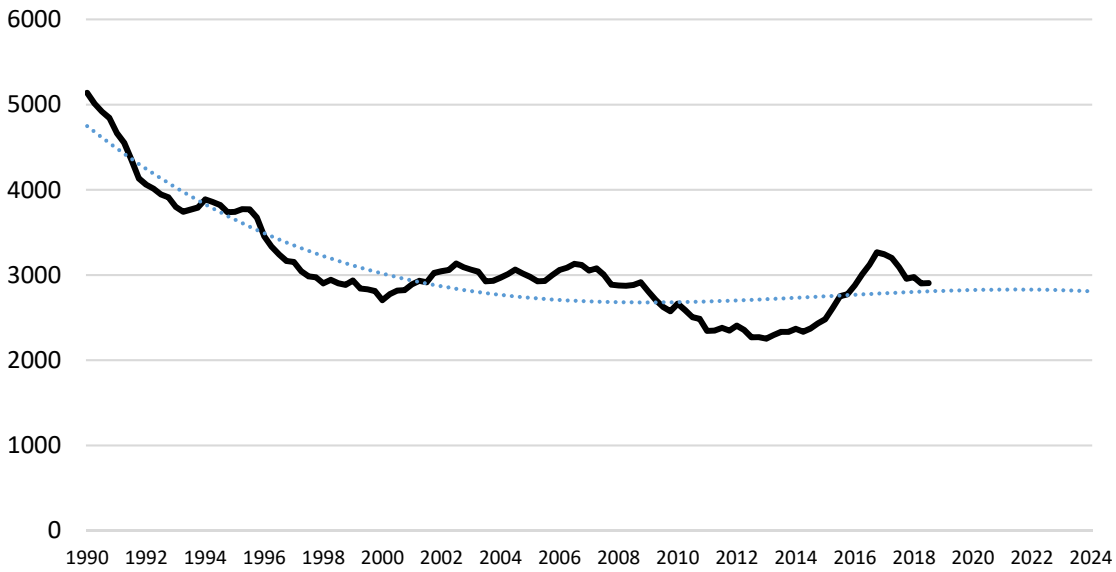
Baseline projections

Overall decrease in deaths and serious injuries since 1990

Plateau around 3000 per year

Likely to remain at that level with existing road safety interventions

Road deaths and serious injuries 1990 - 2019



Explanatory data coverage

Economic

- GDP
- Unemployment
- NZ$ Trade Weighted Index
- Interest rates
- CPI
- Construction
- Fuel price

Transport

- Vehicle fleet
- Mode distribution
- PT options
- Traffic offences
- Truck crashes
- M/cycle crashes
- Infrastructure risk

Societal

- Population
- Young population
- Older population
- Non-fatal injuries
- ACC claims
- Licence status
- Urban/rural profile

Explanatory variables

Scatterplots illustrate the relationship between explanatory variables

Pearson correlation coefficients stronger than 0.7 and -0.7 suggest relationships

- *GDP and road deaths*
- *Population and road deaths*
- *Unemployment and road deaths*
- *Petrol price and population*
- *GDP and unemployment*
- *VKT and GDP*
- *VKT and unemployment*
- *Population and GDP*
- *Population and unemployed*
- *Trade Weighted Index (TWI) and GDP*
- *TWI and unemployment.*

Colin Morrison and Ernest Albuquerque, Modelling New Zealand Road Deaths to 2025, Australasian Road Safety Conference 2019

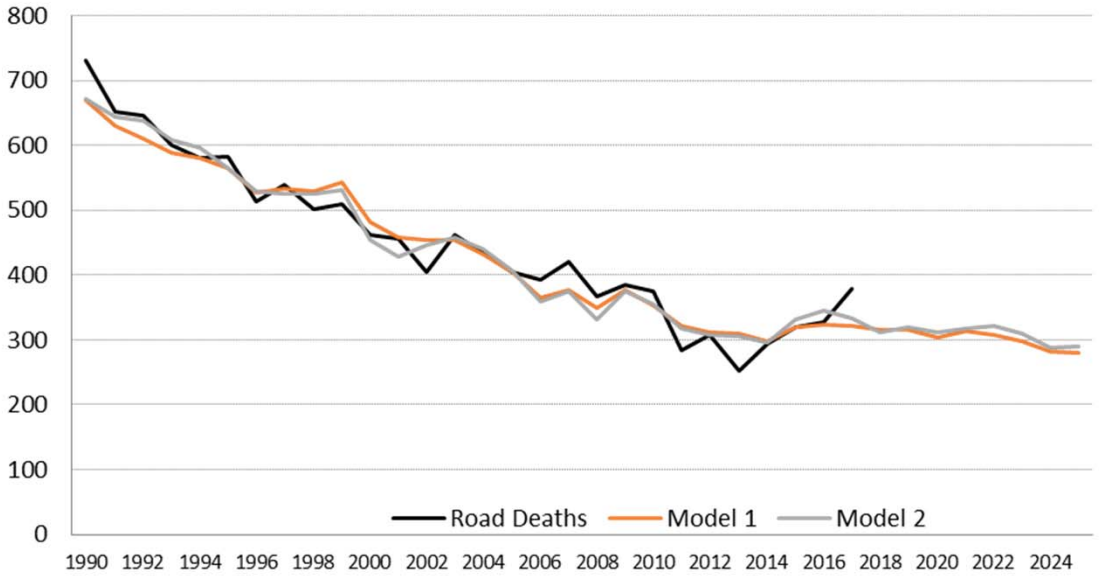
Baseline projections

Fitting against fatalities

Three variables produce the best fit with past trends

[Economic] unemployment
[Demographic] youth population
[Travel] petrol price

ARDL modelling road deaths – unadjusted results



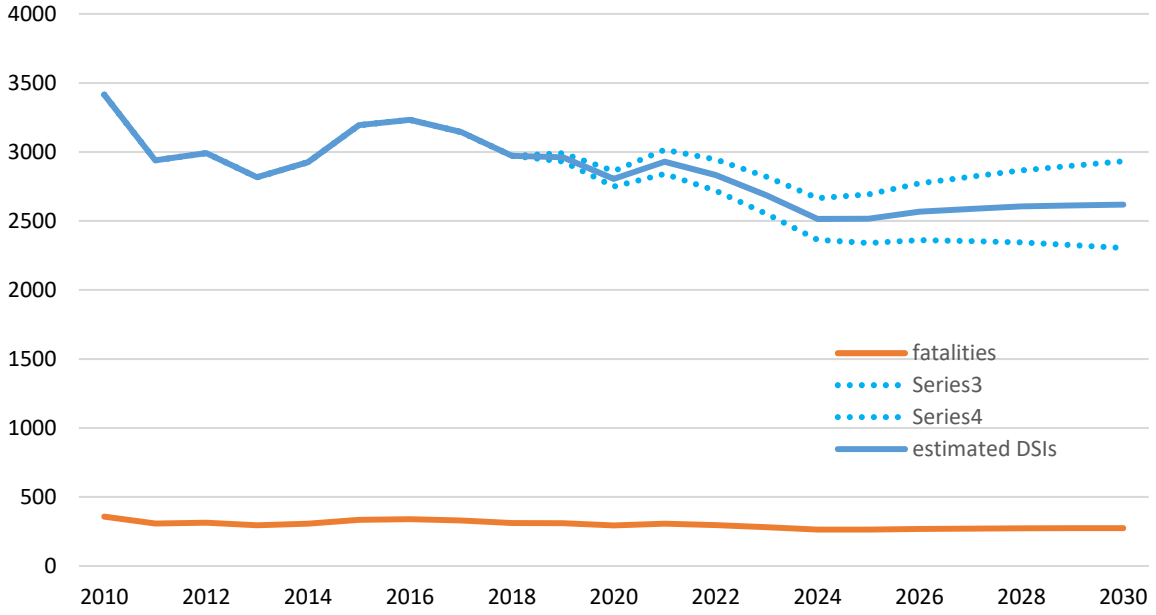
Baseline projections

Estimated DSIs based on historic relativity between fatalities and serious injuries

Uncertainty increases with time

By 2025, all estimates already +/- 7%

Results of ARDL modelling - Estimated DSIs



Users and crash types

Subdivide casualty data by user types, road characteristics and crash types

Workable limits reached after 4 or 5 subdivisions

Recombine based on stable proportions over past several years, and subdivide again

	DSIs
• vulnerable users - pedestrians, cyclists - and motorcyclists	500 550
• 1 or 2 star car occupants	1300
• 50 km/h zones	1100
• crashes on high risk roads	250
• crashes involving excessive speed	700
• alcohol-related crashes	450
• head-on and run off road crashes	1100
• intersection crashes	900

Users and crash types

user	VULNERABLE								MOTOR VEHICLE							
m/cycle	M/CYCLE				PED/CYC				MOTOR VEHICLE							
urb/rur	URB		RUR		URB		RUR		URB				RUR			
1 / 2 star	-		-		-		-		1 / 2		-		1 / 2		-	
alcohol	A	-	A	-	-		-		A	-	A	-	A	-	A	-
	ALL															
head-on	HEAD-ON								NOT							
urb/rur	URB				RUR				URB				RUR			

Users and crash types

- improve vehicle safety

user	VULNERABLE						MOTOR VEHICLE							
m/cycle	M/CYCLE				PED/CYC				MOTOR VEHICLE					
urb/rur	URB		RUR		URB	RUR			URB				RUR	
1 / 2 star	-		-		-	-	1 / 2		-		1 / 2		-	
alcohol	A	-	A	-	-	-	A	-	A	-	A	-	A	-
	ALL													
head-on	HEAD-ON						NOT							
urb/rur	URB				RUR		URB				RUR			

Users and crash types

- reduce urban speeds

user	VULNERABLE						MOTOR VEHICLE							
m/cycle	M/CYCLE				PED/CYC			MOTOR VEHICLE						
urb/rur	URB		RUR		URB		RUR	URB				RUR		
1 / 2 star	-		-		-		-	1 / 2		-		1 / 2		-
alcohol	A	-	A	-	-		-	A	-	A	-	A	-	A	-
	ALL													
head-on	HEAD-ON						NOT							
urb/rur	URB				RUR			URB				RUR		

Interventions

- baseline DSIs related to underlying trends in petrol prices, unemployment and population of 15-24 yr olds
- 50% increase in enforcement = 4.4% reduction in fatalities [Elvik 2012], across the network
- 29% of urban DSIs at 657 segments with SAAS=40 or 30, if lowered to 30km/h expect DSI reduction of 50% (40% m/c)
- fitting ABS reduces motorcycle DSIs by 30%, applies to 45,000 bikes not yet equipped
- increasing safety rating to 3+ reduces risk of DSI to 1/2 star occupants in crash by 33%
- 440 suitable camera sites, 60 already installed, international review 20% DSI reduction at sites
- applying speed management programme at 1785 highest risk road segments, 27% DSI saving
- apply speed management treatments to further 7000 road segments, 8% DSI saving
- already 300km median barriers, increasing to 1301km reduces DSIs at sites by 65%
- 6614 high risk intersections on 3305 corridors, treatments reduce DSIs by 25%
- 1399 intersections suitable for RLC, reduce red light running DSIs by 26%
- 1248 rural corridors eligible for LCLR treatments, average 15% DSI reduction
- From 2007-2010, 1.2M increase in CBTs corresponded with 30% decrease in alcohol DSIs
- Interlocks = 60% reduction in repeat offending, involved in 10% alcohol-related DSI crashes, effectiveness 6% (MoT 15%)

Intervention logics

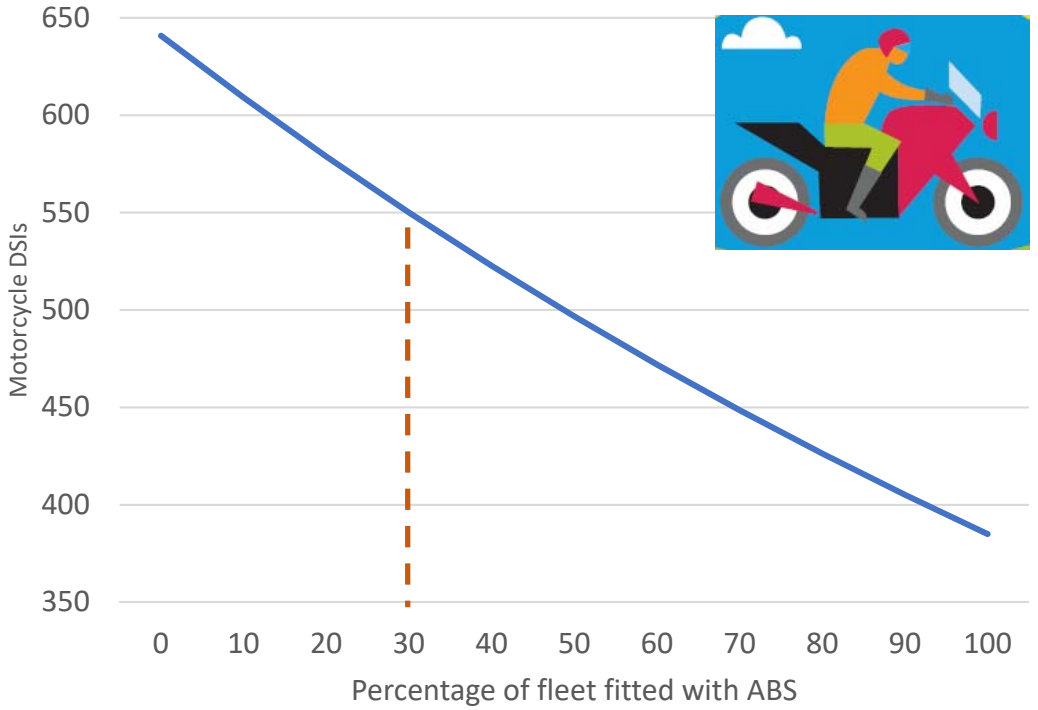
Motorcycle ABS

motorcycle fleet = approx 64,000 (and another 16,000 mopeds)

approx 30% of motorcycles already equipped with ABS

approx 30% DSI reduction if equipped with ABS

motorcycle DSIs per year = 550

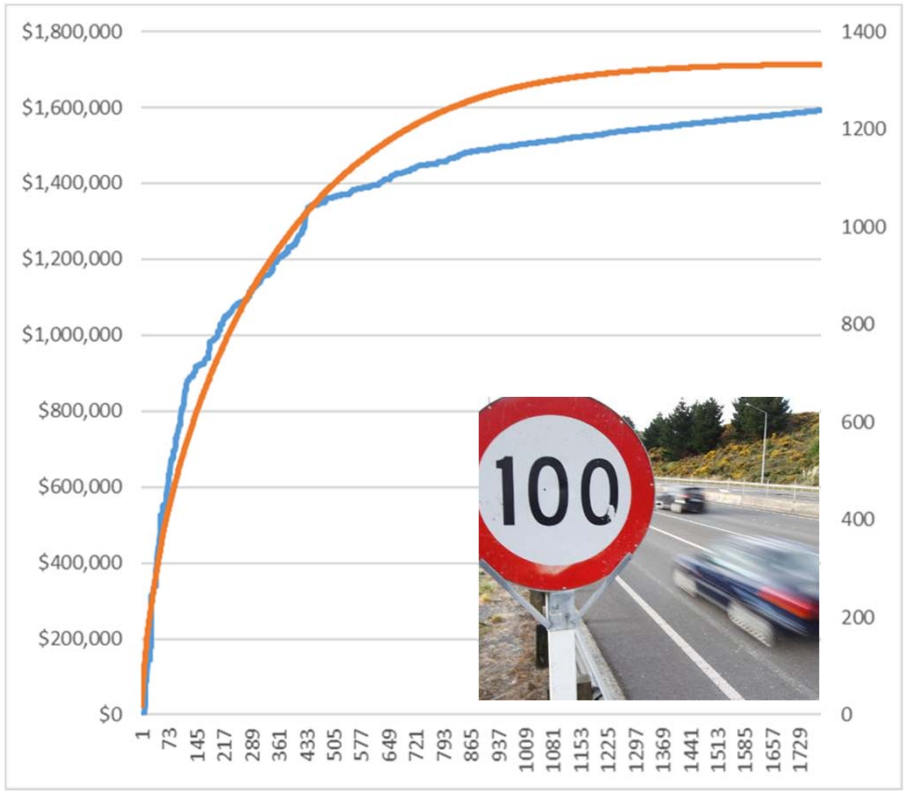


Intervention logics

Speed management

Treat the top 10% highest risk road segments

1332 DSIs saved over 5 years = 266 per year, out of 5216 estimated total DSIs = 26%

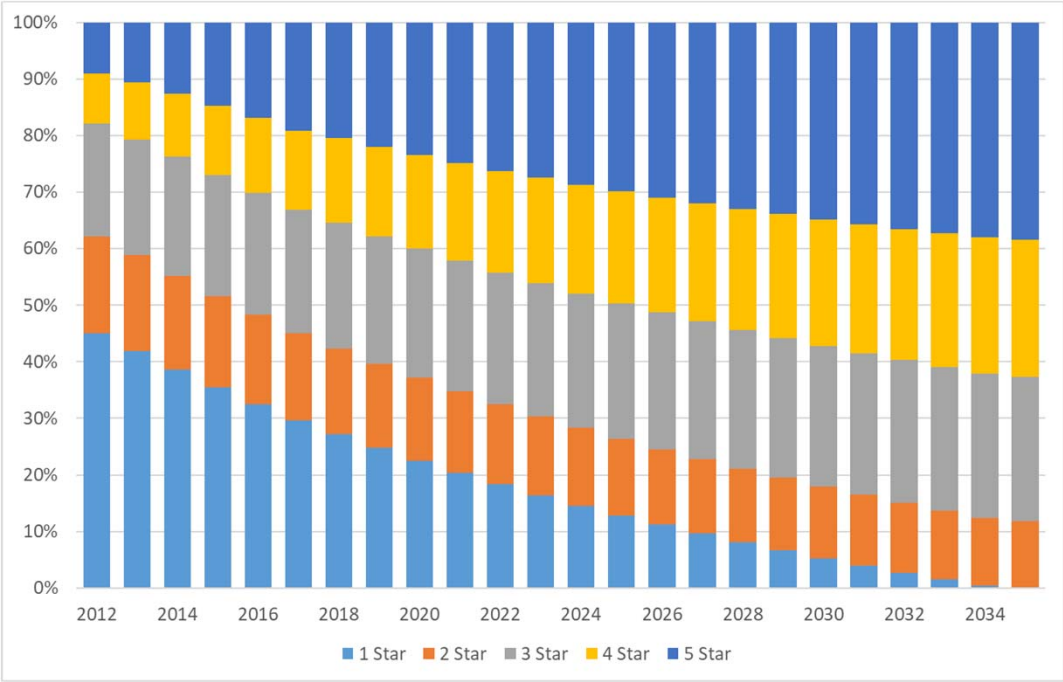


Intervention logics

Improve vehicle safety

increasing safety rating to 3+ reduces risk of DSI to 1/2 star occupants in crash by 33%

Increasing safety rating to 3+ reduces risk of DSI to 1/2 star occupants in crash by 33%



IILM user settings

Predicted unemployment rate		2.80%
Predicted petrol price (cents/litre)		216.89
Effectiveness decay rate		6%
Urban speed reduction multiplier for non ped/cyc		0.1
Speed management effectiveness for motorcyclists		1.5
Vehicle fleet settings	new scrappage 1/2	70000
	purchase 1/2	20000
	scrap 1/2	70000
	purchase 3+	150000
	scrap 3+	4%
	Turn off the tap	2030

			Region	NEW ZEALAND			
	Year 1		Year 2	estimated DSIs	DSIs saved	Cost ($M)	
	2020	-	2023	11252	639	$ 2,262	
					6%	4 years	
Speed enforcement (from 900,000)	900	,000		Corridors with intersection treatments	0	*0 intsectns*	
30 km/h urban corridors	0			Red light cameras	0		
Motorcycle fleet with ABS (from 30%)	30%			BOOST programme treatments	0		
Net exit rate of 1/2 star cars (from 70,000)	100	,000		Increased alcohol enforcement	0%		
Speed management on Top 10% of network	500			Increase in alcohol interlocks	0%		
Speed management on remaining 90%	0						
Median barriers (from 300km)	600	km		Speed cameras (from 60)	60		

increase to 8 years

			Region	NEW ZEALAND			
	Year 1		Year 2	estimated DSIs	DSIs saved	Cost ($M)	
	2020	-	2027	21437	1240	$ 2,382	
					6%	8 years	
Speed enforcement (from 900,000)	900	,000		Corridors with intersection treatments	0	*0 intsectns*	
30 km/h urban corridors	0			Red light cameras	0		
Motorcycle fleet with ABS (from 30%)	30%			BOOST programme treatments	0		
Net exit rate of 1/2 star cars (from 70,000)	100	,000		Increased alcohol enforcement	0%		
Speed management on Top 10% of network	500			Increase in alcohol interlocks	0%		
Speed management on remaining 90%	0						
Median barriers (from 300km)	600	km		Speed cameras (from 60)	60		

increase urban treatments and alcohol enforcement

Region: NEW ZEALAND

Year 1: 2020 - Year 2: 2023

estimated DSIs	DSIs saved	Cost ($M)
11252	1543	$ 3,789
	14%	4 years

Speed enforcement (from 900,000)	900	,000	Corridors with intersection treatments	1000	*2195 intsectns*
30 km/h urban corridors	500		Red light cameras	0	
Motorcycle fleet with ABS (from 30%)	30%		BOOST programme treatments	0	
Net exit rate of 1/2 star cars (from 70,000)	100	,000	Increased alcohol enforcement	50%	
Speed management on Top 10% of network	500		Increase in alcohol interlocks	0%	
Speed management on remaining 90%	0				
Median barriers (from 300km)	600	km	Speed cameras (from 60)	60	

increase vehicle safety

Region: NEW ZEALAND

Year 1		Year 2	estimated DSIs	DSIs saved	Cost ($M)
2020	-	2023	11252	2269	$ 4,729
				20%	4 years

Speed enforcement (from 900,000)	900	,000	Corridors with intersection treatments	1000	*2195 intsectns*
30 km/h urban corridors	500		Red light cameras	0	
Motorcycle fleet with ABS (from 30%)	30%		BOOST programme treatments	0	
Net exit rate of 1/2 star cars (from 70,000)	300	,000	Increased alcohol enforcement	50%	
Speed management on Top 10% of network	1000		Increase in alcohol interlocks	0%	
Speed management on remaining 90%	0				
Median barriers (from 300km)	600	km	Speed cameras (from 60)	60	

Strengths

- The models' ability to combine the effect multiple interventions allows it to:
  - gives a guide to the optimum mix of modelled interventions
  - shows the relationship between the "dose" of intervention and the projected effect on reducing DSIs
  - accounts for any overlap in interventions ie. avoids double-counting DSIs.

Assumptions

- Interventions will vary in both cost and impact over time.
  - Median Barriers will have an immediate impact and continue to do so for many years but will require maintenance investment.
  - Speed limits will have an immediate impact and low ongoing costs.
- Interventions work synergistically – no single intervention will significantly reduce DSIs on its own.

Limitations

- The model will only work if there is robust data available for interventions already in place.
- It is a high level tool and cannot report to a regional level
  - Data becomes too granular when broken down by regions and cannot consider regional variations.
  - We are looking at the possibility of providing Auckland, Rest of North Island and South Island data sets.