Sustainable Urban Development - Implementation of Car-free Zone: NZ Case Studies

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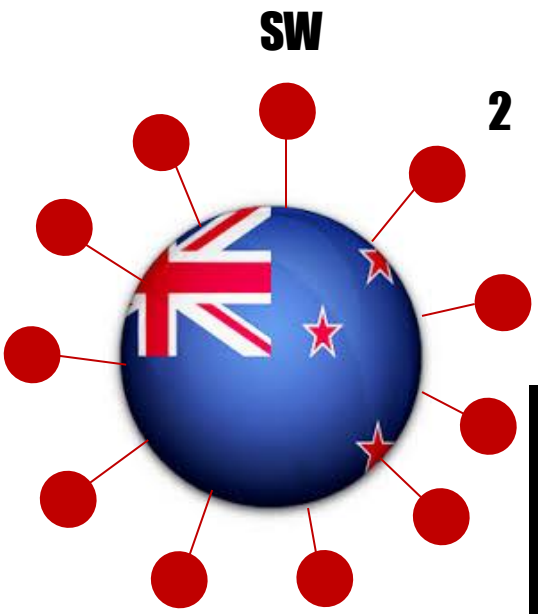
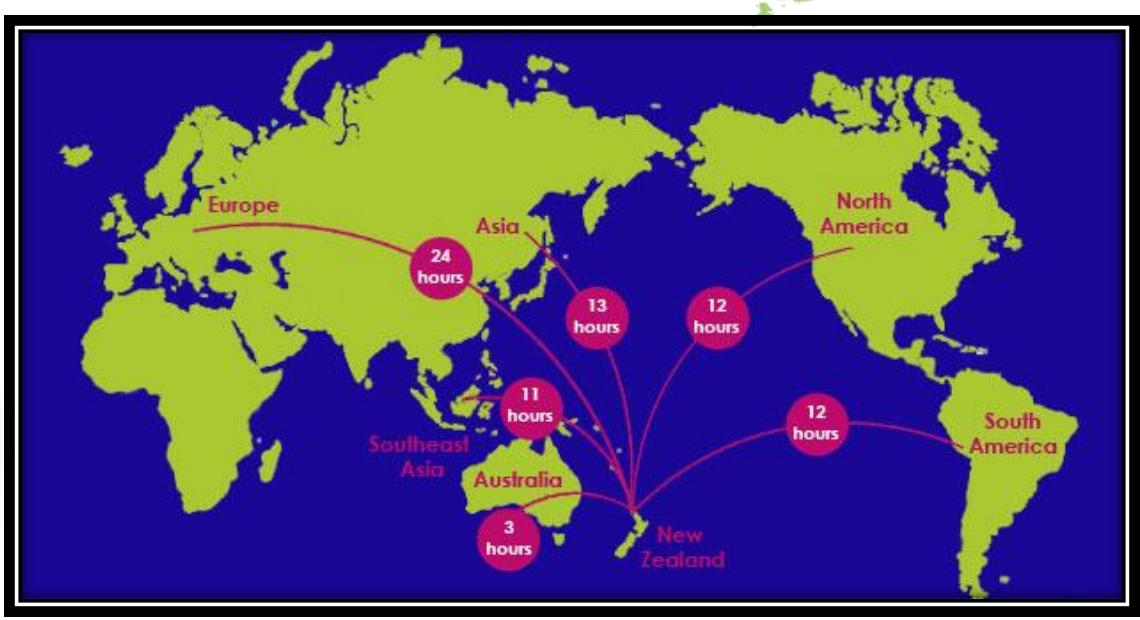
Introduction



4.7 Million



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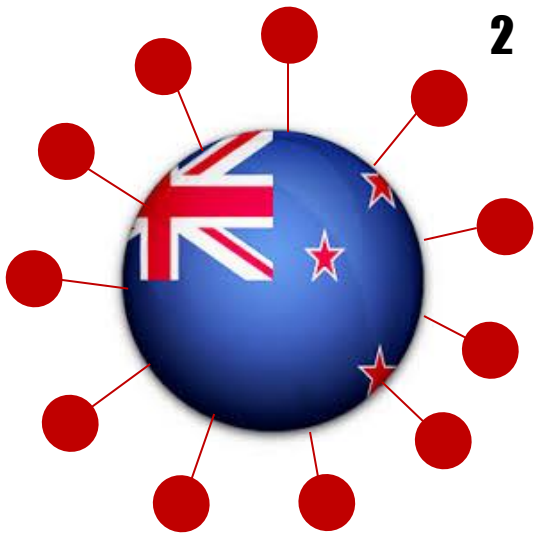
Introduction

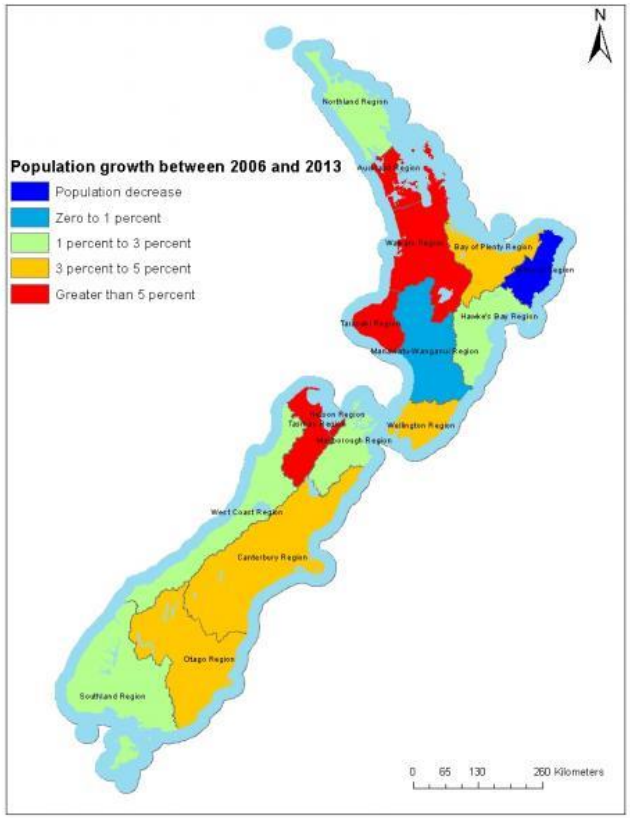
SW

2



4.7 Million

12.5%



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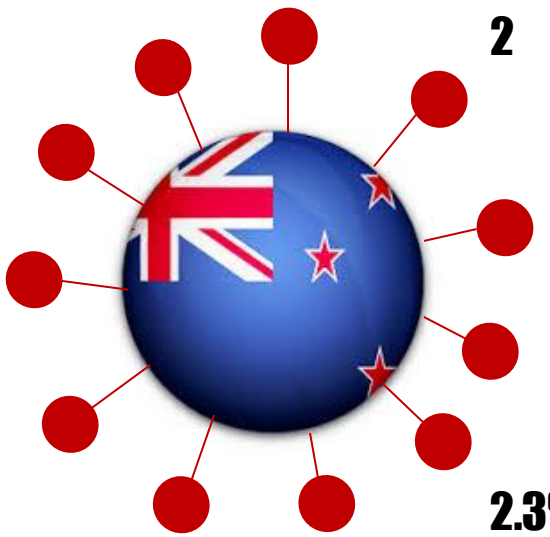

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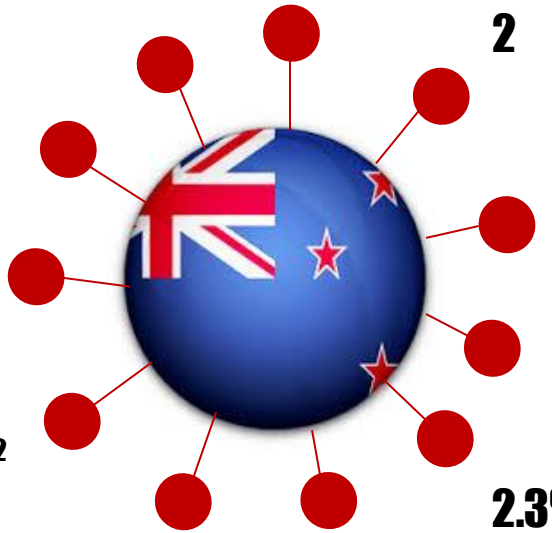

SW

2

4.7 Million

12.5%

2.3%

3rd

380k

nia

4 km²

8 km

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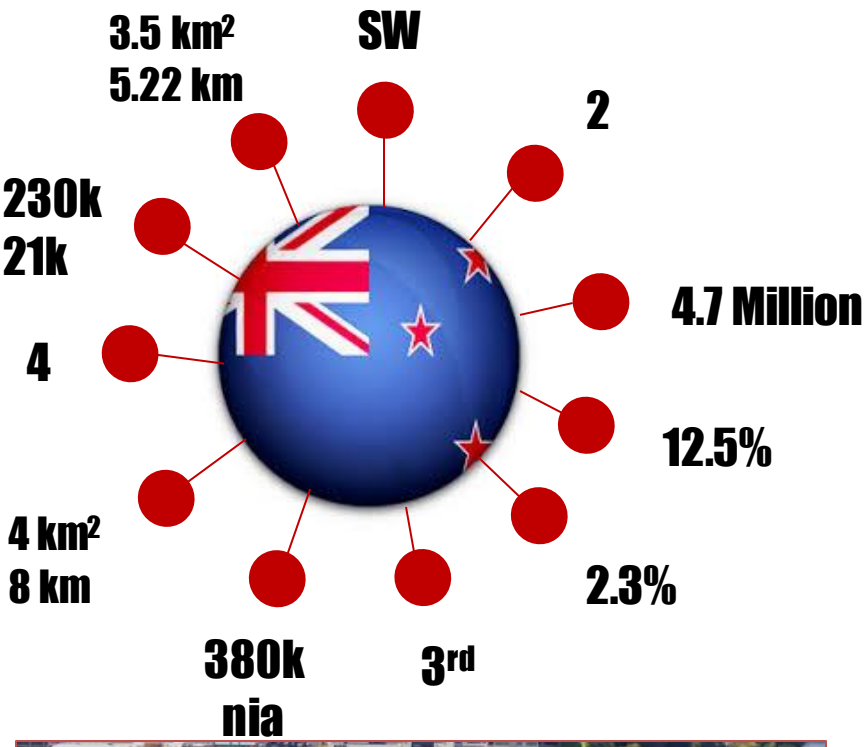

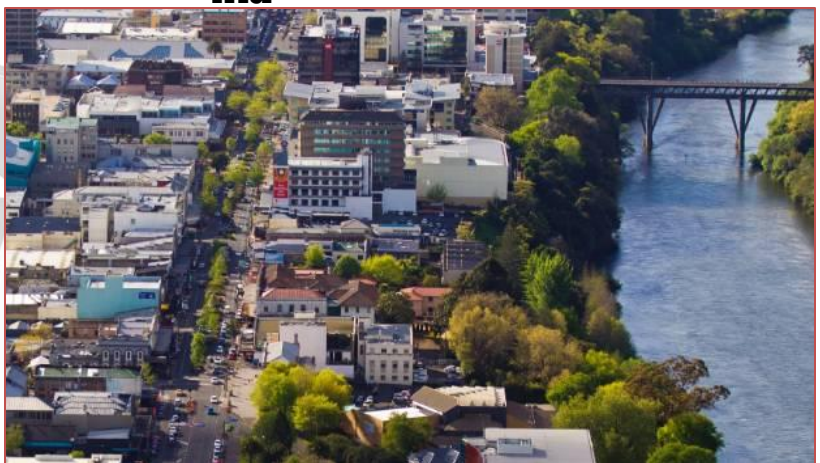

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NZ Urban Design Protocol [MoE, 2005]
NZ Transport Strategy [MoT, 2008]

Sustainability

Literature Review

NZ Urban Design Protocol [MoE, 2005]
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Sustainability

Auckland Sustainability Framework [ARC, 2016]
Sustainable Urban Design [HCC,2012]
Greater Christchurch Urban Development Strategy [CCC, 2008]

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Walking & Cycling, Car-sharing, PT & Transit, Car-free Zone

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Walking & Cycling, Car-sharing, PT & Transit. Car-free Zone

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Literature Review

Car-Free Zone Case Studies

Car-Free Zone

Copenhagen [Denmark]:

-Stroget's 'The Pedestrian Street' (1.1 km length)
-Convert roads into pedestrian only streets,
-Gradually reduce traffic and available parking,
-Convert car parks into public squares,
-Promote Cycling- the most bicycle friendly

-Carbon neutral by 2025 initiative [2012]:

- Green mobility
  - Developing bicycle connections
  - The use of electrical bikes for longer rides
  - Using electricity and biofuels to fuel large buses

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Literature Review

Car-Free Zone Case Studies

Car-Free Zone

Ghent [Belgium]:

- -35ha in the city centre, 'Low emission zone',
- -'Cycling street' - 30% modal share,
- -'Pedestrian Only Streets' for up to 18h/day- traffic free
  - ·no freight traffic,
  - ·no car traffic,
  - ·no taxis, and
  - ·no cyclists
- -The Sustainable Urban Mobility Plan Ghent 2030

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Literature Review

Discrete Choice Model

The perceptual approach:

$$P_{ni} \equiv Prob(Person\ n\ choose\ Alternative\ i) = G\left(x_{ni,}\, x_{nj} \forall j \neq i, s_n, \beta\right)$$

Random utility theory (McFadden, 1973)

$$U_{ni} = \beta z_{ni} + \varepsilon_{ni}$$

Understanding Transport Users' Behaviour

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Literature Review

Understanding Transport Users' Behaviour

Discrete Choice Model

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Random utility theory (McFadden, 1973)

$$U_{ni} = \beta z_{ni} + \varepsilon_{ni}$$

Logistic Regression Model

$$U_{ij|s} = \beta_s x_{ij} + \varepsilon_{ij|s} \qquad Pr_{ij|s} = \frac{exp^{(\beta' s x_{ij})}}{\sum_{n=1}^{N} exp^{(\beta' s x_{jn})}}$$

- **Multinomial Logit & Mixed Logit model**

$$Pr_{is} = \frac{exp^{(a' s z_i)}}{\sum_{s=1}^{S} exp^{(a' s z_i)}}$$

- **Latent Class Logit [Fixed and Random]**

$$Pr_{is} = \sum_{s=1}^{S} \left[\frac{exp^{(a' s z_i)}}{\sum_{s=1}^{S} exp^{(a' s z_i)}} \right] \prod_{T}^{t} \frac{exp^{(\beta' s x_{int})}}{\sum_{n=1}^{N} exp^{(\beta' s x_{jnt})}}$$

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Stated Preference Survey

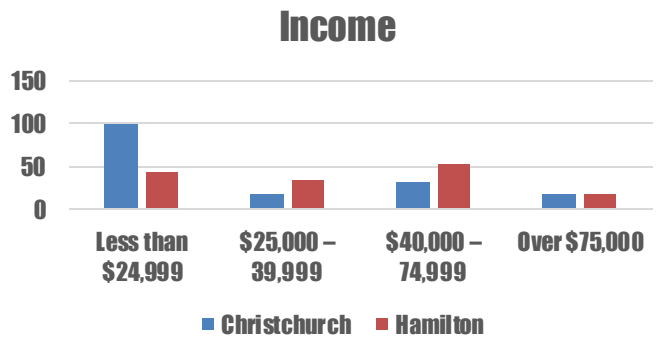
Total 322 Respondents

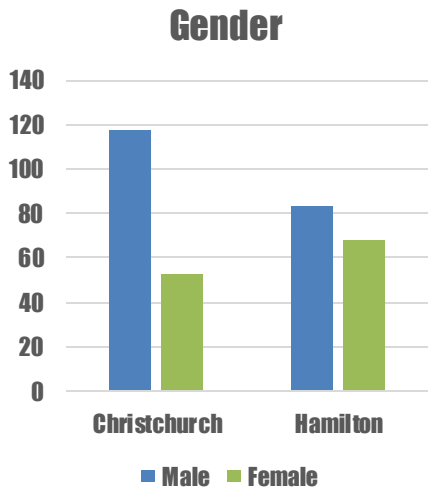
171 from Christchurch

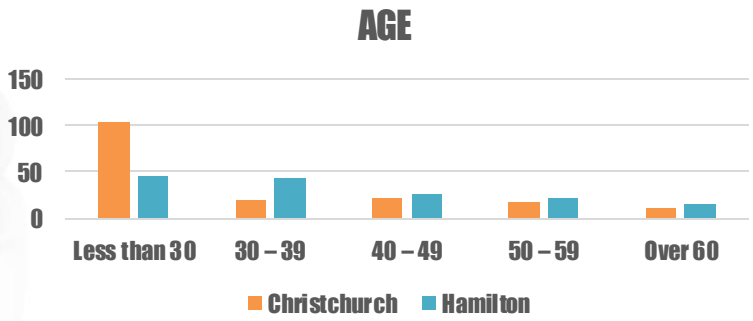
151 from Hamilton

Survey Respondent

Survey & Sample Details:







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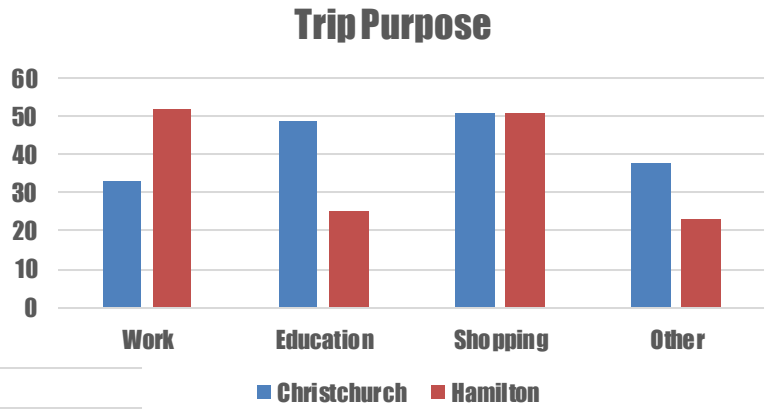

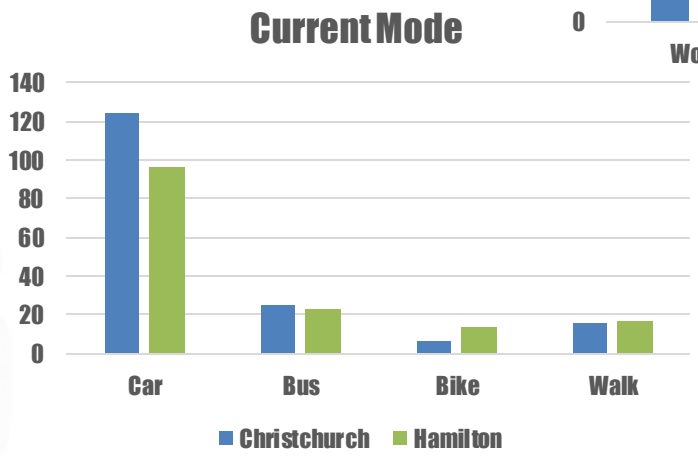

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Stated Preference Survey

RP/SP Survey

7 RP & 8 SP Questions: 2,576 Choice

3 Attributes:

- Parking Rate [0.5$, 1$, 2$/hr],
- Walking distance [<100, <250, <500, <750m]
- Service Frequency [shuttle][2, 3/hr]

Sample Question

		OPTIONS		
CHOICE SET		CURRENT	New Car Park Only	New Car Park with Shuttle
1	Parking Rate ($)	$2 /hour	$0.5 /hour	$0.5 /hour
	Walking Distance (m)	100 m	500 m	750 m
	Service Frequency/hr	-	-	3 /hr (every 20 min)
YOUR SELECTION:				

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Analysis: Car-free CBD in NZ

Christchurch

Model	No. classes	Log Likelihood	Pseudo R^2	AIC	BIC	No. parameters
MNL	base	-1362.2	0.039	2732.5	2753.3	4
LCMNL	2	-923.20	0.376	1864.4	1911.3	8
	3	**-849.11**	**0.426**	**1726.2**	**1799.1**	**8**
ML	Base	-984.8	0.335	1979.6	2005.7	8
LCML	2	-923.39	0.376	1868.8	1926.1	8
	3	**-849.11**	**0.426**	**1732.2**	**1820.7**	**8**

Determine Optimal Number of Classes

Hamilton

Model	No. classes	Log Likelihood	Pseudo R^2	AIC	BIC	No. parameters
MNL	base	-1173.5	0.026	2355.1	2375.2	4
LCMNL	**2**	**-650.9**	**0.477**	**1319.8**	**1365.1**	**8**
	3	Not Converged				
ML	base	-800.6	0.357	1613.3	1643.6	8
LCML	**2**	**-650.8**	**0.478**	**1323.6**	**1379.0**	**8**
	3	Not Converged				

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Analysis: Car-free CBD in NZ

The coefficients of the MNL, ML and Three-class LC models

Attributes-	MNL	LCMNL		
		Class 1	Class 2	Class 3
COST	-1.344***(0.000)	-1.337(1.101)	-1.087***(0.371)	-3.035***(0.359)
DIST	-0.003***(0.000)	-0.005***(0.002)	-0.010***(0.000)	-0.001(0.001)
FREQ	-0.004(0.069)	-0.302(0.559)	0.097(0.223)	0.106(0.103)
ASC	-0.702***(0.003)	3.649**(1.578)	-2.410***(0.525)	0.478(0.617)
LCMNL class membership probability		0.270***(0.036)	0.360***(0.041)	0.370***(0.041)
Log Likelihood	-1362.2		-849.1	
Pseudo R^2	0.039		0.426	
AIC	2732.5		1726.2	
BIC	2753.3		1799.1	

Attributes	ML	LCML		
		Class 1	Class 2	Class 3
COST (mean)	-1.149***(0.300)	-1.334(1.101)	-3.035***(0.041)	-1.087***(0.371)
COST (SD)	6.905***(0.581)	0.002(0.190)	0.011(0.201)	0.001(0.089)
DIST	-0.004***(0.000)	-0.005***(0.002)	-0.001(0.001)	-0.010***(0.000)
FREQ	0.060(0.082)	-0.298(0.559)	0.106(0.103)	0.097(0.223)
ASC	-0.811***(0.307)	3.645**(1.577)	0.479(0.616)	-2.411***(0.525)
LCML class membership probability		0.270***(0.365)	0.370***(0.041)	0.360***(0.041)
Log Likelihood	-984.8		-849.1	
Pseudo R^2	0.335		0.426	
AIC	1979.6		1732.2	
BIC	2005.7		1820.7	

*** p<0.01, ** p<0.05, *p<0.1

Christchurch: Three Class LC Models

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Analysis: Car-free CBD in NZ

The coefficients of the MNL, ML and Two-class LC models

Attributes	MNL	LCMNL	
		Class 1	Class 2
COST	-1.067***(0.177)	-1.196*(0.454)	-1.430***(0.269)
DIST	-0.002***(0.000)	-0.003***(0.000)	-0.002***(0.000)
FREQ	0.147**(0.071)	0.105(0.266)	0.013(0.093)
ASC	0.302(0.252)	2.627***(0.902)	-1.085**(0.441)
LCMNL class membership probability		0.385***(0.050)	0.615***(0.050)
Log Likelihood	-1173.5		-650.9
Pseudo R^2	0.026		0.477
AIC	2355.1		1319.8
BIC	2375.2		1365.1
Attributes	**ML**	**LCML**	
		Class 1	Class 2
COST (mean)	-1.707***(0.360)	-1.198*(0.631)	-1.431***(0.269)
COST (SD)	7.199***(0.897)	0.064(0.280)	0.011***(0.335)
DIST (mean)	-0.009***(0.001)	-0.003***(0.000)	-0.002***(0.000)
DIST (SD)	0.023***(0.002)		
FREQ	0.274*** (0.101)	0.106(0.266)	0.013(0.093)
ASC	-1.238*** (0.348)	2.627***(0.901)	-1.085**(0.441)
LCML class membership probability		0.385***(0.050)	0.615***(0.050)
Log Likelihood	-800.6		-650.8
Pseudo R^2	0.357		0.478
AIC	1613.3		1323.6
BIC	1643.6		1379

*** p<0.01, ** p<0.05, *p<0.1

Hamilton: Two Class LC Models

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Conclusion

Discrete Choice Modelling:

Fixed parameter based model (MNL, LCMNL)

vs Random parameter based model (ML, LCML)

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Conclusion

Discrete Choice Modelling:

Fixed parameter based model (MNL, LCMNL)

vs Random parameter based model (ML, LCML)

Willingness to Pay [Christchurch and Hamilton]:

Walking Distance

[WTP for decreasing 100m walking distance]

Hamilton: 52 cents

Christchurch: 34 cents

Service Frequency [Shuttle]

[WTP for increasing shuttle service frequency]

Hamilton: 46 cents

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Conclusion

Discrete Choice Modelling:

Fixed parameter based model (MNL, LCMNL)

vs Random parameter based model (ML, LCML)

Willingness to Pay [Christchurch and Hamilton]:

Walking Distance

[WTP for decreasing 1km walking distance]

Hamilton: 52 cents

Christchurch: 34 cents

Service Frequency [Shuttle]

[WTP for increasing shuttle service frequency]

Hamilton: 46 cents

Car-free CBD in NZ

Latent Classes

Hamilton [2cls LCML]: Status-quo [38.5%] vs Car-free zone [61.5%]

Christchurch [3cls LCMNL]: Class1 [27%] vs Class2 [36%] vs Class3 [37%]

[Status-quo [27%] For class 1 vs Car-free zone [36%] For class 2,
Class 3: Cost sensitive,
Class 1: Distance sensitive]

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Conclusion & Research Direction

Discrete choice models allow researchers to analyse and predict how people's choices are influenced by their personal characteristics and by the alternatives available to them

Car-free CBD in NZ

Measure **Willingness-to-pay (WTP) or Willingness-to-accept (WTA)** to evaluate elasticity of transport user demand based on various urban policy/regulation

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Q & A

For further inquiry and comments

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