

Making a city safe enough for travel by bicycle:
comparing Inner Melbourne, Amsterdam, and Copenhagen

by

Warwick Hilton Pattinson

ORCID: 0000-0003-4603-6546

Submitted for total completion for the degree of
Doctor of Philosophy

April 2020

Melbourne School of Design
The University of Melbourne

Abstract

Many people in Inner Melbourne are missing out on the benefits of bicycle riding for transport, benefits as demonstrated in cities like Amsterdam and Copenhagen. Safety, however, is a threshold issue for new riders. Previous research has established that a wide range of factors can influence the safety of bicyclists and that local differences in context are important. This thesis explores the possibility that Inner Melbourne could become safe enough for many more adults to travel by bicycle.

An interpretive research methodology was used, which involved predominantly qualitative methods together with analysis of quantitative data on road trauma. A case study approach examined the social and technical features that influence city safety for bicycling in Inner Melbourne, Amsterdam, and Copenhagen. The research integrates the *Safe System* framework from road safety with a broader public health policy framework. Original interviews, document analysis, and observations were used to explore differences in safety and to reveal opportunities for change. Three themes were used for the analysis: the historic and policy contexts; the decision-making processes; and the content of measures that influence safety.

The research introduces several concepts to explore the production of good enough safety, including reducing risk and reducing perceptions of danger. It suggests that the policy context needs to be framed to value the potential contribution of bicycling to liveability; that decision processes need to connect bicycling to community needs; and that locally appropriate *Safe System* content could be re-imagined to consistently communicate safe behaviour for all road users at modest cost. The findings suggest that Inner Melbourne could be made safe enough for new adult riders by co-production involving government, stakeholders and road users.

Declaration

I certify that this thesis:

Making a city safe enough for travel by bicycle:
comparing Inner Melbourne, Amsterdam, and Copenhagen

- (i) comprises only my original work towards the Doctor of Philosophy;
- (ii) includes due acknowledgement in the text to all other material used; and
- (iii) is fewer than the maximum (80,000) word limit in length, exclusive of tables, maps, bibliographies, and appendices.

Signed:

Warwick Pattinson

April 2020

Acknowledgements

I express my gratitude to my Supervisor Dr John Stone for his support, patience, and knowledge. His guidance helped me through critical times in the conduct and writing of this thesis. I would like to thank the members of my supervisory committee: Assoc Prof. Russell Thompson, and Mr Alistair Cumming for their insightful comments and encouragement. Also, Prof. Priyan Mendis from Infrastructure Engineering who encouraged me to apply for an APA scholarship and then supported me in the early stages of my research. Supervision that was then provided by Prof Carolyn Whitzman, who helped me on my research journey, recognised that I needed to learn about research methodologies, and connected me to a supportive cohort of PhD researchers. The ongoing assistance of Jane Trewin in the Graduate Research office was much appreciated. Also, thanks to fellow PhD candidates and people who attended presentations I gave for the stimulating discussions and helpful suggestions. I thank my professional friends in VicRoads, TAC, City of Melbourne, RACV, ARRB, the Department of Transport, staff at Bicycle Network and the Amy Gillet Foundation for helpful discussions and material.

My deep thanks go to Prof. Amanda Sinclair, Prof. Billie Giles-Corti, Dr Mary Black, Prof. John Alford, Dr Jan Garrard, and Prof. Mary Sheehan AO, who together with many others provided advice and suggestions. During my scouting fieldwork, I met with social research methods expert Prof. Emma Bell, who suggested I use the Interpretive Research approach as described by Schwartz- Shea and Yanow (2012). The interpretive approach became central to my work. Without the support of these people and my family I would not have enjoyed or completed this research.

I thank my interview participants and the many people who have contributed ideas, shared experiences, and suggested people to interview, key documents, seminars, and meetings to attend. I am also grateful for the changes suggested by the examiners.

Finally, I thank my family for support throughout the process. My wife, Prof. Amanda Sinclair who provided academic wisdom; Amy, Huw, and Charlie for technical support; and Tom for excusing my lack of performance as a grandparent while this thesis monopolised my attention.

Table of Contents

Abstract	ii
Declaration	iii
Acknowledgements	iv
Common abbreviations	xi
Units of measurement	xii
Chapter 1 Introduction.....	1
1.1 Research purpose and approach	3
1.2 Aim: understanding safety for potential bicyclists	5
1.3 Research questions and approach.....	9
1.4 Significance and contribution.....	10
Chapter 2 Literature review: the safety of city bicycling	15
2.1 Why safety for bicyclists is important.....	15
2.2 What Melbourne crash studies show.....	17
2.3 Beyond recorded injuries.....	23
2.4 Systematic approaches to road safety	36
2.5 Local implementation of a <i>Safe System</i>	42
2.6 A city safe enough for bicyclists	46
2.7 Implementing change	47
2.8 An integrated model for analysis	56
2.9 Research gap and questions.....	57
Chapter 3 Study approach and methods	59
3.1 Methodology.....	59
3.2 Methods.....	60
3.3 Preliminary scoping and engagement	60
3.4 Comparative case study	62
3.5 Injury data.....	64
3.6 Qualitative exploration	67
3.7 Ensuring ethical and quality research.....	75
3.8 Summary	78

Chapter 4 Understanding safety	79
4.1 Defining the case study areas	79
4.2 Comparing risk	85
4.3 Conclusion.....	91
Chapter 5 Amsterdam, where people on bikes are the ‘queens’ and ‘kings’ of the road	93
5.1 Amsterdam	94
5.2 Context.....	98
5.3 City processes.....	103
5.4 Content.....	110
5.5 Conclusions.....	124
Chapter 6 Bicycles and cars in Copenhagen.....	127
6.1 Copenhagen.....	127
6.2 Context.....	133
6.3 City processes.....	144
6.4 Content.....	150
6.5 Conclusions.....	165
Chapter 7 Inner Melbourne, much safer by car than bicycle .	166
7.1 Inner Melbourne	167
7.2 Context: History, culture, and policies	170
7.3 Process	176
7.4 Content.....	188
7.5 Conclusions.....	202
Chapter 8 Discussion of case study findings	204
8.1 Context.....	204
8.2 Process	216
8.3 Content for safety	223
8.4 Lessons for a safer Inner Melbourne.....	236
8.5 Limitations	242
8.6 Further work	244

Chapter 9 Prospects for a safe enough Inner Melbourne	248
9.1 Introduction.....	248
9.2 Context opportunities	250
9.3 Process lessons and opportunities.....	252
9.4 Content (actions)	255
9.5 Summary.....	263
Chapter 10 Conclusions.....	264
10.1 What is 'good enough' safety in a city for adults to travel by bicycle and how safe are Inner Melbourne, Amsterdam, and Copenhagen?	264
10.2 Why is it that safety is good enough for many adults to travel by bicycle in Amsterdam or Copenhagen but not in Inner Melbourne?	265
10.3 What can be learnt for Inner Melbourne from Amsterdam or Copenhagen?	267
10.4 Contribution.....	268
References	271
Appendices	292

List of Figures

Figure 1-1	Bicycling in Amsterdam, Copenhagen, and Melbourne	2
Figure 1-2	Chapter outline	12
Figure 2-1	Changes in road user deaths.....	16
Figure 2-2	Infrastructure risk and danger	27
Figure 2-3	Safety influences on mode choice	30
Figure 2-4	Reasons for not riding for transport	32
Figure 2-5	SRA <i>Safe System</i> model	37
Figure 2-6	Health policy triangle	49
Figure 2-7	Benington and Moore's strategic triangle	50
Figure 2-8	CPC Analytical model to explore city safety.....	56
Figure 3-1	Methods.....	60
Figure 4-1	Amsterdam Case Study Area	80
Figure 4-2	Copenhagen Case Study Area	81
Figure 4-3	Inner Melbourne Study Area	82
Figure 4-4	Inner Melbourne, mode share and injuries	86
Figure 5-1	Trips and injuries in Amsterdam	97
Figure 5-2	Road space allocation, Amsterdam	114
Figure 5-3	Controlled intersection, Amsterdam.....	116
Figure 5-4	Elevated entrance.....	118
Figure 5-5	Truck with improved vision, mirrors, and side under-run.....	122
Figure 6-1	Road trauma trend in Copenhagen.....	129
Figure 6-2	Safety trends in Copenhagen	130
Figure 6-3	Amagerbrogade Copenhagen 1945.....	135
Figure 6-4	Strøget, Copenhagen, 1962.....	136
Figure 6-5	Danish travel posters circa 1940.....	139
Figure 6-6	Providing for cyclists during Metro construction.....	149
Figure 6-7	Modern Copenhagen bike lane.....	150
Figure 6-8	Blue paved, potential conflict area	155
Figure 6-9	Danish Sperm Bank bike	160
Figure 6-10	Turning car stopped to let cyclists pass through on the right	161
Figure 6-11	Woman with infant, stopped to talk on her phone.	163
Figure 7-1	Melbourne Trains c.1891	171
Figure 7-2	Melbourne Trams c.1901	171
Figure 7-3	Swanston St corner Flinders St c.1900.....	172
Figure 7-4	Inner Area PBN.....	189
Figure 7-5	Inner Melbourne, arterial road bike lane	191
Figure 7-6	Melbourne 'Copenhagen' bike lane.....	192
Figure 7-7	Kerbside Inner Melbourne local street	194

Figure 8-1	Tram and train development compared	205
Figure 8-2	Melbourne c. 1910	207
Figure 8-3	Copenhagen c.1940	209
Figure 8-4	Risk and danger nexus - examples.....	231
Figure 9-1	Production of safety	255

List of Tables

Table 2-1	Synthesis of Melbourne data on bicyclist injuries.....	18
Table 2-2	Garrard's comparisons of perceptions	33
Table 2-3	Principles of Sustainable Safety	39
Table 2-4	Synthesis: factors present in successful change	55
Table 3-1	Data sources and analysis.....	69
Table 4-1	Inner City Comparisons, Melbourne, Amsterdam, and Copenhagen	83
Table 4-2	Travel exposure: Mode share (percentages of trips)	87
Table 4-3	Serious Injury (KSI) Risk by Mode in Inner Melbourne (2013).....	89
Table 4-4	Bicyclists traffic 'Risk'.....	90
Table 5-1	Amsterdam informants.....	95
Table 5-2	Netherlands road hierarchy.....	112
Table 6-1	Copenhagen informants	129
Table 6-2	Danish Road Types	152
Table 7-1	Melbourne informants	168
Table 7-2	Persons Killed and Seriously Injured by Mode in IMAP, 2013	169
Table 8-1	Adaption and bicyclist safety from the 1980s.....	212
Table 8-2	Cultural influences and consequences	215
Table 8-3	Process factors compared	217
Table 8-4	Actors	220
Table 8-5	Safety co-production rating.....	222
Table 8-6	Road infrastructure characteristics	226
Table 8-7	Features of roads for bicyclists	227
Table 8-8	Safety influence of vehicles	233
Table 8-9	Behavioural differences	234
Table 8-10	Content influencing factors	236
Table 9-1	Developing individual competence	260

Common abbreviations

4WD	Four Wheel Drive
AITPM	Australian Institute of Traffic Planning and Management
Ams	Amsterdam municipality
ANWB	Algemene Nederlandse Wielrijdersbond, Royal Dutch Touring Club
Austrroads	Association of Australian and New Zealand Road Transport Authorities
BUGs	Bicycle User Groups
CBD	Central Business District
CLOCS	Construction Logistics and Community Safety – partnership to embed road safety in construction projects
CPC	Context Process Content framework
Cph	Copenhagen municipality
CrashStats	The database of Victorian fatal and injury road crashes reported to Victoria Police
CROW	Technology platform for transport, infrastructure, and public space in The Netherlands
CVC	Central Traffic Commission, Amsterdam
EU	European Union
€	Euro, the European Union currency; One Euro is equivalent to approx. \$1.60 Australian and \$1.10 United States of America
FDM	Federation of Danish Motorists
FSI	Fatal and Serious Injury, the same meaning as KSI
GDP	Gross Domestic Product
Gov.	Government
IMAP	Inner Melbourne Action Plan
IRTAD	International Traffic Safety Data and Analysis Group
ITEANZ	Institute of Transportation Engineers, Australia and New Zealand
ITF	International Transport Forum
ITS	Intelligent Transport Systems
kiM	Netherlands Institute for Transport Policy
KSI	Killed and Seriously Injured, the same meaning as FSI
LED	Light Emitting Diodes
LGA	Local Government Area, municipality
MMRA	Melbourne Metro Rail Authority
MUARC	Monash University Accident Research Centre
Munic.	Municipality
MV	Motor Vehicle
NACTO	National Association of City Transport Officials (North America)
NCD	Non-communicable disease
NGO	Non-Government Organisation
NTC	National Transport Commission, Australia
OECD	Organisation for Economic Co-operation

OPEC	Organisation of the Petroleum Exporting Countries
PBN	Principal Bicycle Network, Melbourne
PIA	Planning Institute Australia
R index	Risk index
RACV	Royal Automobile Club of Victoria
Ret.	Retired
RMIT	Royal Melbourne Institute of Technology, University
SRA	Swedish Road Administration
St	Street
SUV	Sports Utility Vehicle, usually four-wheel drive and heavier than cars
SWOV	<i>Stichting Wetenschappelijk Onderzoek Verkeersveiligheid</i> Dutch Institute for Road Safety Research
TAC	Victorian Transport Accident Commission
TCPA	Town and Country Planning Association, Melbourne
TNO	Netherlands Organisation for Applied Scientific Research
TRB	Transport Research Board, USA
UK	United Kingdom
USA	United States of America
VAED	Victorian Admitted Episodes Dataset on public hospital care
VAT	Value Added Tax
VEMD	Victorian Emergency Minimum Dataset on presentations at public hospitals
VicRoads	Roads Corporation of Victoria
VISTA	Victorian Integrated Survey of Travel and Activity
VPA	Victorian Planning Authority
VSTR	Victorian State Trauma Registry of major trauma care in hospitals and healthcare facilities
WHO	World Health Organisation
WW2	World War Two, 1939-45

Units of measurement

km/h	kilometres per hour
km ²	square kilometres

Chapter 1 Introduction

Bicycling can be a key contributor to sustainable city access and mobility. However, unless a city is safe enough for trips by bicycle, many trips will be made at higher cost by car or public transport. Also, in a city that is unsafe for bicycling, the community foregoes health, environmental and social co-benefits.

Researchers have argued the need for location specific studies on the efficacy of policy interventions in a city with low levels of bicycling as:

infrastructure provision, program, or policy might have different impacts on bicycling in different contexts, making it risky to generalize about the effectiveness of any individual measure.

(Pucher et al., 2010, p. s121)

In this research, I seek a deeper understanding of the contextual and safety differences between Inner Melbourne, which has comparatively low levels of bicycling compared to the exemplary bicycling ‘big cities’ of Amsterdam and Copenhagen as identified by Buehler and Pucher (2012). I ask: what could be changed to make Inner Melbourne safe enough for a broad demographic of adult car users to change to bicycles for short city trips?

Inner Melbourne¹ is a compact area that developed in the pre-car era; it retains many characteristics that suggest the potential for more adults to ride to nearby activities instead of using cars. Safety fears and driver behaviour are, however, established barriers to more transport cycling (Garrard et al., 2008; Godefrooij, 2014; Sweeney, 2018).

A sample survey for the Victorian government road agency, VicRoads, found that 75% of bicycle owners were risk-averse and restricted their riding because of safety concerns (Hall and Partners, 2010). A 2018 survey of Melbourne residents found that most

¹ Inner Melbourne is the small central area of Greater Melbourne, in the State of Victoria. Inner Melbourne (see Figure 4-3) is the area defined by the five municipalities of Maribyrnong, Melbourne, Yarra, Port Phillip and Stonnington: a grouping used in the Inner Melbourne Action Plan (Inner Melbourne Action Plan, 2013) and Plan Melbourne (Government of Victoria, 2014).

considered bicycling as too intimidating because of the risk of a collision or car dooring (Sweeney, 2018).

However, in cities such as Amsterdam and Copenhagen, a large number of riders can be observed, in designated space, on utility rather than sport bicycles, and dressed for their destinations be that work, shopping, or social activities, see Figure 1-1. The demographic of riders includes more women and people across a wider age range than in Melbourne (Garrard, 2011).



Amsterdam



Copenhagen



Melbourne

Figure 1-1 Bicycling in Amsterdam, Copenhagen, and Melbourne

To make a trip in Inner Melbourne with a low risk of injury, it makes sense to avoid bicycle use. In 2009 bicycle riders made 4% of trips (by all modes) but experienced 22% of the recorded serious injuries (Department of Transport Victoria, 2009) (CrashStats 2009-2013). Potential transport riders, the could-be riders², are unlikely to know the comparative statistical risks, but they perceive that riding is more dangerous than other modes – car use, public transport, or walking – as is reflected in their travel choices.

Many factors influence perception of safety for could-be riders, including the speed, volume, number, and size of vehicles in traffic, the views of friends and family, and how they feel about their operational competence to create a safe enough trip. Safety is a personal construct is subjective, variable, relative, and tradeable, for speed and other perceived benefits as discussed in Chapter 4 (Slovic et al., 2004). Provision of good

² A could-be rider is a person who has access to a bicycle but rarely rides for short transport trips. They may ride for recreation but make most short trips by car or public transport.

enough safety for bicycling in a city is thus a complex challenge for policymakers. Aldred et al. (2017) also argue that safety needs to be high enough to meet the needs of under-represented groups such as women and older people (Aldred et al., 2017).

International and local research and practice over the last 50 years has suggested a variety of measures to improve rider safety, ranging from controls on riders, support through the four E's: Engineering, Encouragement, Education, and Enforcement (Scott et al., 1978), to comprehensive and integrated urban planning and national policies that prioritise bicycle riding and control car use (Pucher & Buehler, 2008).

1.1 Research purpose and approach

My motivation is to contribute to knowledge and practice on city sustainability, as envisioned in the 'sustainable mobility paradigm' outlined by Prof David Banister, with a change from car to bicycle for some short trips (2007, 2008). The first issue is the perception among car users in Melbourne that bicycle use for transport is too dangerous. A second issue is an apparent concern amongst policymakers for the safety of those who could be encouraged to ride (Schepers & Heinen, 2013). As observed by Wegman et al., these concerns are reasonable as bicycling 'is rather dangerous' (Wegman, 2012, p. 19). The unprotected human body is fragile, vulnerable in traffic and bicyclists can also fall and sustain serious injuries. The safety questions to be faced for individual travellers and policymakers hinge on the feasibility of more people using bicycles as transport without an increase in fatalities and injuries (Wegman, 2012).

A very distressing example of the traffic risk faced by people who decide to travel by bicycle was put to me as I started this research. A friend from Inner Melbourne told of a neighbour, a young professional woman, who was advised to try riding to work, had done so and was run over by a truck and critically injured. The details were shocking: as the young woman had been wearing a helmet, she remained conscious while being crushed under the truck's wheels. She then spent weeks, confused, in an induced coma believing she was being tortured. Her recovery took many months and several complex operations. I thought this is not good enough, surely travel by bicycle in Inner Melbourne could be made safer.

As an engineer and transport planner, my professional interest in bicycles as transport started in the 1970s and continued with my work at the Commonwealth Bureau of Roads, the Melbourne and Metropolitan Board of Works, the Ministry of Transport, Road Construction Authority/ Road Traffic Authority/ VicRoads, City of Melbourne, Department of Infrastructure, ARRB Group and at Halcrow Pacific. My initial motivations included: concerns over Melbourne's car dependence, reliance on imported oil; the road toll (which in Victoria had reached 1066 deaths); and the equity issues associated with car dependence, as raised by Ivan Illich in his book *Energy and Equity*. Illich was a strong influence as he brought these issues together and put a compelling case for the bicycle as efficient and equitable urban transport (Illich, 1974; Tranter, 2012).

In the late 1970s and early 1980s, following the lead of bicycle riders³ including community activist Alan Parker, journalist Keith Dunstan and Brian Dixon MP (then the Victorian Minister for Youth, Sport and Recreation), I worked with colleagues on the Geelong and Melbourne Bicycle Plans. The Geelong Plan study team included a planner, Mike Scott, originally from the UK, who, with activist Alan Parker, was familiar with what was happening for cycling in Amsterdam and the Netherlands. Child safety was a major concern for Victoria, as it was in the Netherlands, which led to development of Victoria's Bicycle Ed program for year five and year six Primary School children; recommendations for the default urban speed limit to be reduced from 60 km/h to 40 km/h – with an eventual compromise of 50 km/h introduced in 2001, and 'secondary' safety through compulsory bicycle helmet legislation. Measures were framed around the 4 E's of Engineering, Education, Enforcement, and Encouragement (Scott et al., 1978), developed 20 years before the Road Safety, *Safe System* and *Vision Zero* framework (Tingvall & Haworth, 1999).

The efforts to improve the city for bicycling in Melbourne in the 1970s and 1980s, however, succumbed to 'automobilisation' (Sweezy, 2000). Banister, in the UK, observed that getting attention for bicycling as transport was hampered by the dominant

³ I generally use the terms bicycle riders (or riders) to distinguish transport or utility riders from recreational 'cyclists', however cyclists is also used as this is common usage in Europe.

transport policy paradigm that time spent travelling was a cost to be minimised and with savings in travel time quantified as a benefit for the numerator in the benefit-cost analysis used to justify road projects. Less and slower motorised traffic in cities was not acknowledged as being of value for city amenity and safety, and the value of time spent on active travel, like bicycling, was yet to be incorporated as a benefit in public discourse.

A strong argument, built on economic, environmental, social and health grounds for more bicycle use, has, however, not led to the widespread adoption of measures to support growth in travel by bicycle (Cavill, 2012; Giles-Corti & Whitzman, 2012; Grous, 2011; Pattinson, 1977; Pucher & Buehler, 2012; van Ommeren et al., 2012). The benefits for cities from more bicycle riding – less car use, less noise and air pollution; reduced road and public transport congestion (Low, 2007); and health benefits to the community from incidental exercise while travelling, and a safer road system for all users (Marshall & Garrick, 2011) – has not received community or political recognition.

A further issue is that in Melbourne and Australia, the road safety focus for the last 50 years has been on protecting car occupants by safer roads, safer cars, and safer drivers. Also, contemporary local research on bicycle rider safety has primarily focused on the safety of existing riders, that is, to reduce the risk – the number of injuries – as distinct from improving the perceived safety of bicycle riding to increase the numbers riding. To attract new riders it will be necessary to think beyond the safety needs of existing riders, understand the needs of a broader demographic, and tackle local systemic barriers.

1.2 Aim: understanding safety for potential bicyclists

To further the understanding of the complex problem of city safety for adult ‘could-be’ transport riders in Melbourne, I use the Interpretive Research methodology in a comparative case study with mixed methods. Interpretive research can start from puzzling about why things are how they are (Schwartz-Shea & Yanow, 2012), rather than testing hypotheses. In this thesis safety is explored as a social phenomenon, to be understood in specific contexts, as well as to learn from differences.

Safety and risk are complex issues (Adams, 1995; Twisk et al., 2013). For this research, however, two practical dimensions are considered: objective safety or measurable risk; and subjective or perceived safety – what I call 'danger' (see Chapter 4). Objective safety, risk, can be assessed by crash analysis with attention then directed to high-risk aspects such as: engineering standards; vehicle design; traffic regulations and road user behaviour. Perceived danger is different, as, although the perceptions may draw on the objective environment, decisions are based on individual beliefs and constructs, influenced by emotions rather than facts. As explored later in Chapter 4, these two dimensions, risk and danger, are not always congruent.

Cities are complex systems and safety is a complex issue. Safety for travel by bicycle is in part a product of how a city has developed: its history, infrastructure, land use, institutions, and policies at all levels of government, including the extent to which policies have privileged private motorised travel, automobility, over other modes (Beckmann, 2004; Marshall & Garrick, 2011). In cities, the safety of trips by bicycle may vary with contextual factors, such as trip lengths to reach destinations, motor traffic volumes and speeds experienced, and individual rider operational choices, such as route and speed, as well as the characteristics of riders, such as age and operational ability. 'Safety' is thus a local, city-specific, socially, and individually constructed socio-technical phenomenon which one can seek to understand but not necessarily fully explain.

Complexity influenced this research as it led me to shift my focus from safety engineering measures for bicyclists to the broader question of why some cities were safe-enough for people to make trips by bicycles while others, like Melbourne, were not. The socio-technical systems approach (Trist, 1980) and the Deep Design concept (Wann, 1995) show that for effective change in fields involving planning, engineering, and design, it is necessary to engage both with people's conscious thoughts and unconscious feelings.

To explore these issues, I drew on research from several disciplines, including public policy and public health (Walt & Gilson, 1994; Walt et al., 2008). The context of the Walt and Gilson framework was conceptualised as including transport and land use policies; and the content as including engineering measures, such as bicycling

infrastructure and vehicle safety – of both bicycles and motor vehicles, and the management of motor vehicle volumes and speeds.

It is acknowledged that safety is but one of many factors in travel choice (Goodwin, 2008). Other concerns, not covered here that deter potential transport bicycle riders include possible theft of their bicycle, weather extremes, limited ability to carry objects, the possibility of delays due to mechanical failure or minor incidents, abuse from motorists, and reluctance to go against prevailing group norms favouring motorised transport (Australian Department of Infrastructure and Transport, 2012; Bauman et al., 2008b; Pojani et al., 2017; Vandenberg & Steinemann, 2007). These barriers, however, also have a secondary influence on safety as, by reducing the amount of bicycle riding, the ‘Safety in Numbers’ effect is not developed for those who do ride (Jacobsen, 2003).

Excluded from this research are the wide-ranging benefits of more transport bicycling, the economic, environmental, and social benefits, including the business case for more travel by bicycle, which, as noted above, has been well covered by others.

As the motivation for this research was to understand how a city can further sustainability by being safe enough for significant amounts of travel by adults on bicycles instead of in motor vehicles, the safety of bicycle use is explored relative to the safety of other modes, particularly motor vehicles. Safety for children is thus also out of scope for this research, although the overlap of interests is clear (Tranter, 2018). Safe bicycling for children has also been well covered by others, such as Freeman and Tranter (2011).

Recreational bicycle riding – on and off-road – is also out of scope, although trips with a dual or secondary recreational purpose are notionally included. Dual-purpose trips support the idea of transport bicycling being called ‘utility’ bicycling; however, ‘transport’ bicycling is used in this research as it stresses the transport purpose. Safety concerns are also more important as a deterrent to transport cycling than recreational cycling, which is not particularly dangerous compared to many other sports (Bauman et al., 2008b). It is to be noted that as the available mass data on crashes does not separate transport bicycling from recreational cycling, this tends to overstate the number of

transport-bicycling injuries, but the numbers have not been adjusted as to do so would exacerbate the underreporting of injuries to bicyclists (Harman, 2007).

During the period of this research, 2012 – 2019, there was significant growth in e-bike use, ‘Bike Share’ programs, and new personal vehicles such as scooters; the issues for these phenomena are out of scope. However, safety for these sub-categories of vulnerable users could be expected to be improved in a city made ‘safe-enough’ for more bicycling. It is also noted that others have explored these important developments (Fishman & Schepers, 2014; Rose, 2012; Rose & Johnson, 2013; Schepers, J. et al., 2014).

This research aims to contribute to a *sustainable safety* vision for Inner Melbourne, building on local characteristics and drawing inspiration from Amsterdam and Copenhagen, with sensitivity to the differences in city contexts and the challenges of knowledge transfer.

Regarding time horizons for measures and programs, this thesis looks to the medium-term – 10 to 20 years.

In seeking inspiration on what ‘good enough’ safety may constitute, I drew on the ideas of the British psychotherapist Winnicott of ‘good enough’ parenting, which also recognises the importance of developing individual competencies. Then, to suggest a practical path for implementation, I drew on the public policy ideas of adaptive failure (Heifetz, 2003) and value creation through co-production (Alford, 2009; Benington & Moore, 2011).

In summary, several fields, including public health and public administration, suggest that a deep understanding is needed of the specific local contexts, policy frameworks and processes for effective change. Wegman et al. warn that the transfer of findings from a city like Amsterdam must be undertaken with caution, and must be focused on understanding principles (e.g. of the *Sustainable Safety* approach), not copying of detailed measures (Wegman et al., 2012).

1.3 Research questions and approach

This research started from an engineering perspective, to study if further *Safe System* measures used in northern Europe for bicycle safety could be adapted and transferred to Melbourne. However, it became apparent that to improve the safety of adult bicyclists sufficiently to encourage more travel by bicycle, there were bigger questions relating to the contextual factors. The research questions are thus framed from a socio-technical systems perspective to understanding why safety for bicycling is different in Inner Melbourne to the two exemplar cycling cities, Amsterdam, and Copenhagen? This is explored by three questions:

- 1) What is 'good enough' safety in a city for adults to travel by bicycle and how safe are Inner Melbourne, Amsterdam, and Copenhagen? (Chapter 4)
- 2) Why is it that safety is good enough for many adults to travel by bicycle in Amsterdam or Copenhagen but not in Inner Melbourne? (Chapters 5, 6, 7 and 8)
- 3) What can be learnt for Inner Melbourne from Amsterdam or Copenhagen? (Chapters 8 and 9)

These questions are asked within the interpretive frame (see Chapter 3), to understand what is going on in each city, rather than testing hypotheses. The interpretive research approach, used within the broad constructivist-interpretivist framework, involved analysis of secondary quantitative data and then the collection and analysis of different types of qualitative data and. Interpretive research privileges the empathic, that is, it is undertaken without judgement but involves interpretation of documents, data, and the views of participants valuing their local, situated knowledge (Schwartz-Shea & Yanow, 2012, p. 5).

The comparative case study approach is used to advance understanding of the differences in real and perceived safety for people using bicycles for transport in Amsterdam, Copenhagen, and Inner Melbourne. The trip making by bicycles, for shopping, social activities, work or education, is envisaged as 'low intensity' riding; that is at a leisurely pace of less than 25 km/h, wearing clothes for the destination not for the ride, as for trips made on foot, in public transport or by car.

As shown by Pucher, Buehler and others much can be learnt from studying bicycling in other cities and countries (Buehler & Pucher, 2012b; Pucher & Buehler, 2008, 2013; Pucher & Dijkstra, 2000). As others have undertaken broad comparisons across multiple cities (Buehler & Pucher, 2012b), this research is based on only three inner-city areas to allow a detailed and deeper exploration.

The geographic focus for this research is the Inner Area of Greater Melbourne, as defined by the Inner Melbourne Action Plan (IMAP) group of five councils, see Figure 4-3. That is, excluded are the diverse and car-dependent middle and outer suburbs of Greater Melbourne.

In seeking to understand why there is so little transport bicycling in Inner Melbourne, compared to Amsterdam and Copenhagen, the focus is on the differences in the safety of the cities for bicycling by adults. Potential could-be riders in Inner Melbourne may be drawn from a broad demographic who currently use cars, (or public transport or walk), for short, up to 5 km, trips that could more efficiently be made by bicycle. The importance of safety for women was illustrated by Heesch et al. (2012) who found that they feel more constrained than men by environmental factors; a safe-enough city for women to ride needs to be to a higher level of safety (Heesch et al., 2012). New transport riders are envisaged to come from a broad demographic who believe that riding for transport in the Inner Melbourne is too dangerous; this demographic includes more women and ranges from experienced sports cyclists to those who rarely ride a bicycle, to people who have a disability (Aldred, 2017).

1.4 Significance and contribution

This research advances the practice of urban policy and planning through a context-sensitive approach that systematically considers aspects of different national, regional, and local policies. The research approach reveals the possibilities of learning and transfer of principles and ideas to improve city safety for travel by bicycle. It contributes to policy analysis by developing the Walt and Gilson public policy health triangle (see Figure 2-6) for city safety for bicyclists by including the *Safe System* model and extending it to urban policy and planning.

Two neglected areas of city safety for bicyclists in Inner Melbourne are addressed: the safety concerns of 'could-be riders' and the lack of interest by the Victorian and Australian governments in the safety needs of these potential riders. This thesis thus differs from the significant body of research on improving the safety of existing riders and seeks to provide balance to road safety policies focused on the needs of motor vehicle users.

The research provides an example of the interpretive research approach applied to an urban transport policy issue, city safety for bicycling, that draws on both quantitative and qualitative data –from interviews, document analysis, observation and engagement – in a way that has not to my knowledge been previously used to explore safety for bicyclists. This research also contributes to the case study methodology by demonstrating how city areas can be better defined for stronger comparisons, the importance of understanding history, and the insights gained from multiple perspectives.

This research also provides a way to calculate and compare risk – injury numbers related to trip numbers⁴ – the “R” index, for different modes and between cities. The question of when a city is safe enough for bicycle use to be a mainstream choice is then explored. A framework is also provided that considers the relationship between objective risk and subjectively perceived safety – danger – an interaction relevant to governments and individuals. Finally, the research contributes to practice by setting out a vision for good-enough bicycle safety, founded on sustainability and liveability values, that could be pursued through co-production.

⁴ A development of the measure, crashes per 100,000 trips, used by Pucher and Buehler (2016)

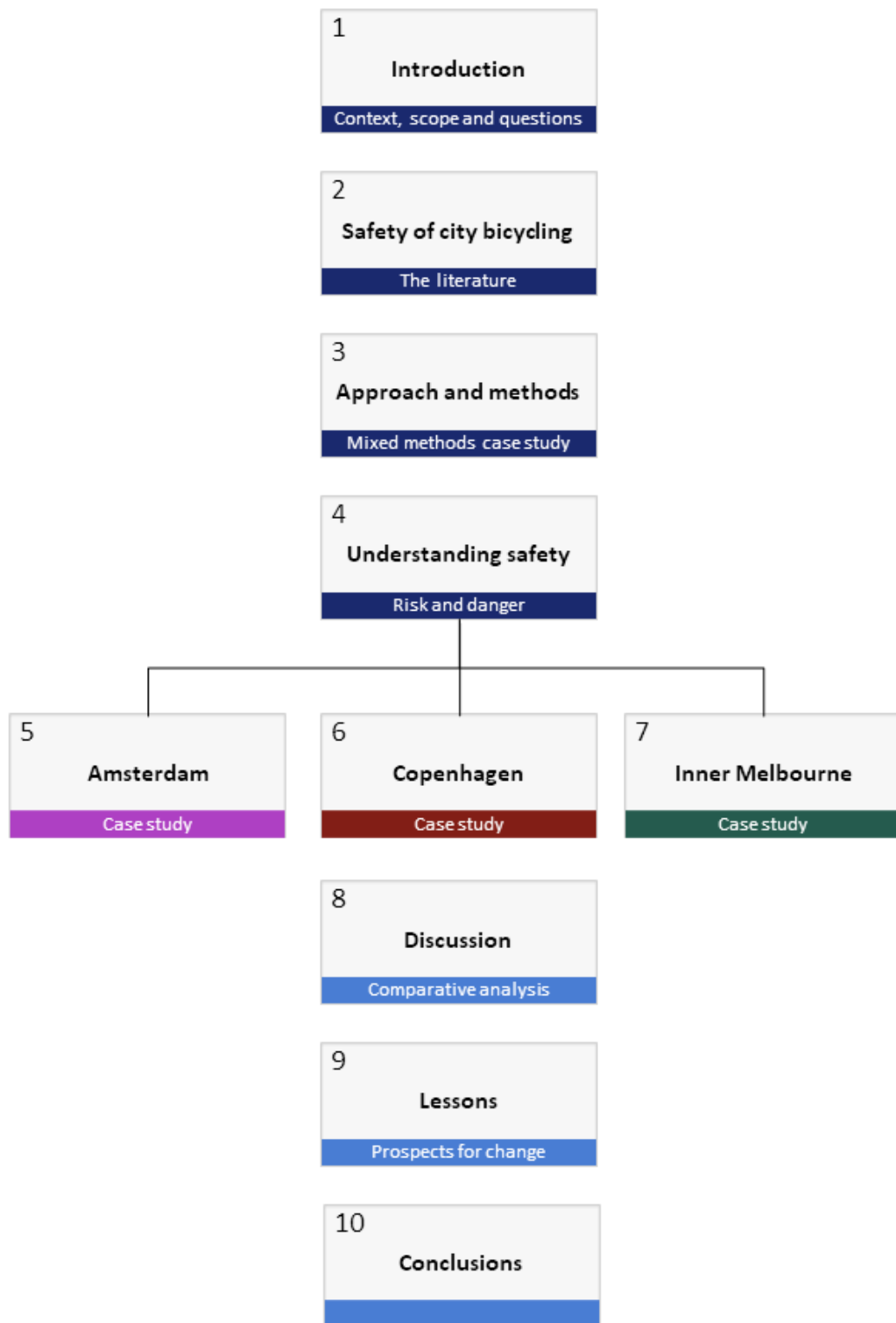


Figure 1-2 Chapter outline

In the next chapter, I review theories and the academic material on the safety of bicycling in cities. Several theories are considered to aid understanding of bicycling safety, including from engineering, socio-technical systems theory, public health, and public policy. Constructs (understandings) of road safety are discussed, including issues with data reliability, exposure, and objective and subjective safety. Selected literature on the development of policy and transfer of best practice is also reviewed. To explore the range of influences on the safety of a city for travel by bicycle, an integrated analytical framework is developed drawing on concepts from: public health policy, public policy, and the *Safe System* approach, see Figure 2.8, the Context, Process and Content (CPC) framework.

Chapter 3 then outlines the rationale for the use of a constructivist interpretive research approach to understanding what shapes safety for bicycle riders, the choice of the comparative case study approach, and the use of mixed methods. Details are then given of the phases of research, including exploratory interviews, use of social media, statistical analysis, document analysis, interviews, observation, and engagement.

In Chapter 4, I define the case study areas: Inner Melbourne, Amsterdam, and Copenhagen. The defined areas are used to explore quantitative aspects of safety for bicyclists in each study area and develop a way of quantifying objective risk by considering injury numbers relative to trip percentages.

Chapter 5 on Amsterdam, Chapter 6 on Copenhagen and Chapter 7 on Inner Melbourne provide the detailed case study analysis, utilising the CPC framework (Figure 2-8), to understand safety for bicyclists in each case study city, drawing on documents, observations, and the perspective of key informants. The findings are organised under three subheadings: the historic, cultural and policy **context**; the **processes** for decisions and implementation; and the **content** of measures.

In Chapter 8, Interpretation and discussion, the lessons for Inner Melbourne in comparison with the exemplar cities, are considered. The contrasting institutional and policy contexts reveal weaknesses in the approach in Melbourne, while also suggesting opportunities to build on the local pride in liveability and road safety achievements. In exploring content measures, such as engineering design and regulation, the potential for

a different (people-centred) design philosophy is identified. Also noted are the perils that may follow from not understanding differences in context.

Chapter 9 sets out a vision for Inner Melbourne to be made safe enough for more travel by bicycle for a broader range of adults. A process of change is suggested, based on community-driven adaptive leadership and co-production, to move toward a city safe enough for transport bicycling in which stakeholders and independent actors contribute to the production of safety.

In Chapter 10, I summarise the answers to each research question and outline my contribution.

Chapter 2 Literature review: the safety of city bicycling

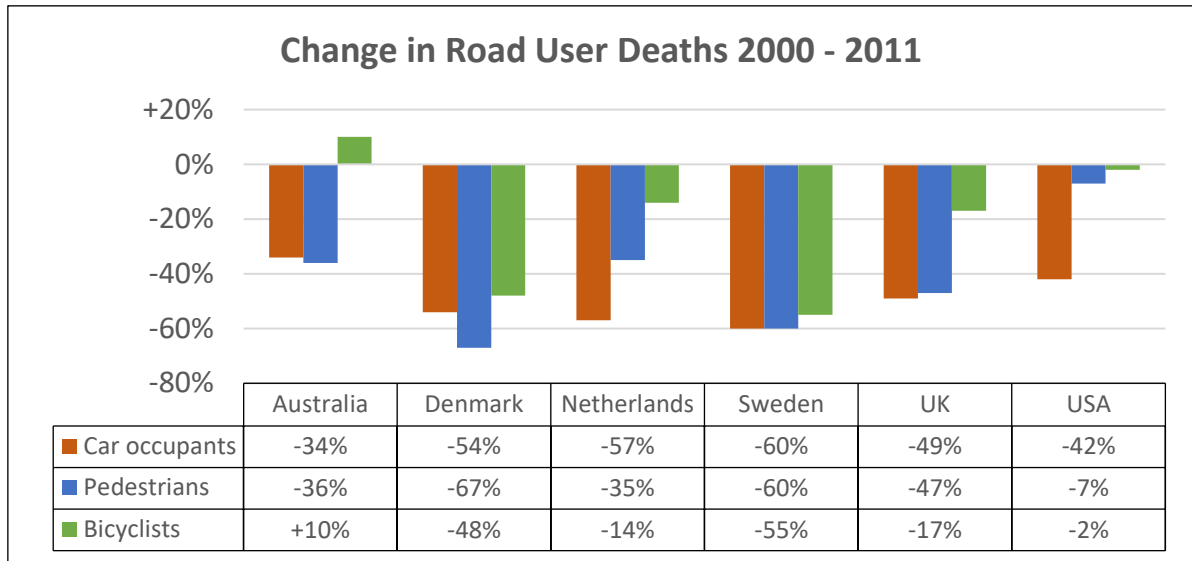
This chapter explores the literature on road trauma to bicyclists and the associated fear of injury that is a barrier to sustainable transport in Melbourne. First, I briefly summarise why safety for bicycling is important for cities then draw out key findings from Melbourne crash studies. Then, current perspectives on reducing road trauma to bicyclists, the safety concepts, and the influence of perceptions of danger that deter could-be riders are discussed.

In the second half of this chapter, I draw on a broader interdisciplinary body of research, including theories and models from public policy, institutional change, and reasons for implementation failure. This chapter concludes with an integrative model used to understand differences and states the research questions explored in this thesis.

2.1 Why safety for bicyclists is important

The literature provides compelling reasons for improving the safety of cities for bicyclists. Pucher and Buehler, in *City Cycling*,(2012), emphasise that bicycling is (potentially) highly beneficial for individuals and society. The World Health Organisation (WHO), has reported that in cities, heavy motorised traffic travelling at high speed has resulted in high levels of road trauma, and then, by deterring active transport, including bicycling, is causing increases in longer-term deaths and disability for motor vehicle users (2013). WHO estimated there were 21.2 million deaths and serious injuries to people who engaged in active transport, and 34.5 million deaths to people with sedentary lifestyles because of reliance on motorised transport (Lee et al., 2012).

During the 20th century, as motor vehicle use increased, the road safety problem emerged and was framed as an unacceptable number of road deaths. Road deaths have persisted as a road safety metric. For example, the OECD 2013 international benchmark study on road safety, was based on road deaths, see Figure 2-1 below:



Adapted from (International Traffic Safety Data and Analysis Group (IRTAD), 2013)

Figure 2-1 Changes in road user deaths

The OECD study revealed that, in Australia, unlike most other OECD countries, bicyclist deaths increased by 10% but decreased in Denmark by 48%, and in The Netherlands by 14%. The data also revealed different trends between modes. In Australia, deaths to pedestrians decreased by 36% and for car occupants by 34%, however, in the Netherlands and Denmark, the improvement in safety outcomes for car occupants was even greater than in Australia. The IRTRAD data thus supports the argument by Wegman et al. that improved safety for bicyclists can be good for all road users (2012).

Differences between countries revealed in the IRTRAD data point to the influence of national policies including: road rules; controls on vehicle design (such as aggressivity of vehicle fronts); economic policies (such as vehicle and fuel taxation); and policies on land use arrangements which influence the accessibility of activities and trip lengths. The next section provides a synthesis of studies of crashes, most of which occurred in Melbourne⁵, Australia, the larger metropolitan area containing the study area for this research.

⁵ Most of the recorded crashes occurred in Melbourne but some data sets included a small number of crashes from beyond Melbourne.

2.2 What Melbourne crash studies show

This section provides a synthesis of findings from several studies on crash data and related in-depth studies. The objective measure used for primary safety outcomes is the combined numbers of deaths and serious injuries (Peden et al., 2004). In Europe, this metric is killed and seriously injured (KSI), and in Australia, fatal and seriously injured (FSI) (Austroads, 2013). The KSI (or FSI) is a more informative indicator of environmental risk for bicyclists, as, for example, in the Inner Melbourne study area in 2013, there were no reported deaths for bicyclists, but over 160 reported serious injuries (VicRoads, 2015).

In Melbourne, over the eight years from 2000, with an increase in cycling, there was a doubling of deaths and serious injuries (Garrard et al., 2010). Garrard et al. also note that there was an increase in the objective risk of potential injury from bicycle use relative to car use. Seven local studies, summarised below in Table 2-1, provide insights into the safety needs of existing bicyclists, as well as indicating some of the risks could-be riders would face. Three of the studies used CrashStats, the road crash data based on police reports that are relied on by Victorian agencies for road safety reporting and policy; this data is however heavily biased to crashes involving motor vehicles. Other studies used additional sources, including hospital data sets, and in-depth sample surveys, to provide further insights, including bicycle crashes that were not collisions with motor vehicles.

Table 2-1 Synthesis of Melbourne data on bicyclist injuries

	CrashStats (Police reports) (2004-08)	CrashStats (Police reports) (2002-12)	Transport Accident Commission (TAC) Claims Sample (2012-13)	VEMD Hospital Injuries (Outpatients) (2001-06)	VAED Hospital serious injury (2001-06)	VSTR Hospital major trauma (2001-06)	VSTR VOTOR major trauma (2013)	MACCS sample of seriously injured riders (2011)	Bicycle Network member reports (2012-2016)
Number	6,432	14,270	1000	25,920	10,552	298	186	159	2,480
MV involved.	87%	94%	100%				44%	40%	
% adults	80%	85%		56%	63%	81%		98%	
% males	77%			77%	80%	88%	81%	74%	
% on-road	100%	100%	100%	51%	41%	82%	69%	75%	79%
% intersections	59%	60%	55%						43%
Zone ≥ 60 kph	66%	65%	67%						
Utility riding				22%		33%	27%	30%	
Bicyclist only	6.4%						56%	60%	
	(Boufous et al., 2010) (1)	(Garratt et al., 2015) (2)	(Nieuwesteeg, M 2013) (3)	(Sikic et al., 2009) (4)	(Sikic et al., 2009) (4)	(Sikic et al., 2009) (4)	(Beck et al., 2016) (5)	(Biegler et al., 2012) (6)	(Bicycle Network, 2017) (7)

Although the findings from these studies have limitations (discussed in the following sections), useful insights include:

1) Inconsistent crash recording

- motor vehicles were involved in less than half the serious injuries to bicyclists seen in hospitals; hence CrashStats, which mostly records crashes involving motor vehicles, gives an incomplete picture (2)(5)(6)(7)

2) Injury severity

- bicyclists with injuries received on-road and from crashes with motor vehicles involved greater trauma – the hospital data contrasted on and off-road injuries (1)(4)(5)(6)
- the severity of injuries for bicyclists increased in speed zones at and above 60 km/h, suggesting the importance of separating bicyclists from high-speed traffic (1)(2)(3)
- serious injuries were mostly to adults, and there were twice as many riders injured over 60 years compared to younger adults (1). From 1992 to 2012 there was a large increase in injuries to older riders (3)
- most serious injuries were to males – but this may reflect that most bicyclists were male (1)(4)(5)(6)

3) Where injuries occurred

- one-thirds of state-wide claims for in-hospital treatment came from municipalities in the Inner Melbourne study area, which has less than 1/12th of the State's population (3)
- there were more injuries at intersections than on road sections, and most were at intersections not controlled by traffic lights, the most common (28.9%) being T junctions (1); as these crashes were dispersed, they could not have been treated by traditional 'black spot' programs, and point to the need for system-wide changes
- only 20% of injuries occurred on paths (7), and as most severe injuries occurred on streets and highways (not paths), this underlines the importance of separating bicyclists from fast-moving and heavy motor traffic (4)

4) Crash dynamics

- almost half of the crashes occurred when the riders estimated their speed to be below 21 km/h, suggesting the importance of infrastructure design standards and path and surface maintenance for rider safety (7)
- most riders were familiar with the crash site (6)

- half the injured riders were unable to take any evasive action to avoid an impending crash. Other road users contributed to 42% of crashes and debris in the rider's path contributed to 18% of crashes (6)
- contributing factors under the rider's control included: fatigue, speeding, distraction, riding when unwell, and poor bicycle maintenance (6)
- only 20% had completed any rider training although most held a driver licence (6)
- use of bicycle lights, including in daylight, was associated with significantly lower injury severity (6)
- most riders were engaged in sport or recreation when injured (not riding for transport) (4)(5)(6)

Key lessons from these studies are that:

- the risk of injury to bicycle riders is much greater than indicated by CrashStats
- some contributing factors to crashes may be of much greater importance for bicycle riders than other road users, such as the effect of infrastructure quality (because of two-wheeled instability), and rider alarm from sharing space with or in close proximity to other road users (e.g. dogs on paths or adjacent large vehicles)
- bicycle riders may lack 'capacity' to produce safety because of a hostile environment and may lack knowledge – holding a driver's license is not enough

Limitations of Melbourne crash studies

The numbers killed are reliably recorded, but a focus on deaths detracts attention from the larger numbers of people injured, only some of which are recorded. As noted by Jacobsen et al, for bicyclists, a low number of fatalities is not a sufficient indicator of traffic safety as compared to motorised road users, bicyclists experience many more injuries than fatalities (2009). The focus for this thesis is, therefore, on the avoidance of serious injury; what is called primary safety (Haddon Jr, 1972). A focus on injury numbers (KSI) however, also deflects attention from consideration of exposure and policies that influence mode choice.

The above studies also have significant limitations, as noted by the authors, including Garrat et al. who said:

it is important to acknowledge that while police data provides one of the most comprehensive data sources about road user crashes, there are limitations that need to be considered' such as the large number of injuries that are not recorded by police (2015, p. 1)

Biegler et al. noted the recording bias in Crash Stats towards crashes involving motor vehicles, that neglected many bicycle-only crashes (Biegler et al., 2012). The Police statistics may cover as few as 5% of injuries experienced by bicyclists (Harman, 2007). Also, Police statistics do not differentiate between types of bicycling – recreation or transport – or differences in rider expertise that would aid policy formulation. Hospital data captures more injuries but is of limited use for road safety analysis as it is primarily collected to aid treatment of the injured. The reported 'serious injury' is not always representative of the seriousness of injuries to bicyclists. For example, many fractures, a common outcome of falls by older bicyclists, do not usually require 'serious' medical interventions and are not classified as 'serious'. However, many of these injuries may seriously affect the lives of injured bicyclists, requiring months of restricted mobility and in some cases long term consequences, such as permanently reduced movement and loss of confidence. The reported 'serious' injury statistics also fail to see the relatively greater significance of 'minor' injuries to bicyclists compared to car occupants, who rarely receive any injuries. The large datasets based on police reports and hospital admissions also inevitably exclude injured cyclists treated by general practitioners – for example, for simple fractures – and those treated by first-aid providers. Additionally, as observed by Aldred (2017), the under-reporting of injuries to bicyclists conceals the significant social exclusion through fear of injury, that denies many people the benefits of (safe) bicycling.

In Victoria, countermeasures that have been effective in reducing the small number of fatal motor vehicle crashes have not achieved reductions in the much larger number of

injury crashes. Using South Australian data, Wundersitz and Baldock⁶ found that the underlying difference was that fatal crashes were often the result of extreme driver behaviours, such as speeding or drunk driving, while many injury crashes were associated with unintentional road user errors and system failures (2011). The Dutch Institute for Road Safety Research (SWOV) has also called for new and different policies and measures that focus on system improvements, compared to the regulatory and enforcement focus that has contributed to reductions in fatalities (Weijermars et al., 2013b).

A further issue with the use of detailed injury data like CrashStats to formulate site-specific road safety measures, such as for ‘black spot’ programs, is that it diverts attention from the need for system change for bicyclist safety. Also, enforcement campaigns targeting dangerous behaviour such as speeding and driving when impaired, while historically successful in reducing deaths to motor vehicle occupants, have proved ineffective in reducing the number of injuries to bicyclists (Cockfield, 2011; Garratt et al., 2015; Nieuwesteeg, M., 2013; VicRoads, 2013).

A related policy issue is that research in Melbourne has mostly aimed to reduce the number and severity of reported injuries involving motor vehicles, by, for example, the installation of roundabouts, or the legislation for compulsory helmet wearing to reduce the risk of severe head injuries should a crash or fall occur (Cameron et al., 1994). That is, the focus has not been on a reduction in the number of all crashes to all road users.

Cycling research in Melbourne (and Australia) has also mostly focused on current riders, with the safety of on-road sports and commuter cyclists attracting considerable attention (Beck et al., 2016; Biegler et al., 2012; Garratt et al., 2015; Johnson, 2011). Rowe (2013), in her PhD thesis on Cycling Participation, defined four types of riders: organised competitive, organised non-competitive, recreational (self-organised) and commuting or transport who ride to a specific destination. Differences in injuries to

⁶ The study was based on data from South Australia, but senior Police in Victoria said they believe the findings also apply to Victoria.

each group, that could suggest different education and support needs, are lost in the aggregated CrashStats. The specific needs of potential riders are also neglected.

2.3 Beyond recorded injuries

The number of injuries reported to police for bicyclists greatly understates the number of injuries to bicyclists. An estimate for Victoria by Harmen (2007) was that 30 times more injuries were experienced by bicyclists than were recorded by the Police. This local level of under-reporting is consistent with an international survey by Shinar et al. (2017) which found that the level of reporting varied by type of crash and road users involved, ranging from 25% for crashes involving motor vehicles to under 3% for falls by bicyclists.

Wegman and Aarts (2006) see the construction of safety for drivers, as conceptualised in Fuller's (2005) model, as also relevant for bicycle riders. Fuller's model highlights the dynamic interaction between travel task demand, road, and traffic condition - which a rider cannot control; and a rider's capabilities shaped by variables such as training, experience, physical and mental condition. Fuller's model captures how safety outcomes for individuals depend on both external and internal factors, about which riders have incomplete knowledge and understanding. Untrained or inexperienced bicycle riders are likely to be oblivious to some risks and the limitations imposed by their skills, such as riding at excessive speed downhill, passing too close to parked cars, or filtering inside a turning truck.

A further perspective on 'risk' for bicyclists in Australia is provided by Garrard's (2011) 'risk iceberg'⁷, with the visible peak the recorded fatal and serious injuries, and the large hidden base representing the fears about collisions, falls, near misses and harassment experienced. Garrard astutely observed that in contrast to car use, where perceptions of safety are associated with a high sense of control and high levels of trust in the protection provided by a car and the road system, bicycle use invokes feelings of low control and high vulnerability (2011).

⁷ A concept also developed by Adams (Adams, 1995).

Johnson et al. (2008, 2011, 2012) have examined the threats to bicyclists by using the 'naturalistic' approach, capturing the in-traffic experience of commuter cyclists via video cameras attached to the bicyclists' helmets. From an analysis of 127 hours of video recorded by commuter cyclists in Melbourne, two collisions, six near collisions and 46 incidents were identified; riders experienced one threatening event for almost every two hours of riding. The video analysis revealed the significance of near-miss experiences and the behaviours of both drivers and cyclists that endanger cyclists. Johnson et al. found that for bicyclists riding in Melbourne, to avoid injury, they must be constantly vigilant. Riders required 'high situational awareness' to anticipate and react to driver actions (Johnson et al., 2010). By contrast, surveys by the City of Copenhagen found that in 2010, 67% of Copenhageners felt safe in traffic (City of Copenhagen, 2011), and by 2014 the percentage feeling safe had risen to 74% (City of Copenhagen, 2014a).

The literature reflects two main ways of thinking about safety for bicyclists:

- 1) objective safety (risk): the rate of injuries, that is the numbers injured related to travel exposure
- 2) subjective safety (perceived danger), individual beliefs about the 'danger' of being injured

The objective risk of the various transport choices in cities is complex and varies with many factors such as infrastructure and vehicle quality, time of day, routes used, driver and rider behaviour, as extensively explored by Adams (1995). While objective safety is important for trauma reduction, subjective safety is important for travel choices. For could-be transport riders concerns (fear) about safety arise from several sources including media reports about road trauma to cyclists; and their on-road observations as drivers, pedestrians, public transport users or as recreational cyclists (Lindsay, 2013; Nieuwesteeg, M 2013; Pattinson & Whitzman, 2013).

In the middle of the 20th century, psychologist Abraham Maslow identified the importance, to human behaviour, of perceived safety (1943). Maslow observed that after the most basic of needs for shelter and food are satisfied, people organise their lives for 'safety', and to avoid danger, they rely on what is familiar. The insights from Maslow for transport are that adults will only use modes that they perceive and have

experienced as safe and will avoid modes that are new or perceived as dangerous. Sixty years after Maslow, Stern et al. confirmed that people would only consider modes perceived to be safe (Stern & Richardson, 2005). Other studies have confirmed that in travel decisions, fear and feeling vulnerable are avoided (Goodwin, 2008). In city environments dominated by motor traffic environments, Dutch cycling expert Godefrooij says ‘safety is the pre-condition for cycling’ (in Agudo, 2014, p. 43).

Perceived safety also varies with context, such as traffic conditions, and between individuals. The perceived safety of each mode of transport available in a city can, in part, be inferred from the mode choices revealed by travel surveys; that is low bicycle use infers many people may perceive bicycling as being too dangerous. While safety is but one of several subjective factors, such as perceptions about cost and travel time, which influence mode choice, as bicycling is often the lowest cost and most convenient mode for short city trips, low use emphasises the overriding importance of perceived danger as a barrier to bicycling. Prof. Goodwin in the UK, from a synthesis review of over 2000 research references on changing travel behaviour, found the perception of vulnerability amongst bicycle owners who rarely rode to be a powerful influence (2008). By contrast, for people who occasionally rode for transport, mode choice was influenced more by temporal considerations like prevailing weather (e.g. strong winds) and practical considerations like the need to be at multiple locations (Heinen et al., 2010). That is, perceived traffic safety is a threshold consideration for those who could ride but is of less concern to regular riders.

Horton, (2007), from research in the UK, argues that fear of bicycling is constructed through:

- road safety education that emphasises that the vulnerable (cyclists) should act to avoid danger (rather than governments exerting control to reduce the danger created by motorists)
- helmet campaigns that play to fear and do not reduce crashes
- statements that roads are too dangerous for cyclists, so cyclists need to be moved to separate off-road space – rather than making roads safer

Horton points to the ineffectiveness of measures designed to instil fear and caution in potential riders when what is needed are controls on motor vehicle numbers, speed, and size.

The perceived safety of bicycle use compared to other available modes was explored by Professor Noland from the University of California in a mail survey of 506 commuters in Philadelphia (1995). Nolan explored the perceived probability of having an ‘accident’⁸ and the likely severity of an injury, ranging from no injuries to death. Noland found that for bicycle use, compared to other modes, demand was highly elastic, that is, very sensitive to changes in perceived danger. A small increase in motor traffic volume or speed could, therefore, significantly reduce the amount of bicycling, or a perceived improvement, like marked bicycle lanes – which may not objectively improve safety – may increase bicycling (Noland, 1995).

As noted by Noland (1995), an issue for bicycle riders and decision-makers is that the perceived danger may be contrary to objective risk. I have diagrammatically represented the nexus between perceived danger and objective risk in Figure 2-2 below:

⁸ In this thesis, consistent with ‘Safe System’ thinking, I generally use ‘crash’ rather than ‘accident’ except where original research has used accident.

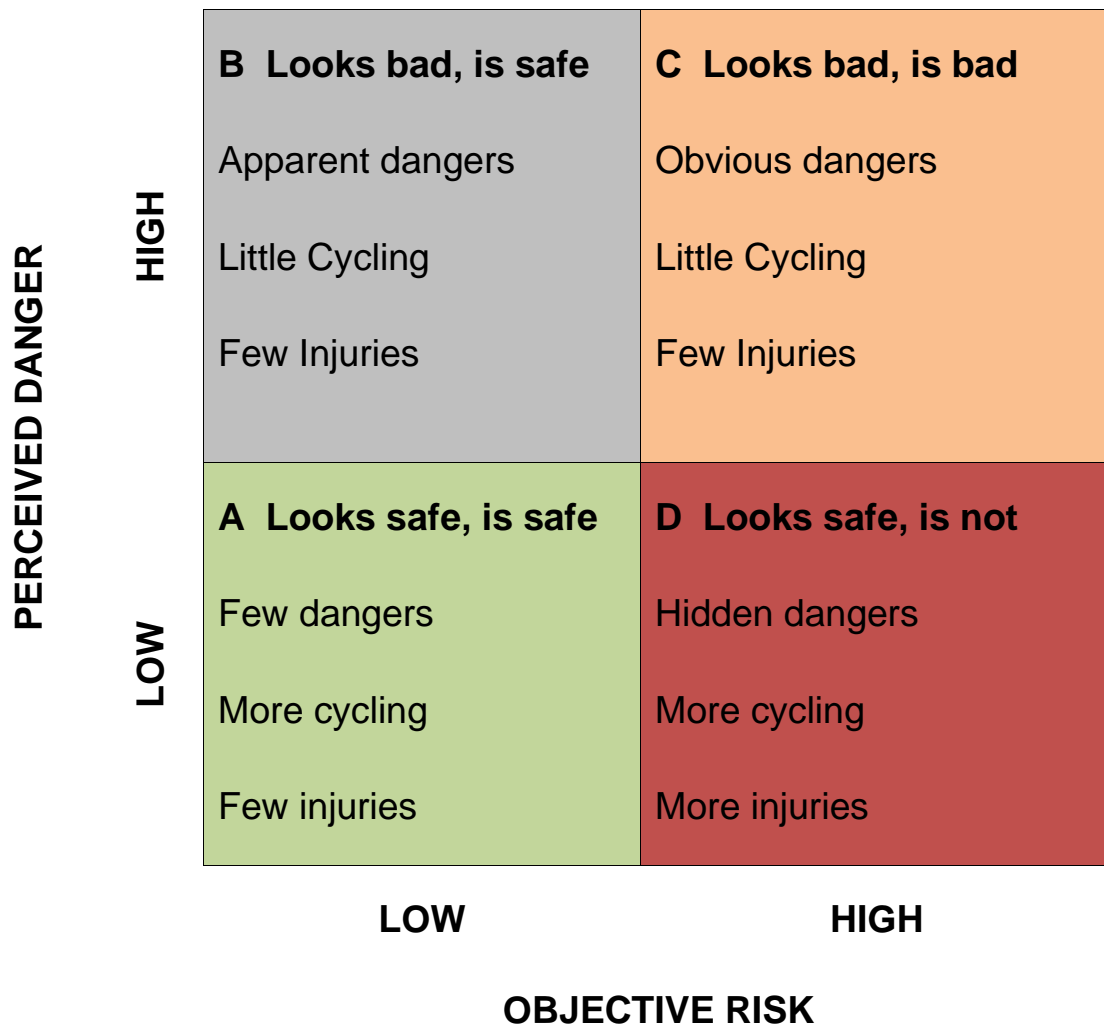


Figure 2-2 Infrastructure risk and danger

In practice, objective risk, and perceived danger of infrastructure (or regulations) are not always congruent, as illustrated above in Figure 2-2. If the road system and road users are to work together to improve safety, then the system elements need to be designed to communicate risk accurately, consistent with perception. That is, the worst case for safety outcomes is an environment that appears safe to riders (low perceived danger) but proves to be high risk (for example, through faulty design), the ‘red quadrant’ (D) in Figure 2-2 above. For example, Garrard (2012) found that in Melbourne, on-road painted bicycle lanes and narrow paths (typically shared with pedestrians) appear to have encouraged some bicycle use although an earlier study suggested such infrastructure may not have improved safety (Garrard et al., 2010). An Austroads study also found that Australian bicycle lanes had no overall effect on objective cycle safety

as the modest effect of the small lengths of high standard lanes were neutralised by travel on the larger length of lesser standard lanes (Turner et al., 2012).

If more people are to choose to travel by bicycle in Australia, both objective safety, and perceptions of danger (the deep fear) need to be tackled (Australian Department of Infrastructure and Transport, 2012). That is, riders need the 'green quadrant' (A) experience illustrated in Figure 2.2. In Denmark, for example, it has long been recognised that to encourage more trips by bicycles, potential riders need to perceive that it will be safe to ride (Anderson et al., 2012).

Writing from a public health perspective, researchers Jacobsen (USA) and Rutter (UK) have challenged the discourse that cycling is dangerous and that encouraging more cycling would result in more injuries to cyclists, as occurs with injuries for motor vehicle occupants when there is an increase in motor traffic (Jacobsen & Rutter, 2012). Jacobson advanced the 'safety in numbers' concept, which holds that policies that increase the numbers of people bicycling improve the safety of the people bicycling (2003). The concept was inspired by research in Sweden by Ekman (1996) who found that at 95 intersections in Malmo, after adjusting for the number of bicyclists, the number of conflicts per bicyclist decreased with more bicyclists.

The explanation for the 'safety in numbers' effect Jacobsen initially offered was that with more cyclists, motorists took more care. Jacobsen, however, noted that in the United Kingdom from 1952 - 1973 when motorisation increased, the distance travelled by bicycles decreased, and bicyclist fatalities by distance travelled increased; that is motorists apparently took less care. Similar effects were observed in Melbourne (Moriarty & Mees, 2006) and the Netherlands (Directorate-General for Passenger Transport, 1999). Jacobsen argues that this effect can be reversed, as it was in the Netherlands from 1980 to 1998, when the number of bicyclist fatalities by distance travelled decreased as distance travelled by bicyclists increased. Over this period in the Netherlands, however, safety was improved by a wide range of policies to make bicycling safer and encourage more people to cycle (Pucher & Buehler, 2008; Schepers, J. P. et al., 2014).

Insights provided by Jacobsen et al. in a later 2009 literature review on the traffic effects of policy interventions are that city traffic can be made less dangerous relatively quickly and inexpensively through measures like:

traffic calming, 30 km/h zones, congestion charging, providing cycle tracks on major streets, and giving priority to the rights and safety of vulnerable road users as opposed to motorised transport

(Jacobsen et al., 2009, p. 372).

Jacobsen et al. also found, however, that in many cities, inexpensive countermeasures to reduce traffic speed and volumes were resisted by car proponents who controlled the writing of traffic regulations and the development of traffic engineering policies (Jacobsen, 2003) (Jacobsen et al., 2009). Later, Jacobson et al. (2015) suggested that the most powerful factor may not be programs aimed at bicyclists, but the community support for more bicycling and the change in motorist behaviour that reflected broader community support for more bicycling, including moderation of motor vehicle volumes and speed.

Pucher et al. (2012) and Van Ommeren et al. (2012) note that in cities that are safe for bicycling, community benefits include reduced road congestion, better health and environment. The most important issue for cities that are unsafe for bicycle riders is these foregone community benefits, as identified by Jacobsen and Rutter (2012). Aldred and colleagues also point out that in countries where bicycling mode share is low (i.e. below 5%), the road system discriminates by design against underrepresented groups including women and older persons (Aldred, 2017; Aldred et al., 2017).

The influences on mode choice are conceptualised below in Figure 2-3. Both the environment and other road users contribute to the construction of beliefs about safety in a dynamic system:

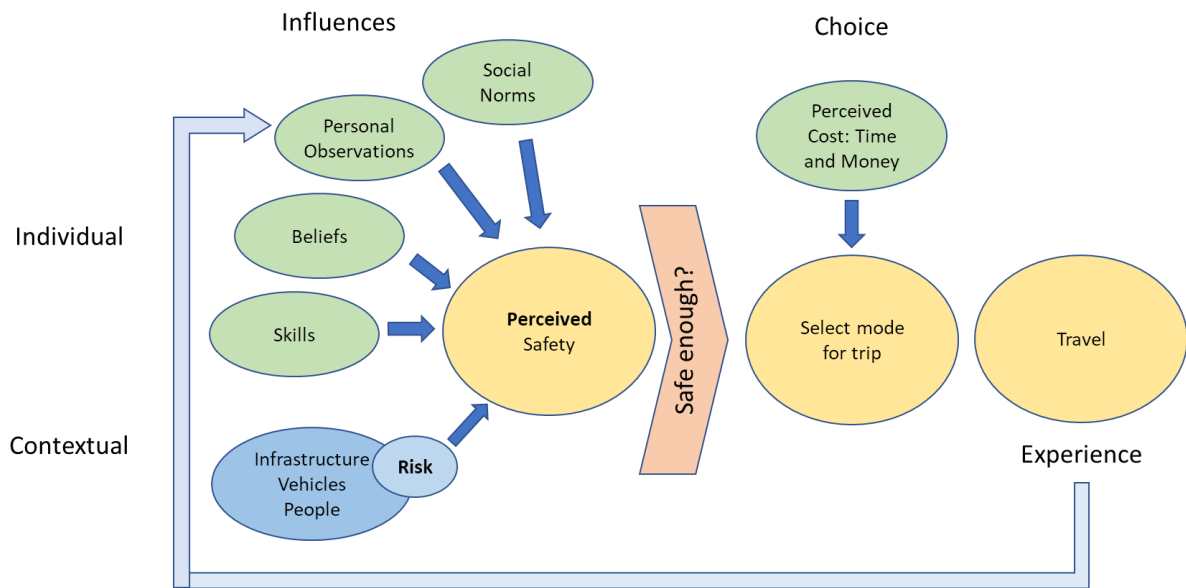


Diagram by Author

Figure 2-3 Safety influences on mode choice

For non-riders, perceived safety (fear) is the threshold to be crossed before considering other cost factors and benefits (Bauman et al., 2008a; Godefrooij, 2014). Non-riders beliefs about the safety of bicycling accrue from multiple sources including what they observe on the road, what they see and hear in the media, what their family and social circle say, their desire to conform to group social norms, and their self-belief in their skills and knowledge to create a safe trip (Aldred, 2017; Bamberg et al., 2011). If they perceive that there is a safe, low danger (comfortable) and continuous route available with low volumes of motor traffic operating at low speed, then they may decide to ride (Jacobsen et al., 2015; Pucher & Buehler, 2013; Pucher et al., 2010).

Some of the factors that influence travel choice are represented in Figure 2-3 and include locations of activities, travel resistances (perceived generalised costs including discomfort from severe weather), the strength of the need to travel, opportunities for benefits, and travellers' perceived abilities to use a mode. Individuals may occasionally re-consider travel choices and the possibility of bicycle use, motivated by lower cost, shorter trip times, free parking, or the benefit of incidental exercise.

To avoid injuries, bicyclists face unique challenges. Unlike pedestrians, bicyclists cannot move sideways or backwards to avoid a sudden vehicle encroachment. They also have difficulty in avoiding collisions or hazards that may be in their path (Biegler et al., 2012). Due to the inherent instability of being on two wheels, they also face the danger of falling. For example, if a bicyclist is cautious and rides slowly, they may lose stability and fall-over. Conflict with drivers may occur in complex traffic situations, such as at roundabouts and uncontrolled intersections, where bicycle riders may be ignored by drivers who focus on avoiding other motor vehicles, and if bicyclists are seen they may have their approach speed underestimated, or their capacity to stop overestimated (Sullivan, 2012; White, 2006). The risk faced by riders, sharing or crossing roads, has also increased from distracted drivers using mobile phones (National Safety Council, 2012) The relatively high risk for bicyclists is such that decision-makers have reasonable concerns about encouraging bicycling (Wegman et al., 2012).

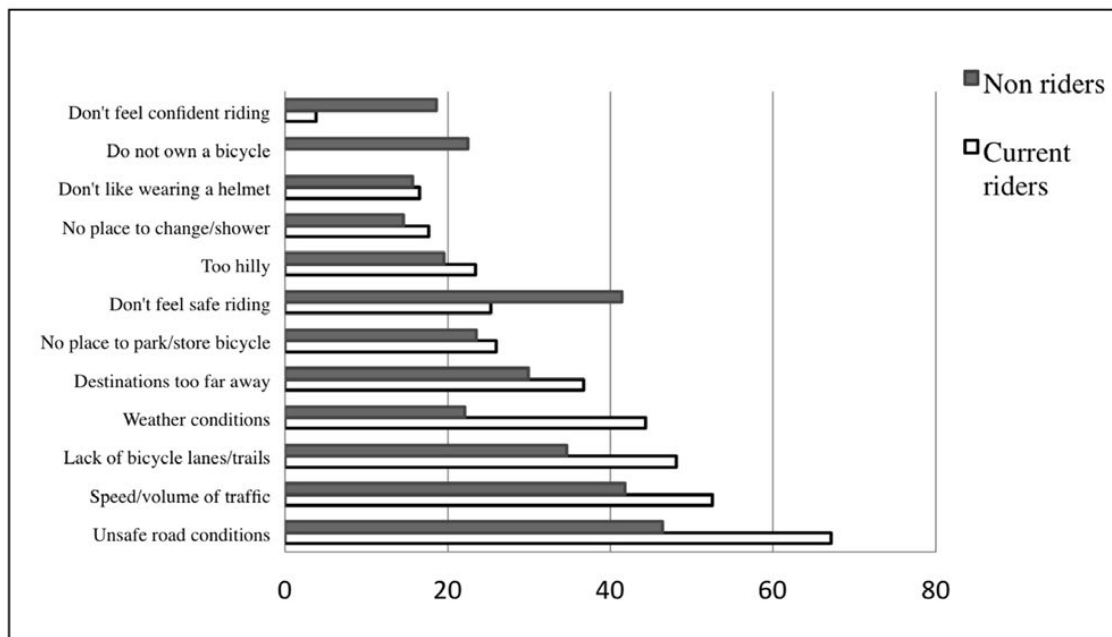
The limitations of research based on recorded crashes highlights the potential for qualitative research to explore the safety needs of people in Melbourne who are not riding because of fear of injury, unlike the broader demographic, by age and gender, that are known to ride in Amsterdam and Copenhagen.

A review of cycling participation by Bauman et al. (2008) for the Australian Government, based on surveys and focus groups, found ‘safety concerns to be among the most significant barriers preventing people from cycling, including among those who cycle regularly’ (Bauman et al., 2008b, p. iii). They found a clear link between excessive traffic speed and road traffic danger (Bauman et al., 2008b). The findings by Bauman et al. are supported by a survey in Vancouver of different types of cyclists: potential, occasional, frequent, and regular, which found that the top nine deterrents related to safety. The strongest deterrents, apart from icy surfaces – not relevant in Melbourne, for all rider groups except regular cyclists, were heavy traffic and interaction with motor vehicles driven faster than 50 km/h (Winters et al., 2011).

Garrard (2008) also identified high speed limits as an example of the privilege afforded to the mobility of motor vehicle users over the safety of unprotected road users. Sustained and substantial expenditure on highly visible improvements in arterial road infrastructure, and regulatory efforts to require safer cars has resulted in improved

safety for car occupants that has become increasingly superior to the safety of the road system provided for bicycle riders (Garrard et al., 2010).

With road safety research in Australia largely focused on existing riders, the safety needs of could-be riders, the focus of this thesis, has received less attention. However, in a survey undertaken for the Cycling Promotion Fund, Fishman et al. noted differences between non-riders (could-be riders) and current riders, see Figure 2-4 below.



Source: Fishman et al. 2012 Used with permission.

Figure 2-4 Reasons for not riding for transport

While not feeling safe is a barrier for could-be riders, current riders have concerns from their direct experience of factors such as unsafe road conditions, speed and volume of traffic and lack of designated space (Fishman et al., 2012).

Garrard describes the could-be riders as Australia’s missing cyclists: the women and older adults who are not riding for transport because of traffic safety concerns (2011). Garrard also shows the concerns of riders are reasonable, given the much higher risk in Melbourne of injury when riding compared to car use; and for riding in Australia compared to The Netherlands or Denmark.

Most people are, however, not aware of the statistical probability of a crash for their intended trip; instead, they follow their habits, beliefs, and perceptions about the danger of using various modes. Garrard (2011) suggests several components that contribute to the perception of bicycle use as dangerous compared to car use, as shown below in Table 2-2:

Table 2-2 Garrard’s comparisons of perceptions

Components of perception of danger	Driving	Cycling
Sense of personal control	High	Low
Trust in other road users (“are they looking out for me?”)	Yes	No
Common/unusual	Common	Unusual
Discrimination: in-group/out-group	In-group	Out-group
Social cues	“Everyone is doing it”	“Not many people do it”
Vulnerability	Low (protective shell)	High (no protection)
Consequences	Usually minor	Potentially severe

Adapted from Garrard (2011)

Additional dimensions of fear, are being in public view, fear of (current) cyclists and fear of being identified as a cyclist (Horton, 2007).

Fear is much less of an issue in Northern Europe, where a safer road system has been provided, and bicycling adopted by a broad spectrum of society (Pucher & Buehler, 2008). Pucher and Buehler compared injury rates and summarised the extensive range of policies and programs that have been used. The practical bicycling supportive measures they identified included:

- intersection designs
- design modifications to trucks
- encouragement to use safer trucks⁹

⁹ Australia has been slow to make improvements for bicyclists in these areas, including: intersection design and traffic signal operations that do not separate bicyclists from trucks, regulations for efficiency

- education of drivers, cyclists, and road managers
- enforcement aimed at behavioural change

Pucher et al. (2011) also undertook a wide-ranging case study analysis of Melbourne compared to Sydney, including reference to overseas practice. Through analysis of statistical data sets, secondary reports, and interviews with 22 bicycling policy and planning experts, Pucher et al. identified and explored factors that could explain why Melbourne had double the cycling levels compared to Sydney (Australia's largest city). Differences in the perception and the reality of the danger of road cycling appeared a key factor. They noted that although per capita injury rates were similar in Sydney and Melbourne, this is a misleading measure as it takes no account of differences in exposure (amount of riding), with more riding in Melbourne.

An expert panel consulted by Pucher et al. over four years to 2010, advised that cycling in Melbourne was safer than Sydney because of:

- stronger cycling foundation and context: Melbourne's longer history and better topography, climate, and street layout for cycling
- Melbourne's more visible system of separate paths and lanes
- driver awareness: Melbourne drivers may be slightly less aggressive
- better integration with rail services in Melbourne, however, better public transport services in Sydney may, in part, explain the lower rates of cycling
- stronger advocacy in Melbourne
- education: primary school cycling training courses reached 30% of students in Victoria, but only 10% in New South Wales schools

The research by Pucher and Buehler demonstrates the value of both case study comparisons and multidisciplinary perspectives, including consideration of geography, urban planning, transportation planning, civil engineering, and public health. In their book *City Cycling*, Pucher and Buehler provide international research on many aspects of city cycling as sustainable transport, drawing on numerous case study cities, grouped

(such as high-speed limits) and a reluctance to mandate design changes to trucks to improve driver field of view (Pattinson & Thompson, 2014).

by size, with the policies and programs considered for each city over time, and how various measures were combined into policy packages (2012). They also examine the roles of national, state, and municipal governments in influencing safety for cyclists in their case study cities. They hold that a crucial influence on bicycle use is safety, both real and perceived, with the key to improved bicycling safety being reductions in the motor vehicle speeds on shared roadways and physical separation from motor traffic on arterials, and the limited regulations and enforcement on motorists to support the rights of bicyclists to use the roads (Pucher & Buehler, 2012).

In 2015, Jacobsen et al. reconsidered how ‘safety in numbers’ may contribute to bicyclist safety as they were concerned that measures to support bicycling, by regulations that are protective of people bicycling, and by bicyclist-friendly street designs and operations, may have only a minor positive effect (Jacobsen et al., 2015). They saw ‘Signal detection theory’ as a basis to understand and achieve the safety in numbers effect. Signal detection theory conceptualises the complex relationship between the physical world, the receivers sensory process, their decision process, and their responses, including the influence of environmental noise, and the subjects experience and biases (Green & Swets, 1966). Jacobsen et al. hold that for individual’s, detection is selective to avoid cognitive overload, with road users operating by individually constructed and simplified mental models, based on expectations and experience. Thus, if drivers mostly encounter motor vehicles, their mental model will be alert to motor vehicles, and they are likely to fail to detect unexpected objects such as the occasional bicyclists. Separation of bicyclists from motorised traffic can thus be understood as the removal of the need for drivers to detect bicyclists. Several other strategies were therefore suggested by Jacobsen et al, including:

- roads designed to remind motorists of the possible presence of people bicycling
- lowering motorist speeds, so drivers have more time to detect, perceive and respond to people bicycling
- framing traffic law to require motorists to protect people bicycling
- visible promotion of bicycling, such as occurs with branded bicycle share schemes

Jacobsen et al. see the effectiveness of the above strategies being that they ‘act’ on motorists to change their behaviour, rather than on bicycle riders per se. They stress the importance of controls on motor vehicles, to change driver behaviour, in contrast to those who seek to reduce risk to bicyclists by comprehensive measures aimed at bicyclists.

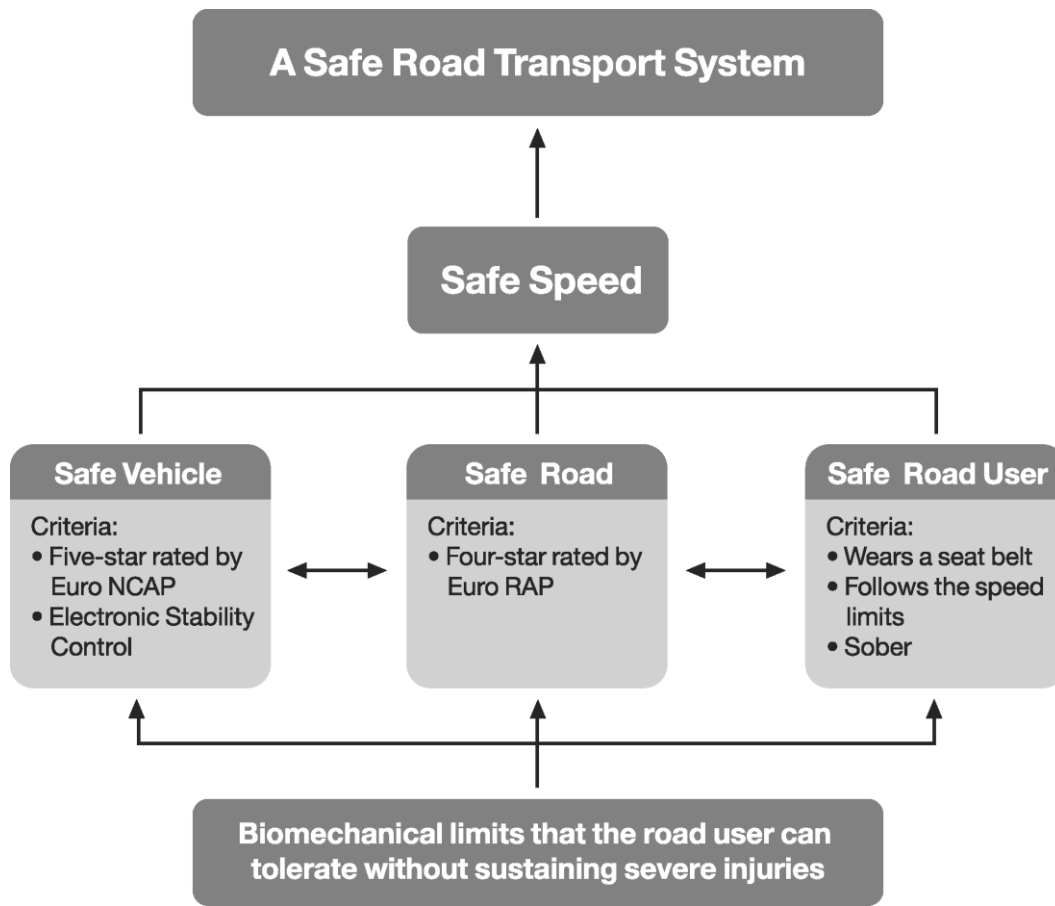
In the Australian literature there is limited recognition on the need for city safety that is ‘good enough’ to encourage ‘could-be’ bicyclists to consider trips by bicycle instead of by car. That is, to focus on improved ‘primary’ safety, as distinct from reducing the number of severe injuries by an over reliance on ‘secondary’ safety measures (like regulations requiring bicyclist to wear helmets).

2.4 Systematic approaches to road safety

A seminal theoretical framework for traffic engineers and road safety practitioners was the Haddon and Brenner, ‘safety matrix’ that placed road injuries in a broader system (Haddon Jr, 1972). Haddon’s USA approach came from concern over an excessive focus on human factors in the pre-crash phase, ‘the nut behind the wheel’, a blaming the victim approach. Haddon advocated for an epidemiological approach to reduce highway crash losses through systematic attention to three distinct phases:

- 1) pre-crash (prevention, failure to avoid)
- 2) crash dynamics (where the crash energy goes and is dissipated, considering human, vehicle, and environment interaction)
- 3) post-crash (promptness and quality of treatment)

The *Safe System* approach can be seen as a development of the three crash factors noted by Haddon: the human road users, the vehicle, and the road environment, for example, as established by the Swedish Road Administration (SRA) (Stigson et al., 2008), see Figure 2.5 below:



Source: Stigson et al. 2008 Used with permission 2019

Figure 2-5 SRA Safe System model

A similar approach to that of the *Safe System* was developed by the Dutch and launched in 1992 as their *Duurzaam Veilig*, the *Sustainable Safety* Vision (Koornstra, 1992). The Dutch vision had the ambition for a sustainably safe road traffic system designed to inherently and drastically reduce crash risk, and, should a crash occur, provide a forgiving design to almost exclude severe injury. The *Sustainable Safety* dimensions described by Wegman et al. (2006) were:

- danger/exposure (to risk)
- risk (of having a crash for the permitted exposure)
- harm/consequences (e.g. probability of injury)

Consideration of these dimensions led to five Principles which were initially thought to adequately include bicyclists, see Table 2-3. From the three dimensions and the five principles, two ‘mediating factors’ were identified to prevent crashes or reduce the severity of injuries to road users:

- control of the speed at which a conflict may occur
- separation of users based on differences in their mass and vulnerability, or protection (in the case of motor vehicles)

However, it was then argued that bicyclists had distinct needs, as had been proven in practice from bike only crashes, where motor vehicle impact speed is not a factor (Schepers, P. et al., 2014; Schepers & den Brinker, 2011; Weijermars et al., 2013a). The laws of physics have harsh implications for the bicyclist. Bicyclist’s bodies absorb most of the crash (kinetic) energy, and in most incidents, the bicyclist then experiences secondary impacts from a fall on the road. The severity of the first event, the motor vehicle impact, depends on collision (combined) speed (v), motor vehicle mass (m) and the impacting vehicle’s characteristics’ (e.g. impact area and aggressivity or capacity to absorb some of the impact energy). The severity of injury from the first impact depends on the amount of (horizontal) kinetic energy (E_k) imparted to bicyclists, as given by the equation, $E_k = \frac{1}{2} mv^2$. Severity is thus proportional to vehicle mass, which makes impact from heavier vehicles more damaging (e.g. 22 times more impact energy from a 22-tonne rigid truck than a one-tonne medium car), and geometrically proportional to the square of the speed (v) of the vehicle, e.g. 2.25 times more energy on impact from a vehicle at 60 km/h compared to 40 km/h. Abrasive injuries also depend on impact speed. The importance of vehicle characteristics for injuries to unprotected road users was illustrated by D’elia and Newstead, who found that the likelihood of death or thoracic injury to pedestrians was 74% higher for impacts from large SUVs compared to large cars (D’elia & Newstead, 2015). Therefore, to reduce injuries from vehicle impacts, the speed and mass of vehicles that bicyclists may encounter need to be kept low and motor vehicles need to absorb impact energy, otherwise bicyclists need to be separated from high speed (greater than 30 km/h) and heavy vehicles (greater than say 2 tonnes).

The general principles of *Sustainable Safety* and the further development of these principles for bicyclists are summarised in Table 2-3 below.

Table 2-3 Principles of Sustainable Safety

Principle	Comment on original Principles (2006)	Development for bicyclists (2013)
'mono-functionality' (of road use)	Any road is to have (only) one of three purposes: - Local Access - Connection and Distribution, or - Through Traffic (high volumes of fast traffic)	Types of facilities may need to be distinguished for bicyclists depending on the function (flow or exchange/residence)
'homogeneity' (harmony/compatibility) amongst users' on each road type	The elimination of the potential for conflict between users of significantly different mass, travelling in different directions, or significantly different speed	Cyclists separated by speed, mass, volume, and manoeuvrability
'predictability' for road users by design consistency and legibility	Road users to be able to tell, from the road design, what type of traffic to expect and at what speed. Includes simplicity, that they will only need to make one decision at a time	Cycling facilities designed for easy recognition by cyclists and to communicate expectations of the road surface, road layout and behaviour of other road users
'forgivingness' anticipate and forgive errors	As well-intentioned road users may make errors, the road design and road use culture should forgive (rather than punish) and reduce the probability of serious outcomes from errors	Explicit forgivingness in: - infrastructure for cyclists, - the bicycle (vehicle), and - cyclist behaviour
'awareness' by road users of their responsibilities and capabilities	Road users to know their responsibilities and be aware of their limitations	Cyclists to be made more aware of their responsibilities, specifically concerning alcohol.

(Sources: Wegman and Aarts, 2006) (Table 3), (Weijermars et al., 2013a) and (Furth, 2017).

Some researchers have taken the view that speed control and separation are so important that they should be put as the first principle (Furth, 2017). Furth's view on priorities could be understood as a response based on the USA context with high speeds and most bicycling on the roads. Some Australian researchers have also put 'safe speed' as a key fourth pillar of the *Safe System* approach, which is understandable in the higher speed environment in Australian cities (Corben & Oxley, 2006; Mooren et al., 2011).

An emphasis on speed management of and separation from motor vehicles, while necessary, however, reflects a car-centric approach which neglects injuries from single-vehicle bike-only incidents such as crashes into infrastructure and falls. The severity of injuries, e.g. fractures, from falls is influenced by the distance to the ground, and other factors including the fragility of the rider – as with older riders, the hardness of the surface – e.g. paved or grass, and if the rider is wearing protective clothing such as a helmet. A falling bicyclist may also receive abrasions to their clothes and skin. However, as falls are not an issue for car occupants, reducing falls for road users is not yet recognised as a *Safe System* priority.

The car-centric bias that developed in practice, does not, however, detract from the value of the Dutch *Sustainable Safety* approach, which seeks:

- ethical actions: that is, proactive actions and a commitment to provide the next generation with a traffic system that has considerably lower fatality and injury levels
- integration: that is, road safety policy integrated with other policies such as for transport and land use, applied to the entire road network, all vehicles, and all road users in one safe traffic system
- prevention of injuries by interventions that are the most effective and cost-effective

Adapted from Wegman (2010)

The Dutch value-based approach stands in contrast to a victim-blaming approach which was found to be ineffective in preventing injuries as it denied system effects, as noted by Jacobsen et al. (2009); and recognises the need for policy integration.

Aldred (UK) argued that a road system unsafe for bicycling is a 'design failure', with the responsibility to correct such failure resting with, but avoided by, many governments (2017). Insight into the avoidance of responsibility for deaths by people in authority was provided by Sinclair and Haines (1993) who, researching workplace deaths, interpreted avoidance of ethical responsibilities as a coping mechanism. That is, people who have responsibility for a system that has produced deaths, distance themselves from systemic failure by blaming others, particularly the victims, the workers, or in this case the bicyclists. The problem with avoidance of responsibility is that there is no learning and

no steps taken to make systemic changes to reduce future risk (Sinclair & Haines, 1993).

A difference between the Dutch *Sustainable Safety* approach, which emphasises a reduction in risk, and the Danish approach in Copenhagen is that in Copenhagen they emphasised improving commuter perceptions about the safety and comfort of bicycling – to increase in the number of people choosing to travel by bicycle (Anderson et al., 2012). These dual goals were achieved in Copenhagen through a wide range of what Gössling classified as 'soft-policy measures' (2013, p. 201). The Copenhagen approach is also an example of co-production, as the city has actively involved bicyclists in the process, suggesting changes, such as paths needing repair or intersections needing improvement, has given bicyclists the power to influence developments, and pride in the achievements of their city.

Although there is an apparent association between packages of measures, an increase in bicyclist numbers, and improved bicyclist safety, the effectiveness of individual interventions is not clear. A review of interventions was conducted by Pucher et al. for the USA Robert Wood Johnson Foundation which considered 139 international and US studies and secondary data from 14 case study cities (2010). The extensive review found that when cities adopted an integrated package of many complementary interventions, including infrastructure provision and pro-bicycle programs, as well as supportive land use planning and restrictions on car use, a strong association was found between the dual outcomes of a dramatic increase in bicycling levels and improved bicycle safety. The data reviewed did not, however, allow for cause and effect relationships to be established for the individual measures, or identification of the effects of specific contextual factors.

Contextual factors that improved safety for bicycling by reducing the potential for and moderated the consequences of interactions with motor vehicles that are common in Europe but absent in Melbourne, included:

- integrated planning for compact and mixed-use urban activities, which mean shorter trips
- restrictions on car use, including high ownership costs, car-free zones, traffic calming and lower speed limits

(Pucher et al., 2010)

2.5 Local implementation of a *Safe System*

The *Safe System* approach was brought to Melbourne in the late 1990s by Prof Claus Tingvall (from Sweden) when he was appointed as head of the Monash University Accident Research Centre (MUARC) (Mooren et al., 2011; Tingvall & Haworth, 1999). The *Safe System* and associated *Vision Zero* school of thought held that decision-makers have an ethical obligation to ensure that road use by bicyclists and others is objectively safe (Tingvall & Haworth, 1999).

Mooren et al. note that the acceptance of the *Safe System* approach grew as more researchers, including Haddon, questioned the ethics of a road transport system that punished road users with death or serious injuries if they made errors on poorly designed road infrastructure or in negligently designed vehicles (Mooren et al., 2011).

The responsibility for road safety outcomes came to be recognised as shared, as observed by Mooren et al.:

Under the *Safe System* approach, road and vehicle designers and managers are responsible for designing, producing, and managing road travel infrastructure and equipment. Beyond this, road and transport authorities are responsible for putting in place rules and guidance to *Safe System* use – and road users themselves are responsible for abiding by the rules and being alert to injury risks.

(2011, p. 5)

However, as noted by Muir et al., *Safe System* thinking, although formally adopted by the Victorian Government in 2004, required a major change in agency thinking that had not, by 2018, occurred:

Political commitment has not been consistently sustained over the past two decades and continues to be volatile. Public opinion does not seem to have moved past the historical 'blame the victim' stage, and this partly explains the political reluctance to embrace the evidence base. The cost of transformational changes to infrastructure is the second key blocker.

(2018, p. 5)

Safe System thinking has been useful to explore why some bicycle crashes occur and how to systematically prevent, or at least minimise some critical consequences (Corben et al., 2010) (Peden et al., 2004). The research value of using a *Safe System* framework to explore bicycling issues has been demonstrated in several studies, including the 'naturalistic' studies of bicyclists in Melbourne (Johnson, 2011).

In Melbourne and Australia, the approach to the safety of cyclists has, however, largely been shaped by, and subsumed within the local version of *Vision Zero* and *Safe System* thinking that was preoccupied with the safety of motor vehicle occupants. As observed by Corben and Oxley, the *Safe System* approach in Victoria was grafted to a traffic system that privileged 'driver mobility, economic development, commercial interests, (and) public transport performance'(2006, pp. 7-8). The approach adopted by road authorities in the decade to 2006, included:

- using 'warrants' (e.g. recorded numbers of people) rather than latent demand, to avoid the installation of facilities
- site-based (e.g. black-spot) programs rather than system-based solutions

- a traffic system that by design, (e.g. high-speed environments) exceeded human capabilities and then expected education, promotion, publicity, and enforcement, to produce safe functioning

(Corben & Oxley, 2006)

The structural separation of interdependent policy areas created institutional silos for policy areas such as road safety, transport, and land use, that has also hampered the *Vision Zero* and *Safe System* approach in Melbourne, Victoria and Australian (Low, 2007). For example, the Victorian and Australian governments have been slow to recognise that encouraging people to use public transport instead of cars would improve the safety of bicyclists and general road safety.

The early observations by Corben and Oxley (above) were supported by Mooren et al. in their 2011 review of the influence of *Vision Zero* and the *Safe System* approach (Mooren et al., 2011). Mooren et al. undertook an examination of the literature relating to the *Safe System* approach and its application in Australian states, including Victoria, Western Australia, and New South Wales. Their work was also informed by each author's extensive practical experience with road safety research in Victoria and New South Wales. They found that the *Safe System* philosophy had been interpreted differently in each jurisdiction and was often compromised by a (local) approach that sought to 'balance' safety with mobility. Accordingly, the pursuit of *Vision Zero* in Australia was challenged by:

- the infrastructure engineering fraternity who seemed to accept that a certain level of death and injury would always occur on roads
- a reluctance to divert resources to safety away from mobility expansion
- motor vehicle manufacturers who were slow to incorporate active safety into vehicle design, e.g. automatic speed reduction
- a community that saw the *Vision Zero* goal as unrealistic
- a low level of political and managerial commitment and leadership

(Mooren et al., 2011).

The limited application of the *Safe System* approach in Australia was also noted by Woolley, who, in a 2012 review for AUSTRROADS found that:

- Systemic changes to the (Australian) road network consistent with *Safe System* principles are required if significant progress is to be made in road safety over the next decades.

(Woolley, 2012, p. iv)

Woolley (2012) gave detailed examples, including the need to:

- improve safety between trucks and cyclists by requiring (through the Australian Design Rules) Heavy Vehicle side under-run protection, the most effective countermeasure for the left turn collisions he reviewed
- give greater emphasis in road design and traffic management guidelines on the risks posed by the interaction between cyclists and left-turning heavy vehicles

The examples highlighted by Woolley are safety measures that have been applied in Europe and Japan (Pattinson & Thompson, 2014) (European Cyclist Federation, 2011).

In a later paper, Mooren et al. (2013) made additional points about issues which are highly pertinent to bicycling safety, including:

- reliance on US road and traffic engineering standards rather than European, particularly Dutch, standards
- the cultural acceptance of unsafe speeds

A recent review by Muir et al. of road safety in Victoria noted that while the *Safe System* approach was adopted as a concept more than 20 years ago, there has been a significant lag in understanding and implementation, and the required major change in institutional thinking and agency reform has not happened. With public opinion and some decision-makers stuck in the historical ‘blame the victim’ approach, there has been political reluctance to embrace the evidence base and drive change (Muir et al., 2018).

The *Safe System* approach in Melbourne has also been compromised by privileging motorised mobility over safety and a failure to see the city as being primarily for people (Gehl et al., 2011). Advocacy by local bicycling groups has effectively focused on improving the safety of current cyclists (Garratt et al., 2015; Katz et al., 2012; Sikic et

al., 2009; Stevenson et al., 2014); and these bicyclist groups do not appear to have connected to groups who have a vision for a sustainable city, a city made safer for people, including those on bicycles, by a wide range of transport and non-transport measures as part of a broad and appealing liveability agenda (Department of Justice & Department of Sustainability and Environment, 2005; Marshall & Garrick, 2011).

2.6 A city safe enough for bicyclists

In Melbourne (and Victoria), road safety and bicyclist safety are mostly seen as issues unconnected to broader policies that affect mode choice or land-use arrangements (Government of Victoria, 2012; Lowe et al., 2015). At a policy level, it does not appear to be understood that if more people were riding for transport instead of using cars, safety for all road users could be improved (Wegman et al., 2012). The ‘safety of bicyclists’ may, therefore, be usefully reframed as a ‘city that is safe for bicyclists’.

A focus on the city, not bicyclists, was suggested by U.K based Professor Banister (2008). Banister points out that as cities are the most sustainable urban form and are where most people live, an alternative, holistic ‘sustainable mobility’ approach is needed, including keeping average trip lengths within the distance thresholds that suit walking or bicycling. He challenges two underlying assumptions of conventional transport planning that have worked against walking and bicycling; firstly, that travel is a ‘derived demand’ and secondly that travel cost, particularly elapsed time, is to be minimised by faster travel. Banister contests the notions that people want to see motor vehicles placed at the top of the transport hierarchy, ‘streets used as ‘roads’, and mobility privileged over accessibility. He advances sustainable mobility as an alternative paradigm that has its focus on people, with stronger links between land-use and transport.

The path to an alternative sustainable future requires clear and innovative thinking about what a city has; what the community would like to see; and the role for transport in achieving these objectives. Key elements of the sustainable mobility paradigm are an objective-based planning system (to implement policy interventions) and the support of stakeholders, which requires an understanding of both behaviour and the means to obtain cooperation (Banister, 2008).

However, as noted above, people will not bicycle and participate in sustainable transport in a city unless it is safe to do so; but when is a city safe enough? As perfect safety is not possible, for a nuanced understanding of safety, I drew on the psychotherapeutic idea of 'good enough' parenting developed by the British psychotherapist Winnicott (1954). Winnicott's research on infant development, by parents who could not be perfect, found that 'good enough' outcomes were achieved when parents tried their best, had the best of intentions, and supported the development of the child's independent operational agency. Sufficient operational agency was demonstrated when the children were subsequently able to independently make successful future adaptations in an environment that was not perfect but was not hostile. Winnicott's two-element concept, providing the best possible environment and development of the capacity to make future operational adaptations, is seen as a useful way to think about constructing good enough safety for bicyclists. Neither parenting nor provision for bicycling can be perfect but needs to be good enough to avoid damaging children or bicyclists, and good enough to build agency for self-care.

The second concept, which relates to implementation, is 'co-production', from the public policy literature. Co-production refers to the co-operative creation of public goods or public value; it involves governments inducing voluntary changes in behaviour by citizens to reduce a problem or create a public value outcome, like safety (Alford, 2009). Co-production of a city safe enough for more transport cycling would involve governments providing a framework for a voluntary partnership between road users, stakeholders, and governments. The approach to implementation of improvements for bicyclists in Copenhagen, as outlined by Gössling (2013), is seen as an example of co-production.

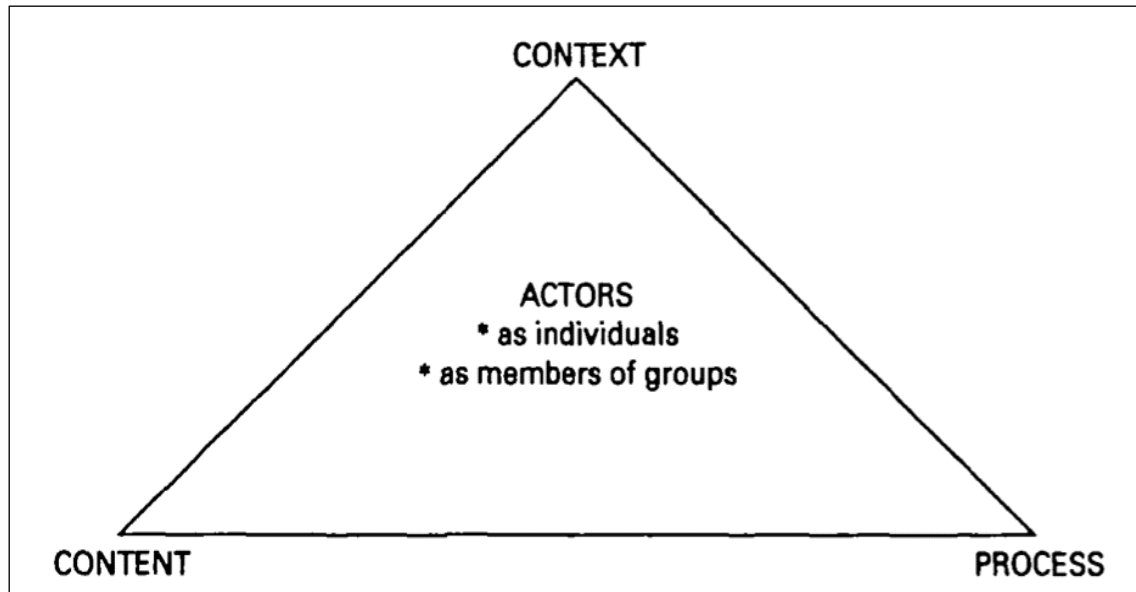
2.7 Implementing change

This section considers research on adapting to change and the transfer of solutions from one country or city to another. The local Melbourne, Victoria failure to fully embrace *Safe System* thinking is an example of failure to change (and adapt best practice interventions) experienced in many fields, including in health, industry, and public policy generally. One early theory aimed at understanding why innovations failed was socio-technical systems theory developed in the 1950s at the Tavistock Institute, UK,

(Trist, 1980). Socio-technical system theory sought to understand diffusion (adoption), or non-diffusion (resistance) of technological innovations, where, social factors overrode technical advantages. Dwyer (2011) describes socio-technical systems theory as being concerned with technological systems containing messy and complex components. Such systems are both socially constructed and society shaping. Socio-technical systems theory provides a nuanced mechanism for exploring complexities (Dwyer, 2011). It also provides a structuring context for exploring human action (Geels, 2004); and it conceptualises the social and the technical as needing to work together. Socio-technical systems theory can be considered at three levels:

- 1) overall society and broad (government) policy, the macro-level – the context
- 2) where, by who, and how decisions are made, the meso-level – the processes)
- 3) what gets done, observable at specific locations, the micro-level – the content)

Walt and Gilson (1994), concerned with health policy failures and successes, developed a four-element analytical framework of Content, Process, Context and Actors, as reproduced in Figure 2-6 below (Walt & Gilson, 1994; Walt et al., 2008). They found that failure often resulted from an excessive focus on measures – the content; to the neglect of the three other domains: actors, policy context, and processes.



Source: Walt and Gilson (1994)
Reproduced with permission.

Figure 2-6 Health policy triangle

The domains of the Walt and Gilson model are:

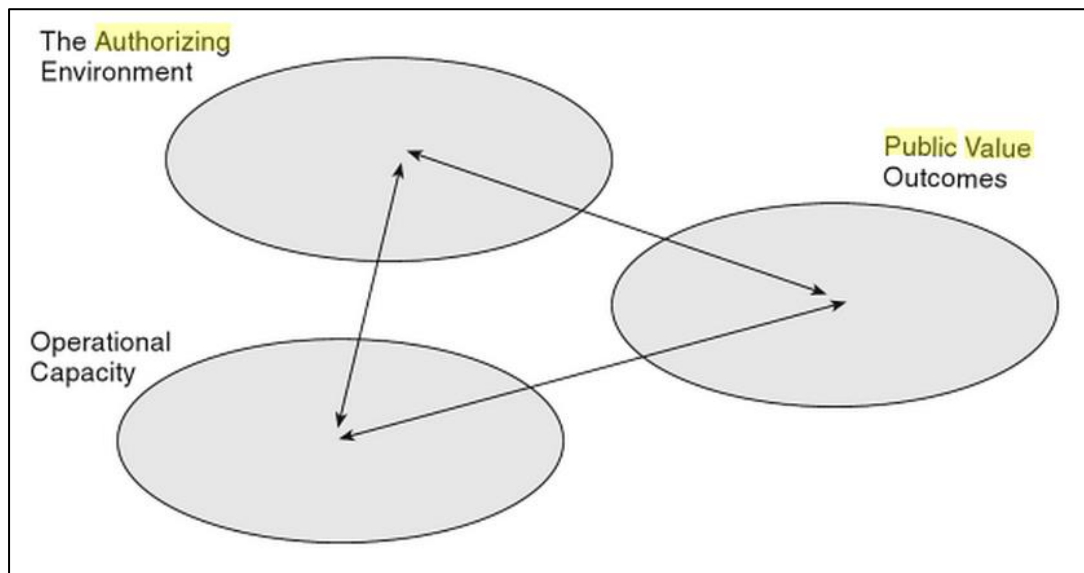
- Policy Context, where problems are defined – the macro level
- Process, concerned with agenda setting, problem-solution formulation, decision making and authorisation of implementation – the meso level
- Content, being what gets done on the ground, is observable and location-specific – the micro level
- Actors, government decision-makers, interest groups, professionals and corporates who act to varying degrees at each of the three levels

These domains are very similar to the levels of the socio-technical system (Trist, 1980); both were developed to understand the issues with implementing new content in different ‘cultural’ contexts, requiring attention to powerful local actors, contexts and processes.

The concept of ‘actors’, central to the health policy triangle (Figure 2-6), includes all those who have an interest in the sector, and can usefully be expanded by the concept of ‘artefacts’ in Latour’s Actor-Network Theory (Latour, 2005). Latour is famous for arguing that non-human ‘artefacts’ are highly influential actors. Latour's artefacts are of two types: the ‘physical artefacts’, e.g. the road infrastructure and vehicles; and the ‘social (non-physical) artefacts’, e.g. organisations and regulations (Hughes, 1989, p.

51). That is, in many cities, the low status and low safety of bicycles are enacted through the artefacts of road and vehicle design for motor vehicles. For example, the users of the low harm, technically elegant, highly efficient, and equitable bicycles have been pushed from the roads in many cities by the physical presence of motor vehicles and the regulations created for the convenience of drivers (Illich, 1974).

The ‘Strategic Triangle’ framework, developed by Benington and Moore in the 1990s, highlights the dynamics of policy development, see Figure 2-7 below, (Benington & Moore, 2011). The Strategic Triangle model adds the insight that communities face complex cross-cutting problems for which there are no simple technical solutions available to governments, and for which the neo-liberal mechanism of market choice has not provided solutions.



Source: Benington and Moore 2011
Reproduced with permission

Figure 2-7 Benington and Moore's strategic triangle

Benington and Moore suggest that by focusing on the difficult question of what people most value, public discourse can productively engage with painful choices and trade-offs, such that it may be possible to harness the state, the market, and civil society to work together towards shared public value goals. The Strategic Triangle model infers that if car use is to be moderated in Melbourne, the focus may need to be on public value outcomes such as liveability, sustainable mobility, and *Sustainable Safety*.

Melbourne urban planning academic Professor Nicholas Low has observed that Australian institutions and decision-makers have largely failed to adapt to new challenges like climate change (Low & Astle, 2009). For Melbourne, over the period 1956 – 2006, governance arrangements and capacities remained focused on the problem definitions of, and the solutions that were available in the 1950s, that is ‘path dependence’, which limited governments and agencies in responding to new challenges. Low et al. identified three drivers of path dependence:

- 1) the physical form of a city, shaped by dependence on the dominant form of transport of the time¹⁰ –the context
- 2) the ‘storylines’ people in positions of power tell one another and construct for the community about the problems they face, such as road congestion, and the available solutions, such as more road capacity – the context and process
- 3) the weakness or strength of the regional planning organisation(s) – the process

To understand why Melbourne’s transport system has not adapted to the requirements of climate change, Low and Astle note that from the late 1950s transport and land use planning in Melbourne was dominated by actors from the road sector who emphasised providing for the motor car and looked to the American solutions of more road capacity, particularly freeways (Low & Astle, 2009). The road institutions also led the metropolitan land use planning strategies which reinforced car dependence¹¹. Low and Astle identify processes that may make institutions unresponsive to new challenges and change, such as lack of integrated planning, weak political leadership, and lack of funding for strategic planning.

Banister (2008) sees the main challenge for change as gaining public confidence and acceptance, which he believes can be achieved through active community involvement. Like others, he identifies context and process factors likely to promote sustainable mobility, including land-use arrangements that reduce trip distances, promotion of slow

¹⁰ As noted by Newman and Kenworthy, (1989) (1999)

¹¹ Over the period 1966 to 2006 I worked at the Country Roads Board, the MMBW, the Ministry of Transport, the Road Construction Authority, the Road Traffic Authority, and VicRoads, and confirm this view of the capture of political agendas by the road agencies.

traffic, providing an alternative vision and the need to build community support for change.

Gössling (2013) interprets the social factors that came together in Copenhagen for cycling to become a self-evident and normal form of transport. A feature of the urban transport transition in Copenhagen was that it involved self-identification as a cycling city, was built on a positive urban vision and often done in a playful and humorous way. Gössling also found no negative depictions or moral claims against cars; his interview participants said that while measures had been contemplated to restrict cars, like reductions in lanes, parking spaces and road pricing, these anti-car measures were abandoned. Marie Kastrup, Head of the City of Copenhagen Bicycle Program, told Gössling that with the normalisation of bicycling, people are primarily 'Copenhageners', not cyclists (Gössling, 2013).

Goldfinch and t'Hart, who have studied political leadership and government reform in Australia and Europe, suggest that opportunities for change are created by leaders who:

- construct the need to change as a crisis or a pressing opportunity
- communicate both the need to change and their commitment and ability to lead change
- who bring together a coalition, representing stakeholders with a diversity of needs

Adapted from (Goldfinch & t'Hart, 2003; t'Hart, 2014).

Communication that recognises emotional engagement such as love of 'freedom' or objects such as cars or bicycles, and the importance of decision-makers knowing different possibilities is also important (Kharis & Friel, 2014). Responding to a diversity of needs is also consistent with Bennington and Moore's (2011) idea of creating broadly recognised public value.

For cities, changing to a sustainable city is what American leadership academic Professor Ronald Heifetz would call an 'adaptive challenge,' as distinct from a technical challenge (2003). Responding to an adaptive challenge involves a process to 'take the best from history, leave behind that which is no longer serviceable, and through innovation, learn ways to thrive in the new environment' (Heifetz, 2003, p. 74). Heifetz

warns that where current decision-makers have created the adaptive challenge problem, 'current expertise, authoritative decision-making, standard operating procedures or culturally informed behaviours' cannot be relied on to produce the needed change (Heifetz, 2003, p. 73). As adaptive change can be expected to be resisted by traditional decision-makers, as has happened in Melbourne, Heifetz says stakeholders need to take responsibility for change. Stakeholder and community mobilisation can be initiated through a process that clarifies orienting normative values, such as sustainability and liveability; and importantly, the process must include listening to those who resist change to understand their concerns (Heifetz, 2003). Adaptive change thus necessarily involves conflict, difficult conversations, time, and perseverance.

Regarding the challenges of transferability, research on the transferability of road safety measures was undertaken for the EU in the *SaferBrain* project through case studies in India and Brazil (Appelt et al., 2011; Quigley et al., 2012). The authors suggest several factors, included in Table 2-4 below, that are necessary for successful transfers, including:

- policy context
 - strategic fit with higher-level policy
- process
 - transparency of decision making
 - engagement of stakeholders
 - guaranteed funding streams
- content
 - adaption of measures to suit local contexts

The above research thus points to several areas where practice in Melbourne could benefit from a deeper understanding of the practices and underlying theories used in Amsterdam and Copenhagen, while recognising that differences between the three cities will influence transferability.

Socio-cultural differences have a strong influence on transferability, as was recognised by socio-technical systems theory, in the EU *SaferBrain* project, and as extensively described by Geert Hofstede in a pioneering study on the impact of cultures on organisations (Hofstede, 2001). Hofstede's five measures of cultural difference cover:

power-sharing, tolerance for uncertainty, individualism vs collectivism, male dominance vs equity, and decision horizons (long vs short). Boonghee et al. (2011) note that Hofstede's approach to cultural understanding has been widely used to explore consumer perception across a wide range of topics. How new measures to reduce risk to bicyclists could be perceived in Melbourne may be predicted by the cultural similarities and differences between the country of origin, The Netherlands or Denmark and Australia. Compared to The Netherlands and Denmark, Hofstede's analysis suggests that in Australia there is less democratic power-sharing across income and social strata; less collectivism, less concern for the general good rather than individualism; less caring and more competition; risk aversion with a low willingness to take risks for the public good; and less generosity by the more powerful to support change that may result in some loss of privilege. Cultural considerations, therefore, suggest the need for caution in transferring measures from elsewhere to provide a safer Melbourne for bicyclists. That is, measures for Melbourne may need to be broadly framed to appeal to liveability and self-interest.

The learning from several fields is thus that best practice innovation may fail through resistance to change, too narrow a focus on technical content, the neglect of the broader social context and through closed decision-making processes. A synthesis of key factors identified in the literature is summarised in Table 2-4 below, grouped under the headings of Context, Process and Content.

Table 2-4 Synthesis: factors present in successful change

Context factors	Sources
A positive vision, responding to understood needs, clearly articulated with agreed objectives	(c) (f) (d) (g)
Integrated planning for strategic needs, expressed through comprehensive regional plans	(a)
Consistent policies across sectors Strategic fit (of policy measures) with masterplans - including reducing the need for motorised private travel	(b) (d)
Lived experience, that bicycles and cars can co-exist when cycling infrastructure is provided	(c)
Pressure for change from those who are cycling	(c) (f) (g)
Support for change from the 'silent majority' who are not cycling	(c) (f) (g)
Supportive and fair legal system	(d)
Process factors	
Change led by a mix of stakeholders Bold political leadership, articulating responses to new challenges Political will and capacity to implement change, withstanding minority opposition from vested interests	(g) (a) (f) (b) (f)
Policy development through a broadly-based public discourse Information and education that explains the need and benefits (of sustainable mobility) Meaningful engagement of stakeholders and city residents who buy into the proposals Identification of common and mutually beneficial interests Articulation of positive outcomes and measurable benefits, like cleaner air and safer traffic conditions, to build support for controversial policies	(b) (g) (f) (a) (d) (g) (a) (f) (b) (f)
Clarity (transparency) in decision making and management	(d)
Institutional permeability, with horizontal and vertical cooperation (as distinct from bureaucratic partitioning/silos)	(d)
Access to adequate funds including the possibility of hypothecation A revenue stream for research, implementation, and monitoring Fair enforcement	(a) (d)
Content factors	
Packaging of 'push' and 'pull' measures, like restrictions on some car use linked to attractive alternatives	(b)
Measures based on design codes that are congruent with strategic policies	(d)
Recognition that diversity (e.g. urban form, topography, economic activities, and constraints), requires the implementation of principles, not prescriptions Audit, testing, and adaption of imported measures to ensure designs will fit local contexts	(d) (e) (g) (b)

Adapted from: (a) (Low & Astle, 2009), (b) (Banister, 2008), (c) (Gössling, 2013), (d) (Appelt et al., 2011), (e) (Wegman et al., 2012), (f) (Goldfinch & t'Hart, 2003), (g) (Heifetz, 2003)

2.8 An integrated model for analysis

The research and frameworks described above lead to the development of the CPC model, see Figure 2.8 below, that brings together socio-technical systems theory; the health model of Walt and Gilson; expands actors to include artefacts, and categorises content by the *Safe System* pillars.

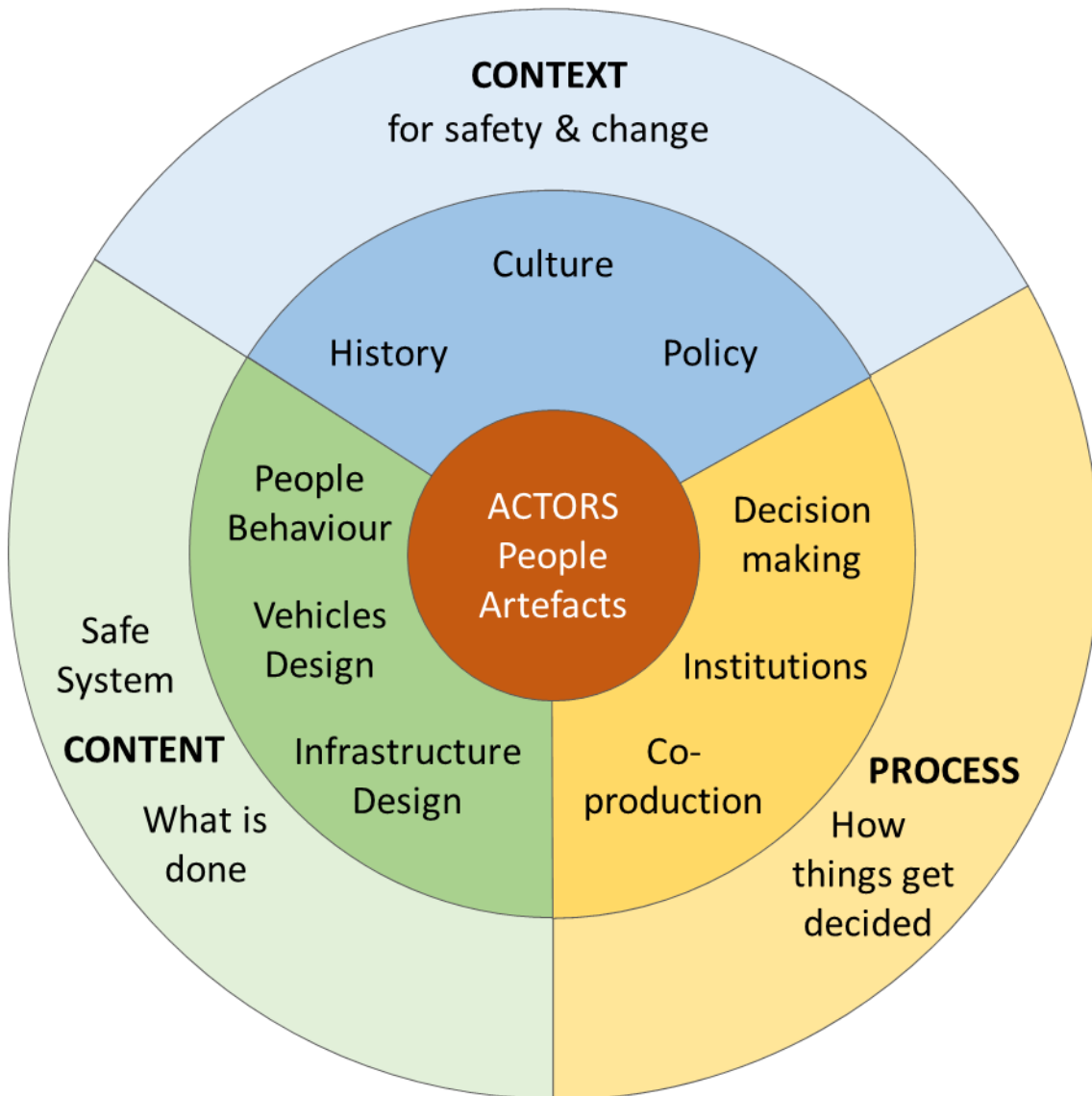


Figure 2-8 CPC Analytical model to explore city safety

The three inter-related domains of the CPC model (Context – Process – Content) are used as organising themes to explore city safety, as described below:

- Context: the high level, macro influences including history, culture, government structures and the broad land-use and transport policies that together shape how safe a city is for bicycling. Context also includes how the ‘safety problem’ is defined for policy responses.
- Process: the meso level that mediates between the higher-level context and the on the ground content of actions and measures. Process includes consideration of the responsibilities, relationships, and decision-making by each level of government, the actors involved, the degree of coordination, and how decisions get implemented.
- Content: the measures and actions that happen on the ground; the infrastructure, vehicle design rules and regulations that determine the experience and safety of traffic operation. Content determines the experience of road use, by the way road space is designed, the characteristics of the vehicles encountered, and the rules that govern the behaviour of road users.

The themes are interdependent, recognising the complex, systems nature of cities and road safety. For example, Content is shaped by the local Context, and content measures are authorised and implemented through local Processes, as noted in the EU *Safer Brain* project on the transferability of road safety ideas (Persia et al., 2010).

2.9 Research gap and questions

The literature shows the benefits of more bicycling; that poor safety is a barrier to more people bicycling; and the wide range of factors that can influence the safety of bicyclists. Previous research also demonstrates the applicability of a range of methods, including data collection through surveys; analysis of secondary statistics; document analysis; site observations; and the value of comparative case studies in drawing out the reasons for differences in outcomes.

To my knowledge, however, research has not previously been undertaken on the specific opportunity in Inner Melbourne to improve safety sufficiently to encourage a broad demographic of adults to travel by bicycle. Also, previous research on bicycling safety in Australia has not been informed by socio-technical system theories, as conceptualised in the CPC framework.

The questions for this research are:

1. What is 'good enough' safety in a city for adults to travel by bicycle and how safe are Inner Melbourne, Amsterdam, and Copenhagen?
2. Why is it that safety is good enough for many adults to travel by bicycle in Amsterdam or Copenhagen but not in Inner Melbourne?
3. What can be learnt for Inner Melbourne from Amsterdam or Copenhagen?

Chapter 3 Study approach and methods

This chapter describes the methodology and methods used to explore safety as an influencing factor on adults in Inner Melbourne who could use bicycles for travel.

3.1 Methodology

This research examined why comparatively few adults in Inner Melbourne made trips by bicycle. It took safety as a threshold issue and examined safety as a social construct, shaped by context, history, policies, and the relative power of actors. It used the socio-technical approach, as developed for public health policy by Walt and Gilson (Walt & Gilson, 1994; Walt et al., 2008). The constructivist-interpretative¹² position provided a nuanced understanding of policy decisions to provide for riding and influence individual decisions about travel in a city. An integral part of the interpretive methodology for late-career researchers – like me – is reflecting on prior knowledge to provide new understanding (Schwartz-Shea & Yanow, 2012). The interpretive position offered the prospect of revealing unknown or surprising findings, compared to a true/false finding on a pre-formulated hypothesis.

A key assumption from which this research proceeded was that fear of injury (poor safety) is a threshold issue for travel by bicycle, that acts as a deterrent in Inner Melbourne but not in some other cities. The research questions, see page 60 above, could have been explored either by a study of differences in aspects of city safety for bicyclists, such as in interactions between bicyclists and trucks, or, as a comparative case study considering multiple factors. As initial exploratory work suggested that multiple factors contributed to safety in cities, the comparative case study approach was pursued to contrast differences (Yin, 2008). That is, by comparing Inner Melbourne to exemplar cities for bicycling, key factors were revealed.

¹² Interpretive research comes from the social sciences and aims to understand situated (in context) meaning making, by exploring phenomenon from multiple perspectives.

3.2 Methods

In Melbourne, objective bicycle safety has been studied (as outlined in Chapter 2), but in practice, safety for bicyclists has not improved. As the reasons for failure to improve safety did not appear to be well understood, multiple perspectives were sought. The interpretivist mixed methods approach is likened by Bell and Thorpe (2013) to making a patchwork quilt as it involves piecing together different methodological tools and techniques.

The approach used involved predominantly qualitative methods with quantitative data on crashes ‘embedded’ in the analysis, what Creswell and Plano Clark (2011) describe as ‘Embedded Design’. The mix of methods used to explore the social and technical features influencing city safety for bicycling are shown below.

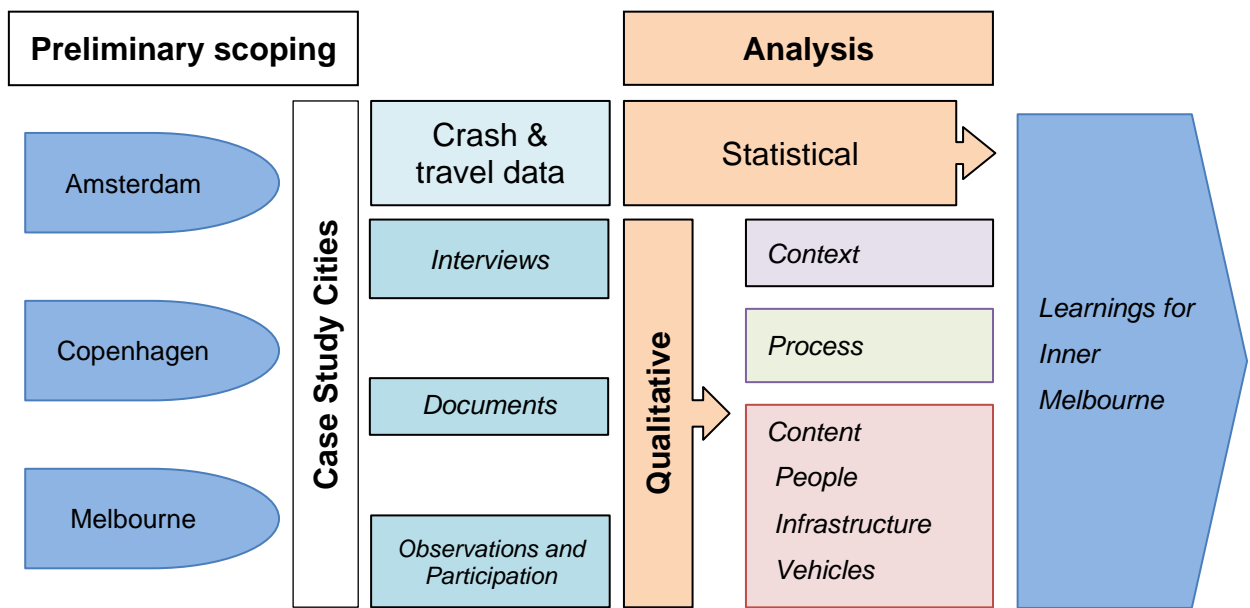


Figure 3-1 Methods

3.3 Preliminary scoping and engagement

To scope the research task, define the case study areas, identify informants and key documents, preliminary scoping was undertaken during 2011 and 2012; this involved reviewing the literature, engaging with internet sites, scouting visits and off-the-record

interviews, including visits to Rome (where EU experts were located), Amsterdam, and Copenhagen.

The exploratory meetings were held with professionals engaged in road safety or bicycling. Informants were selected from people that I knew from my previous work in the area; identified from published material; internet forums and blogs; and on recommendations from my Melbourne contacts. Melbourne discussions were held with informants at VicRoads (5), National Transport Commission (2), Bicycle Network Victoria (2), Town and Country Planning Association (several), City of Melbourne (3), City of Yarra (2), Monash University (2), University of Melbourne (several), RMIT University (1), Truck Australia (1), Department of Infrastructure (2), Transport Accident Commission (2), and ITE Australia (several). Discussions were also held with several international experts in the UK (1), Amsterdam (5), Copenhagen (6) and Rome (2). All these exploratory discussions were conducted 'off the record', although notes were taken with the informants' agreement. Discussions were usually conducted at the informants' place of work or a nearby café and typically were about one hour in duration. Some informants also provided or referred me to research relevant documents and statistics, including some that had not been publicly released and told me of upcoming meetings and seminars that I could attend.

To aid my understanding of 'what was going on in Melbourne', in addition to riding with and observing bicyclists and traffic conditions, I also engaged with key actors and participated in various forums. For example, in discussions with officers from the Transport Accident Commission (TAC) Victoria, I found out that they were soon to sponsor the Bicycle Network Conference, 'Bicycle Futures' 2013 (Melbourne), and suggested that they promote bicycle safety, not simply provide sponsorship. It was agreed that they would hold a workshop on bicyclist safety, at which I spoke (the Bicycle Network 2013 Bicycle Futures Conference Melbourne, 17–18 October 2013). Other engagement included participation in TAC sponsored workshops and community consultation meetings on *Vision Zero*.

Throughout the research I continued to seek opportunities to engage with local experts (e.g. at VicRoads, City of Melbourne, Monash University, and the University of Melbourne). I also monitored developments in several international groups and on-line

forums including London Cyclist, London Cycling Campaign, Cyclist in the City, Better Junctions, NACTO (USA), Transport Research Board (USA), Fietsersbond, Bicycle Dutch, Copenhagenize, and the European Cyclist Federation. In Melbourne I attended and spoke at forums held by the AITPM, ITEANZ, TCPA, and followed on-line discussions by local action groups including Bicycle Network, No Mega Trucks, and bicycle user groups (BUGS) in the Inner Melbourne study area. During these activities I was distilling ideas, sharing information, and gaining a greater focus on bicycle safety issues. Although not a formal part of my approach, some of these activities were ‘action research’, shaping the understanding of actors through the research process.

The scoping phase also informed how to consider ‘safe’ bicycle use for adult travel, that is, the meaning of safety, objectively and subjectively, for people in cities. An initial understanding was also sought of the comparative objective safety in each of the case study areas, the injury crash data, and differences in exposure.

3.4 Comparative case study

Case studies were used as they enabled real-life contexts and contemporary phenomenon to be examined (Bryman, 2012; Yin, 2008). Also, the many variables at play in a city were too numerous to study separately (Pucher et al., 2010; Yin, 1981); and the boundary between the phenomenon being studied (safety) and the influence of context was not clear. The case study method provided an in-depth understanding of Inner Melbourne by comparison with exemplar cities while recognising the influence of each local context; that is, differences in the 'situatedness' of meanings, including historic and contemporary influences, were considered.

The comparator cities were defined so they were similar – except for the amount of travel by bicycle – to minimise the risk of confounding variables and avoid 'noise' from obvious differences. That is, with broadly similar areas – such as in population size and socio-demographics – there was the possibility of revealing less obvious differences. Possible reasons for different outcomes for bicyclists travel and safety were then explored from various perspectives including differences in history, social, institutional, and engineered contexts. The case study approach also set the scene for understanding

the possible socio-technical influences on the future transfer of ideas between cities (Appelt et al., 2011; Persia et al., 2010).

The primary case study area was Melbourne, where I have worked for over fifty years as an engineer and transport planner. Two other cities were chosen for the comparison as one city may have been too restrictive, and more than two could have created practical difficulties for in-depth exploration. A further practical consideration in selecting the cities for comparison was the availability of data and documents in English and the competency in English of local informants. To decide on the two comparator cities, I worked from the list of 'big cities' defined by Pucher and Buehler in *City Cycling*, that included Melbourne, Amsterdam, Copenhagen, Berlin, and Vancouver¹³ (Buehler & Pucher, 2012a, Table 13.1). Amsterdam and Copenhagen were the standout exemplar cities for 'big city' cycling (Buehler & Pucher, 2012a). They are the cities often looked to by other 'big' cities in Europe, the UK, and the USA. For example, the USA NACTO cities draw on Danish expertise, and several UK cities have followed the lead of the Netherlands in the 'Go Dutch' approach.

The comparative analysis included consideration of the history of the development of each city. The pre-car and pre bicycle mid-19th century provided a common starting point. Several parameters were then identified to verify contemporary similarities, including those used by Pucher and Buehler (2012) to categorise 'big' cities with the potential for bicycling. The parameters included population size, population density, per capita GDP (of relevance to car ownership), the presence of Universities (campuses provide adults – staff and students – who tend to use bicycles), rainfall, and extremes of temperature (Buehler & Pucher, 2012a). An additional factor considered was the regional economic context of each city – as an indicator of traffic activity. Differences were also noted in two key areas: road safety performance – as an indicator of environmental safety; and travel – trip making choices – an indicator of perceptions about modes.

¹³ Cities that I had previously visited and informally studied.

To compare risk, between modes and between cities, injuries were related to travel. The secondary data for both injuries and travel were obtained for the same area in each city, with case study areas defined by whole municipal areas. The case study areas of Amsterdam and Copenhagen were readily defined as the single, large, and established municipalities. Melbourne, however, was not so readily defined as there is the small central municipality and the large metropolitan area. Others have faced this problem, for example, Buehler and Pucher (2012) used data from the small area of the City of Melbourne (population 128,000 in an area of 36.2 km²s) while Garrard et al. used data for the much larger and diverse metropolitan area (Garrard et al., 2010; Pucher et al., 2011). The limitation of previous international comparisons, that used geographically dissimilar areas, was overcome by demarcating the case study area as an aggregation of whole municipalities that were in parts of the city developed in the pre car 19th century, that is the five Inner Melbourne municipalities of Melbourne, Port Phillip, Stonington, Yarra, and Maribyrnong, as shown below in Figure 4-3. This grouping of five inner municipalities is known as the Inner Melbourne Action Plan (IMAP) group (Department of Economic Development Jobs Transport and Resources, 2015) and as the *Plan Melbourne* 'Central Area' (Department of Environment Land Water and Planning, 2017). In this thesis, the Melbourne study area is called 'Inner Melbourne' or 'IMAP'.

3.5 Injury data

The quantitative data on injuries, related to travel exposure, was used to provide a foundation for the multifaceted qualitative exploration of the safety of cycling in the three different cities, consistent with a constructivist approach (Bryman, 2012). The comparative analysis of injury data and associated exposure, risk, was the basis for answering Question 1. Differences in safety outcomes for bicyclists were compared to car occupants and pedestrians in Inner Melbourne and to bicyclists in Amsterdam and Copenhagen.

The metric used for road trauma was the reported number of persons killed and seriously injured (KSI). KSI is now the preferred metric in several European jurisdictions as traffic fatalities, previously used as the measure of trauma, are very small compared to the much larger number of injuries. However, while fatalities are

reliably recorded, data on injuries are underreported to varying degrees and inconsistently recorded across road user groups (Avenoso & Beckmann, 2005).

For the work on the analysis of secondary data, I was familiar with the limitations of the data, how it had been collected, structured, and manipulated (Bryman, 2012). For the Melbourne data, I was familiar from my previous professional work, with both the Victorian ‘CrashStats’ database and the Victorian travel surveys, such as VISTA, and understood the data's limitations (see Chapter 4). Working with the quantitative data also revealed the limitations and biases of injury data available in each jurisdiction.

For injury details specific to the Melbourne study area LGAs, I extracted data on the persons injured, rather than the number of injury crashes (as any one crash may have more than one person injured). For the Melbourne travel data (VISTA), I approached the Victorian government officers who were the custodians of the data, and they agreed to extract the data for the Inner Area.

For Amsterdam and Copenhagen, data published by or for the municipalities was used. With Amsterdam, the additional analysis undertaken for the municipality by SWOV was also considered. For Copenhagen, files were obtained from the Danish Road Directorate. Data published by the cycling groups in each city: *Fietsberaad* in Amsterdam, and *Copenhagense* in Copenhagen, were also considered.

Recorded crash statistics provide basic information such as who was injured (by age and sex), where and when crashes happened, the numbers of crashes by speed zones, and on road sections compared to intersections, the types of interactions (with other road users or infrastructure), and, over time, trends in crash numbers. Many factors that may contribute to crashes are, however, not recorded, including trip purposes, the experience level of road users, road-user health (other than apparent impairment), and their behaviour immediately prior to the crash – such as perceptions about danger. Analysis of crash statistics, thus, by necessity, ignores many significant factors that influence safety outcomes. Most importantly, however, crash statistics exclude crashes not attended by police – particularly those that do not involve moving motor vehicles.

Garratt et al. note that:

the insight offered by crash data analysis alone is limited and comprehensive data about cycling trip, or exposure data is required to understand how changes in participation affect crash rates

(Garratt et al., 2015, p. 1)

A limitation of the crash data was also that it could not be disaggregated by trip purpose, that is between crashes occurring for transport or non-transport. The crash data also gave a distorted picture of safety, as, because of a recording bias to injuries from collisions with motor vehicles, it left unexamined the significant numbers of bicyclists injured in crashes involving infrastructure, falls, or conflicts with other bicyclists and other non-motorised road users.

An additional limitation of the crash data was that it obviously related to current bicyclists, whose perceptions about safety are likely to be very different from those of potential bicyclists (Fishman et al., 2012). The current bicyclists in Melbourne were regarded as the 'canaries in the mine', warning of the environmental danger for possible new bicyclists, or alternatively as the 'hardy colonising species' that indicated that it was possible to ride on Melbourne's roads. Current bicyclists in Melbourne were not, however, like or representative of the 'ordinary' people in Amsterdam and Copenhagen, who were just people on bikes, not fearless 'cyclists' (Greig, 2010).

For comparative analysis, the numbers injured are related to a measure of travel exposure associated with those injuries (Jacobsen et al., 2009). As consideration of exposure requires a measure of travel that can be matched to injury numbers, it is rarely explicitly considered. Public health comparisons often use the epidemiological approach (WHO, 2013), which adjusts for population size (Jacobsen, 2003). However, for comparisons by mode between cities, this approach can be misleading unless the levels of use for each mode are similar.

Garrard et al. state that 'the risk of being injured is simply the number of injuries occurring per some measure of exposure' (Garrard et al., 2010, p. 38). Exposure may be defined in various ways, including as trip numbers, time or distance travelled, or the number of potential conflicts encountered. A limitation of all such measures is that they

conceal differences in risk, such as riding at night compared to riding in daylight and differences in risk-taking, such as between men and women riders. The measure of exposure used by Garrard et al. (2010) was estimates of annual distanced travelled. However, for the city to city comparisons, distance travelled, rather than trip numbers, is biased against cities with efficient and proximate arrangements providing shorter trips to access land-use activities.

The benefit of travel, a trip, is the access to activity at the destination, not the time and distance travelled – which are typically considered as costs to be minimised. Trip numbers, expressed as percentages, were therefore used as the measure of exposure for this analysis. It is noted that Pucher and Buehler also used trip numbers for a comparison between USA cities (2016). Estimates of trip numbers were available from travel surveys for each case study area. The main purpose of such travel surveys is to calibrate transport planning models that compute and predict trips between ‘zones’, using assumptions about attraction and generation of travel, with separate estimates made for trips within zones. For the IMAF area, trip estimates by mode and between and within zones, based on a sample of 428 household diaries for the VISTA 2013 survey, were obtained from the Department of Economic Development (2015). For Amsterdam and Copenhagen, municipal estimates of trips were obtained from published sources (Fietsberaad, 2010), (KiM Netherlands Institute for Transport Policy Analysis, 2014).

The statistical analysis described above provided a reference point for the qualitative work that followed. The statistics provided a foundation from which to explore qualitative differences in safety for each case study area.

3.6 Qualitative exploration

This section outlines my approach to obtaining the qualitative data that explored multiple perspectives from actor informants, documents and by direct experience, as described in Chapters 5, 6 and 7. To organise my approach and analysis for this multifaceted research I used the three broad themes of context (C), process (P) and content (C), which underlie socio-technical systems theory, and some public policy models, the CPC model, as shown Figure 2.8 above.

The themes and the actors were recognised as interacting in the 'construction' of city safety for trips by bicycle. Within the content theme, the well-established *Safe System* pillars (Figure 2-5) were adopted to further structure data collection and analysis.

The interpretive approach for this research sought perspectives from documents, interviews with participants, photos, personal observations, and direct experience to provide insights on the safety of each city for bicycling, see Figure 3-1. Participant informants for recorded interviews were chosen for their knowledge of the city and bicycle safety, and not as a representative sample of the local inner-city population.

Table 3-1 Data sources and analysis

Description	Perspective	Source / Selection	Origin	Analysis Type	Population
Documents: policies, standards, regulations, public media & photographs	Official guidance	Relevant to safety for bicyclists	Secondary	Qualitative	Municipal, State, National
Actors, key informant interviews	<ul style="list-style-type: none"> • Government decision-makers and practitioners • Interest groups • Researchers and experts 	Recruited from contacts, via snowball sample & authors of published sources (contacted by email and phone)	Primary	Qualitative	Inner-city actors: road managers, officials, advocates, regulators 6 in Amsterdam 7 in Copenhagen 18 in Melbourne.
Site observations photographs and experience	Subjective interpretation and observation	Inner Melb., Amsterdam & Copenhagen. (sites selected with advice from key informants)	Primary	Qualitative	Infrastructure: paths, lanes, intersection, T-junctions, and roundabouts.

The data were analysed under the CPC themes of context, process, and content. For each city, historic context influences were interpreted from documents and photos. Cultural and policy factors were interpreted from documents and the informant interviews. Under process, the decision-making processes and actors that influence the conditions provided for bicycling were explored. The influence of content was examined, using the interdependent sub-themes of the *Safe System*: infrastructure, vehicles, and road user behaviour. Site observations provided verification of the views of the informants.

Key informant interviews

The Interpretative Research approach seeks purposeful exposure to ideas, not saturation sampling. In Amsterdam and Copenhagen, where the approach to bicyclist safety is well developed and relatively uncontested, fewer interviews were required. In Melbourne, however, there is no such agreement on bicycling safety, and more perspectives were sought. The persons interviewed in each city were selected for their knowledge of bicycling safety and were drawn from three broad ‘actor’ groups: government practitioners, interest groups, and researchers, as listed in each of the finding’s chapters. After ethics approval, interviews were conducted in each city during 2013 and 2014. Informants included government employees/practitioners, cycling advocates, motoring interest advocates, academic researchers, and where possible, elected government representatives. Contact with potential Melbourne informants was made through previous work associates, public forums and by phone, with follow up by email. Initial contact with informants in Amsterdam and Copenhagen was usually by email, giving the referring person's name. Some informants were also sought through web forums and although there was only a small number of responses, these were very helpful. For most categories of actors, I was able to get matching informants in each jurisdiction, except for elected representatives and police officers in Amsterdam and Copenhagen, but I did get insights into the role of these actors from other informants. All but four of the informants, and these were in Melbourne, were experienced riders. One-third of the informants in Melbourne were women, half in Amsterdam and five of the seven in Copenhagen.

Before each interview, informants were provided with a 'plain language' invitation and a statement about the project (see Appendix 3). Most interviews were conducted at or near the informant's place of work or home, except in two cases when they were held at my rented apartment and in two other instances by phone (as informants' workplaces did not support Skype). Interview data was obtained by open-ended interviews with a purposive sample of actor informants in each city: 18 in Melbourne, six in Amsterdam and seven in Copenhagen. For the conduct of the open-ended qualitative interviews I drew on my training as a psychotherapist, which included the practice of empathy and non-judgement, which are central to interpretivist research and the understanding of what is 'normal' in different contexts.

For face to face meetings, I requested informants find a quiet place, where we would not be disturbed. Most interview locations worked well except that some informants suggested interviews in cafés with significant background noise and one suggested an inner-city club where the interview was truncated when the informant 'networked' with a senior government person who walked past. Attending workplaces provided occasional bonus contacts through introductions to senior staff and other colleagues before or after the interviews. The phone interviews were less productive, but this was compensated for by subsequent email exchanges.

The original interview strategy was to follow a semi-structured format, but during the first interview it became obvious that it was more productive to invite informants to talk about their experience through open queries. The approach to the in-depth interviews thus followed the advice of Seidman¹⁴ and sought to understand the lived experience, observations and learning of informants, and make sense of that experience (Seidman, 2013). My challenges included to background my personal meaning-making and to set aside interpretations based on my own expertise. The open-ended questions allowed informants to reveal their lived experience. I noted Seidman's (2013) caution, from

¹⁴ Seidman's interest in the use of in-depth interviews grew (as did mine) from the experience of psychotherapy – a process that values language and personal stories to aid knowing and understanding.

Schutz (1967), that although one may strive to understand the informant, it is never possible to understand another perfectly, but trying is worthwhile.

Most interviews were of one-hour duration, some extended to over two hours, and most were recorded (informants at only one interview declined to be recorded). Informants who worked for or represented state agencies in all three study areas were universally concerned to maintain their anonymity.

The interview recordings (totalling more than 40 hours) were commercially transcribed off-shore, which greatly reduced the risk of identification of any informants.

Transcription was also commissioned with an explicit requirement for maintenance of confidentiality and the names of informants were redacted from the recording labels. The transcriptions were then checked, corrected, and summarised under the headings of context, process, and content. To reduce the risk that comes with interpretive methods of misreading the meaning-making of informants because of the influence of one's beliefs and experience, the overseas informants and several local informants were provided with summaries for them to check and comment on (Schwartz-Shea & Yanow, 2012). The dialogue associated with checking was a most useful step, as discussing suggested changes deepened my understanding and sometimes led to additional reference material. The interview and checking back was a process of co-generation of meaning, which included accepting their meanings if they differed from mine (Schwartz-Shea & Yanow, 2012).

The interview data was complemented and verified by documents, photographs, and the experience of participation in and observing traffic in each city. The findings relating to Questions 2 thus involved working from the individual perspectives of informants and interpretation of key documents, acknowledging that there are potentially 'multiple intersubjective social realities' (Schwartz-Shea & Yanow, 2012, pp. 44, 88).

Document analysis

Document analysis provided additional perspectives on context, process and content and included historic documents, technical reports, and guidelines. From the documents, safe-cycle friendly policies and measures were identified and understanding deepened. The document analysis also provided ideas to explore in the interviews (e.g. provisions

for each road user group) and further perspectives on findings from the interviews. Also, the meaning I made from documents¹⁵ was checked with informants and with observations in each city. (The list of documents examined for each study area, is provided in Appendix 2).

Throughout this research, I also monitored on-line developments in several international groups and forums including London Cyclist, London Cycling Campaign, Cyclist in the City, the European Cyclist Federation, Better Junctions, NACTO (USA), AITPM, TRB, Fietsersbond, and No Mega Trucks.

Photographs

Photographs by others, (extant photographs), mainly of historic street scenes and from on-line sources were studied to gain a sense of cycling conditions in each city (Bryman, 2012). Examples of these photographs are provided on my Pinterest 'boards' for Melbourne, Amsterdam and Copenhagen, with over 150 'pins' (see: <https://www.pinterest.com.au/wazza50/> –open as a hyperlink). The historic photographs, mostly street scenes – selected when they included at least one bicycle rider, provided insight into traffic conditions, the amount of bicycling, and the age and gender of early bicyclists.

Original photographs and videos were also taken for use as illustrations, as data to be studied, and as an extension of my field notes (Bryman, 2012). Taking photographs was also helpful as it required thinking about what to record, for example, to illustrate behaviour or an item of infrastructure.

Observations and participation

In the interpretivist methodology, the researcher is a 'research instrument' who checks on their sense-making and reflects on what may influence their sense-making (Schwartz-Shea & Yanow, 2012, pp. 99-101). As a 'research instrument' I observed and experienced bicycle travel in each city and obtained an embodied understanding of what

¹⁵ The meaning of some documents was obscure, as, although they were published in English, the translation needed clarification.

it was like to bicycle in each city. Observation aided in understanding how infrastructure and regulations worked, and the risk-taking by bicyclists, such as those who ‘ran’ red lights. Participation in traffic gave me the experience of what it felt like to be a rider, including the level of consideration experienced from motorists. Personal experience was also used to verify the meanings I took from the interviews and the literature. Observations thus complemented and enabled the critiquing of my understandings from the interviews and document analysis (Bryman, 2012).

Several forums and workshops, relevant to city cycling and safety were attended, with international presenters including: Prof. Jan Gehl from Denmark (2013), Prof. Robert Bertini from the USA (2014), Prof. Fred Wegman from the Netherlands, Dr Marco Dozza from Sweden, and Mr Johan Diepens (Mobicon) from the Netherlands. Insights were also gained by attending forums, workshops and presentations convened by local bodies including the City of Melbourne, Victorian Transport Accident Commission, Bicycle Network, City of Port Phillip. Presentations specifically on bicycling in Melbourne that I attended included those given by: Melbourne Lord Mayor Cr Robert Doyle, Cr Cathy Oke (City of Melbourne), Dr Bruce Corben (Road Safety Consultant), Dr Cameron Munro (Consultant), Dr Alison Carver (Health Researcher), Mr David Shelton (Executive Director, VicRoads), Mr Haig Poulsen, Principal Engineer City of Melbourne, and Mr John Bartels, Transport Coordinator, City of Port Phillip. I also attended several safety-related forums, including the City of Melbourne community forum (April 2013), the Motor Vehicle Standards industry briefing, Melbourne (3/6/2013) and contributed to the TCPA submission to the Melbourne Bicycle Strategy.

In 2012 a final year engineering student (Sarah Godwin) was mentored for a project on cycling at CBD intersections, which enabled me to gather additional information from City of Melbourne officers. The ‘Trucks and bikes’ paper (Pattinson & Thompson, 2014) was also the basis for the thesis by Luke Poland: Heavy Vehicles and Vulnerable Road Users: Examining the Barriers and Opportunities for the use of Side Under Run Protection submitted as part of a Master of Urban Planning degree at the University of Melbourne (2015).

3.7 Ensuring ethical and quality research

Ethics approval was obtained from the University of Melbourne, Faculty of Architecture and Planning, ID 1340843. The statistical analysis based on secondary data from VicRoads and the Victorian Transport Accident Commission, was ethically unproblematic as the aggregated data contained no information on any individual.

For the interviews, participation was restricted to adults, and any direct experience by informants of serious road trauma was not probed, although some informants volunteered their experiences of serious injury. Before the interviews, invited informants were provided with a written Plain Language Statement on University of Melbourne letterhead, identifying me as the researcher and naming my supervisors as contacts (see Appendix 2). The Statement was drafted as a consent form and signed by the informants. The research was described to potential informants as being about road use and to provide material for a PhD. No informants exercised their right to terminate an interview.

Participants were advised that any quotes in the thesis or research papers would be made under pseudonyms or otherwise coded unless they had given permission to be quoted and identified. The proposed codes to be used were checked with informants and, at the request of informants, were made more general to reduce the risk of identification, for example, to not identify their organisation.

The persons engaged for the transcriptions were located overseas (in the Philippines) hence were very unlikely to know any of the informants, but the need for confidentiality was made an explicit condition of engagement. As noted above, the University of Melbourne procedures were followed, including for data storage and security¹⁶. Recorded and written material was retained in strict confidence and identification of individuals was excluded unless permission was expressly granted.

¹⁶ The interview recordings, transcriptions and summaries will be held by the University of Melbourne.

Criteria for qualitative research specified by Tracy (in Bryman, 2012) are that the research be on a worthy topic and make a significant contribution to theory and practice (Bryman, 2012). Further criteria suggested by Guba and Lincoln (in Bryman, 2012) are trustworthiness, credibility, transferability, dependability, confirmability, authenticity, fairness, contribution to understanding, appreciation of settings, empowerment, and providing the impetus for change. This research is asserted to be ‘worthy’ as a high level of city safety for bicyclists is a pre-requisite for travel by bicycle to contribute to city sustainability.

As noted above, summaries were provided to informants for validation. My understandings and interpretations were also to be checked across several interviews and from reports and other publications. The quality of the findings from this research is also supported by the cross-checking inherent in the methodology that involved obtaining multiple perspectives from the mix of quantitative and qualitative methods.

Observations in each city also enabled the views and constructs of informants to be verified, for example, by direct experience of the nuisance of mopeds mixed in with bicyclists on Amsterdam's bike lanes, and in Copenhagen, seeing that motor vehicle drivers did in fact, check for and give way to through bicyclists when turning right.

This research builds on, and provides continuity from work by others, such as Gössling, Pucher and Buehler, (Buehler & Pucher, 2012a; Gössling, 2013; Pucher & Buehler, 2008; Pucher & Dijkstra, 2000; Pucher et al., 2010; Pucher et al., 2011) as described in Chapter 2. Ongoing checks were also made by ‘following’ the writings of others in social media (Bicycle Dutch, 2012, 2014; Copenhagenize Design Company, 2015; Fietsberaad; Kambanas, 2012; KO, 2011; Wagenbuur, 2013).

Findings were also discussed with experts and practitioners and were tested by:

- submitting conference papers for review and discussion, including:
 - The Eighth International Conference on City Logistics (Pattinson & Thompson, 2014)
 - State of Australian Cities conferences in 2013 and 2015, (Pattinson & Whitzman, 2013) (Pattinson, 2015)
- presentations at:
 - Bicycle Futures, Melbourne, 2014
 - Conference of Australian Institutes of Transport Research (CAITR), Melbourne, 2015
 - Healthy Cities, University of Melbourne, 2015
 - EcoCity, Melbourne, 2017, (Pattinson, 2017)
 - Centre for Accident Research, QUT, 2017
 - ITEANZ Seminar - On Your Bike *Cities 'safe enough' for travel by bicycle?* RMIT, 24 July 2018

My ideas and findings were also progressively tested in interactions at forums, such as the TAC, *Vision Zero* Community Forum, discussions with bicycling advocates and individual municipal councillors, and decision-makers such as Jamie Ross, Director, Safety of the MMRA.

Regarding risk management, during the field observations, as a trained road safety auditor and trained in occupational health and safety, appropriate care was taken, for example, photographs were only taken from a safe place, clear of traffic. Also, in the unfamiliar cities of Amsterdam and Copenhagen, I did not ride during my scouting visits. On my subsequent visits, before riding in traffic, I observed traffic for at least one day as a pedestrian to get used to traffic behaviour norms and to get used to traffic approaching on the near-right side, instead of the far-left side. Then, when initially riding, I was either accompanied by a local person, or I informally joined slow local cyclists. To further minimise risk, I did not ride at night or on roads with traffic speeds above 50 km/h.

3.8 Summary

This research sought fresh and practical insights for Inner Melbourne by an inquiry based on a socio-technical systems approach, with a mix of qualitative methods. It provided a deeper understanding of international ‘best practice’ possibilities to improve the safety of Inner Melbourne for future bicyclists.

Chapter 4 Understanding safety

In this chapter, I define the case study areas: Inner Melbourne, Amsterdam, and Copenhagen that are used to explore quantitative aspects of safety for bicyclists in each study area, including a way of quantifying objective risk by considering injury numbers relative to trip percentages. The analysis in this chapter provides a foundation for the qualitative explorations in the subsequent chapters.

4.1 Defining the case study areas

This section describes how the case study areas were defined for injury and travel data and to provide a geographical focus on factors that influence safety for bicyclists. In the book, *City Cycling*, Amsterdam, Copenhagen, and Melbourne were classified as ‘big cities’ (Pucher & Buehler, 2012). As Amsterdam and Copenhagen are recognised as the exemplars for big city bicycling, they were chosen as the cities with which to contrast Melbourne.

The Municipality of Amsterdam (the City), is at the heart of the Amsterdam Metropolitan Area (AMA) with over two million inhabitants, two airports, two seaports and three universities¹⁷. With 371 cars per thousand inhabitants, car dependence is moderate (UITP (Union Internationale des Transport Publics), 2015). Amsterdam informed work on the Melbourne Bike Plan in the 1970s and has been used by others as an exemplar cycling city (Appelt et al., 2011; European Transport Safety Council, 2013; Fishman et al., 2012; Meggs et al., 2012; Pucher & Buehler, 2008).

Copenhagen is the capital city of Denmark, a nation with a population of 5.7 million people (like the State of Victoria, Australia, but Denmark has an area about 1/5 the size of Victoria).

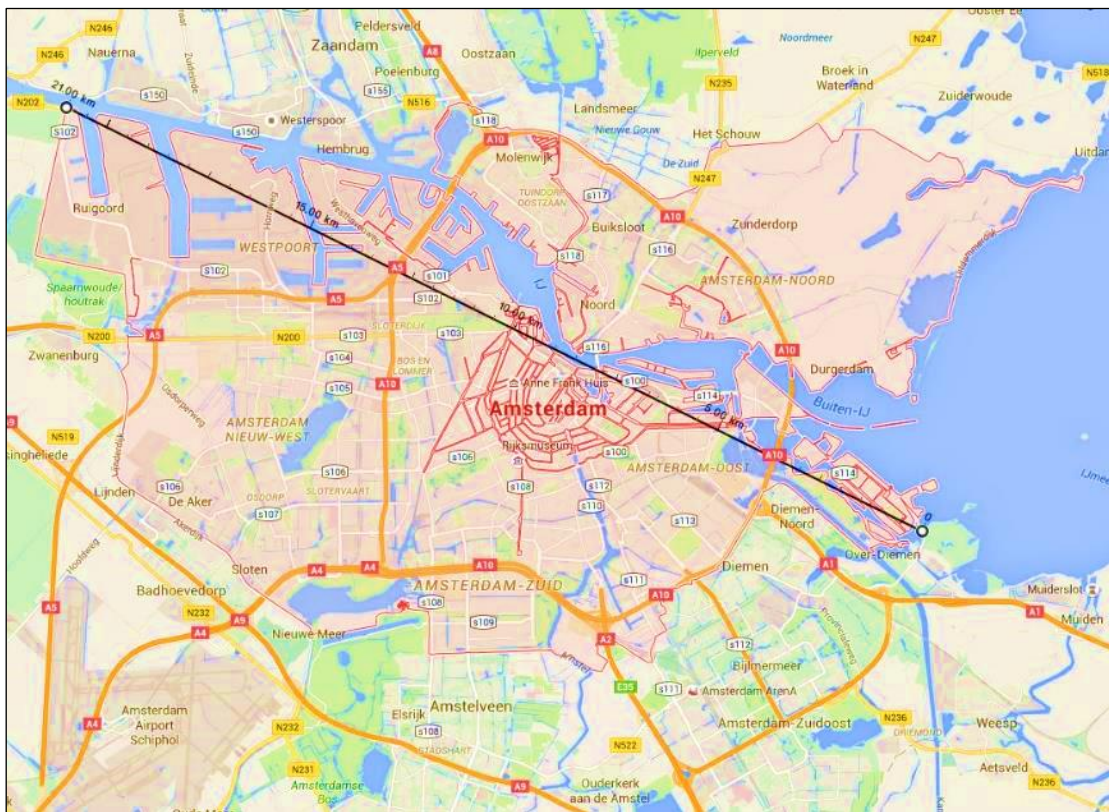
The Inner Area of Melbourne is at the centre of a large metropolis, the Greater Melbourne metropolitan area of 9990 km², with a population of over 4,485,000 (2016),

¹⁷ The Amsterdam Metropolitan Area (AMA) lies to the north of the Randstad and encompasses the city of Amsterdam and the Dutch provinces of North Holland and Flevoland. <https://www.iamsterdam.com>

where most people live in the suburbs and depend on private cars for transport. However, like the European case studies cities, the morphology of the small Inner Melbourne study area reflects development in the pre-car era.

To calculate and compare travel risk, injury and travel data was needed for the same study area, which was local government areas. For the qualitative data, the areas only needed to be similar in terms of socioeconomic characteristics, urban morphology, and geography. The case study areas are illustrated below:

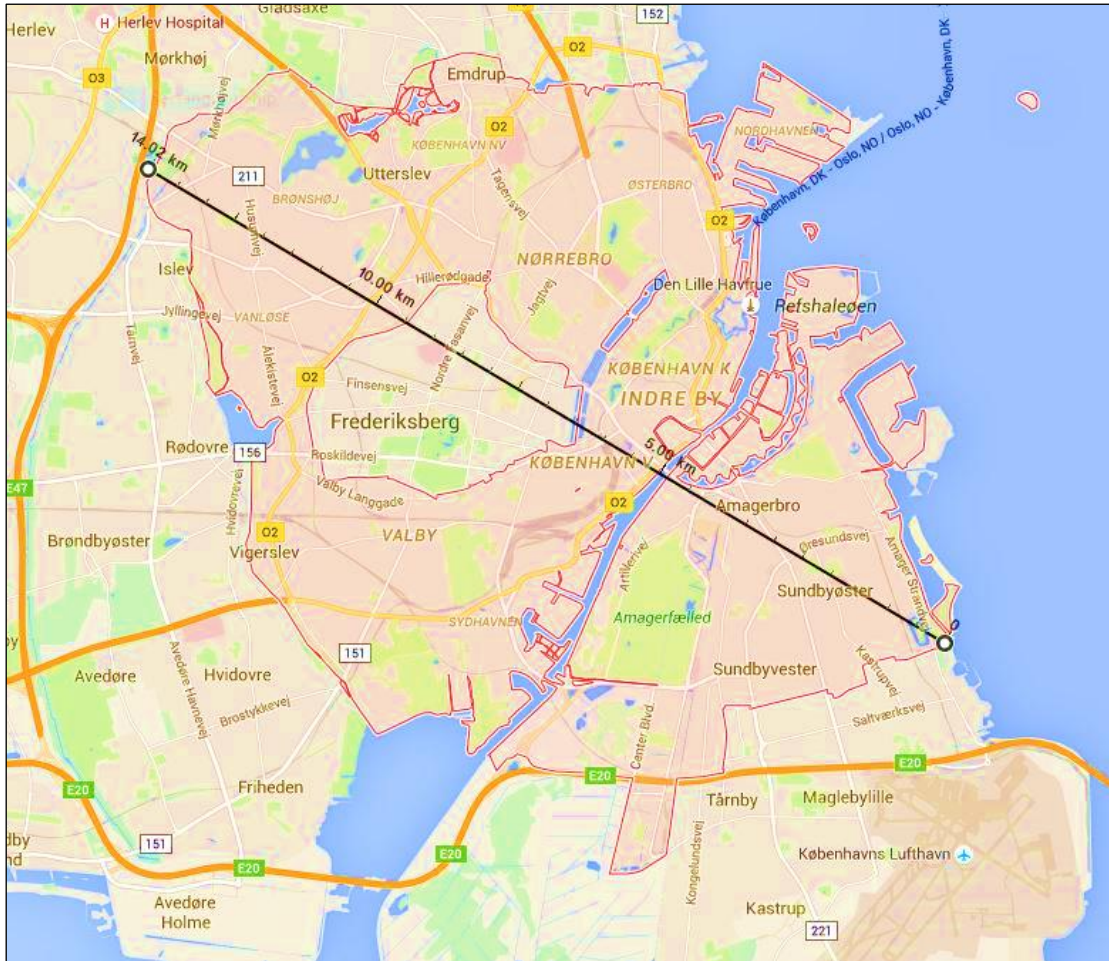
The Amsterdam case study site is defined as the Municipality of Amsterdam, the pink area in Figure 4-1, largely contained within the motorway ring: A9-A5-A10-A4, covering some 180 km², with over 840,000 inhabitants.



Source: Google Maps (that includes UNdata)

Figure 4-1 Amsterdam Case Study Area

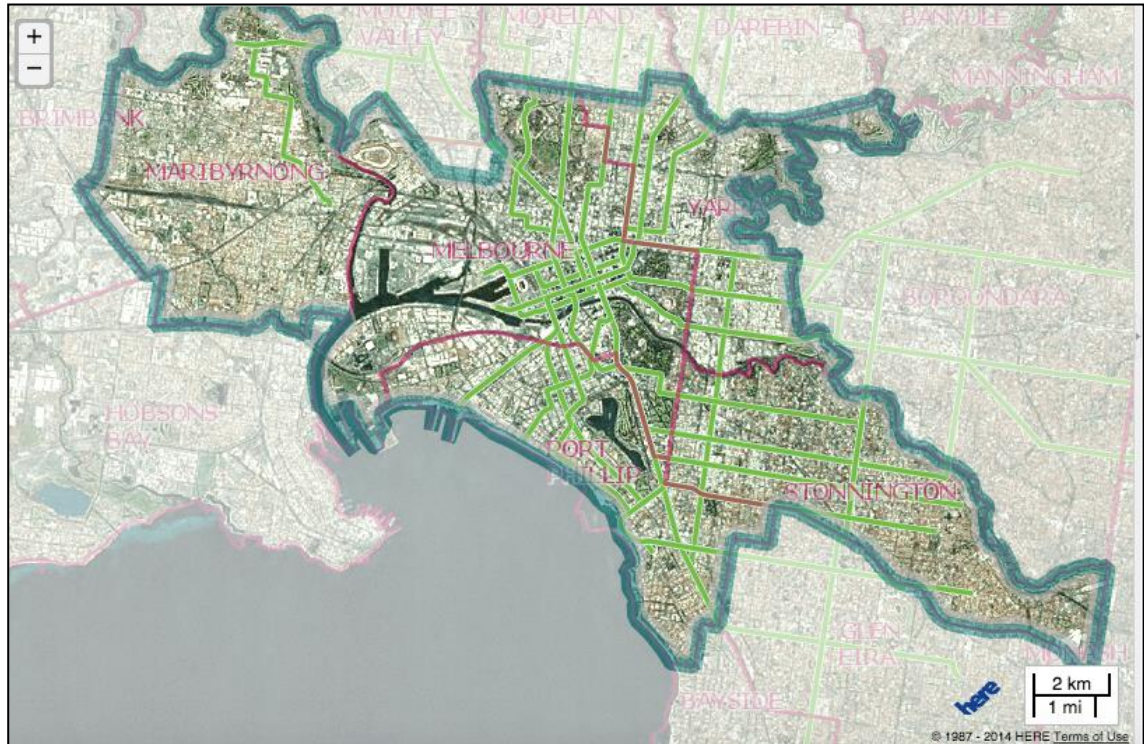
The Copenhagen case study site is defined by the Municipality of Copenhagen, excluding the small separate municipality of Frederiksberg that is contained wholly within the municipality of Copenhagen. The Municipality of Copenhagen covers an area of 77.2 km² with a population of 562,400 (City of Copenhagen, 2013a), see Figure 4-2.



Source: Google Maps including UNdata

Figure 4-2 Copenhagen Case Study Area

The Melbourne case study area was defined to include much of the area developed in the 19th century, now covered by five municipalities: Maribyrnong, Melbourne, Yarra, Stonnington and Port Phillip – known as the IMAP group, with a resident population of 446,000 in an area of 135 km².



Source: (Inner Melbourne Action Plan, 2013)

Figure 4-3 Inner Melbourne Study Area

Although Melbourne is a much younger city than Amsterdam or Copenhagen, the inner area of Melbourne was developed in the pre-car 19th century. By the 1860s, Melbourne's population surpassed that of Copenhagen and by the early 1880s that of Amsterdam (Brown-May et al., 2005). The morphology of the inner areas of Amsterdam, Copenhagen, and Melbourne are similar in that they reflect initial development suited to walking and equestrian transport. Each city also shares a history of cycling that dates from the late 19th century. Over the second half of the 19th century, development of each city was shaped to varying degrees by public transport, discussed further in section 8.1.1 below.

Both Amsterdam and Copenhagen have provided inspiration for urban planning in Melbourne. For example, Amsterdam informed work on the Melbourne Bike Plan in the 1970s, and the City of Melbourne has a forty-year urban design association with Copenhagen through Prof. Jan Gehl, who advised on the transformation of Inner Melbourne from a 'doughnut city' – with nothing in the middle – to a world-class liveable city (Gehl et al., 2011).

A comparison of the case study areas, based on several of the parameters given in section 3.3, are summarised in Table 4-1 below.

Table 4-1 Inner City Comparisons, Melbourne, Amsterdam, and Copenhagen

	Measure	Population (000's)	Inner Area (km ²)	Density (Res/km ²)	Regional Context	Road deaths per 100,000 ¹⁸	Bicycling (% of trips)
Study Area	Melb. (IMAP)	446	135	3300	State of Victoria (pop. 5.5 mil.) in Australia	5.1	¹ 3.9 (2007)
	Ams. (City)	820	219	3745	Province of North Holland (pop. 7. mil) in E. U.	3.9	² 29. to ³ 50. (2008)
	Cph. (City)	559	77	7260	State of Denmark (Pop. 5.4 mil) in E.U.	4.7	² 29. (2008)

Sources:

1. The Victorian Department of Transport 2007 Victorian Integrated Survey of Travel (VISTA) (Department of Transport Victoria, 2009).
2. (Rask & Skov-Peterson, 2013)
3. (Voerknecht, H. 2010, estimate for Inner Amsterdam)

In the 2010s, the resident populations in each of the study areas were of the same order of magnitude. The population density in the IMAP area was similar to Amsterdam and

¹⁸ As discussed above in section 2.1, deaths are reliably measured but are not a good indicator of the environmental risk or traffic danger.

about half that of Copenhagen. Inner Melbourne, like Amsterdam and Copenhagen, contains several university campuses, including Melbourne, RMIT and Victoria Universities, and city campuses for other Universities including Monash and Southern Cross.

Climate and topography, important for bicycling, have both some similarities and differences across the study areas. Rainfall, for example, a key factor for cycling safety (and comfort) is similar for the three cities. Temperature extremes, however, which influence cycling participation and safety were different. Until 2019 Melbourne typically had at least thirty hot (>32 °C) days per year compared to none for Amsterdam and Copenhagen (Buehler & Pucher, 2012a). The significance of hot days to the safety of bicycling is that high ambient temperatures¹⁹ contribute to rider fatigue and the risk of heatstroke. Riders in Amsterdam and Copenhagen, had however, (until 2019)²⁰ experienced winter hazards absent in Melbourne, that included ‘black ice’, which can result in skidding and loss of control. High winds are also a deterrent for bicycling and Melbourne experiences several days with strong ‘southerlies’ in winter and strong and hot ‘northerly’ winds in summer. For the period of this analysis, however, the differences in climatic extremes in Melbourne (days with strong winds and very high temperatures) were likely on balance to be less of a barrier than the months of severe cold and ice in Amsterdam and Copenhagen.

There are also regional economic similarities that influence traffic as each of the case-study areas are at the centre of larger metropolitan regions. Copenhagen functionally relates to a large metropolis that includes Malmö in Sweden. Amsterdam is part of the large and developed province of North Holland, with connected satellite cities – like the relationship between Geelong and Melbourne in Victoria. As economic hubs, the inner areas of all three cities experience severe peak hours congestion, with Melbourne

¹⁹ Bicyclists riding on a bitumen surface in Melbourne on hot sunny days can experience ambient temperatures at least 10 to 20 °C above the shade temperature, that is well above 40 °C. In the European summer of 2019 however, high temperatures were also experienced on some days.

²⁰ In 2019 the northern European winter was unusually mild.

ranked worse than Amsterdam in the IBM Computer Pain Survey 2011 (Major Cities Unit, 2012).

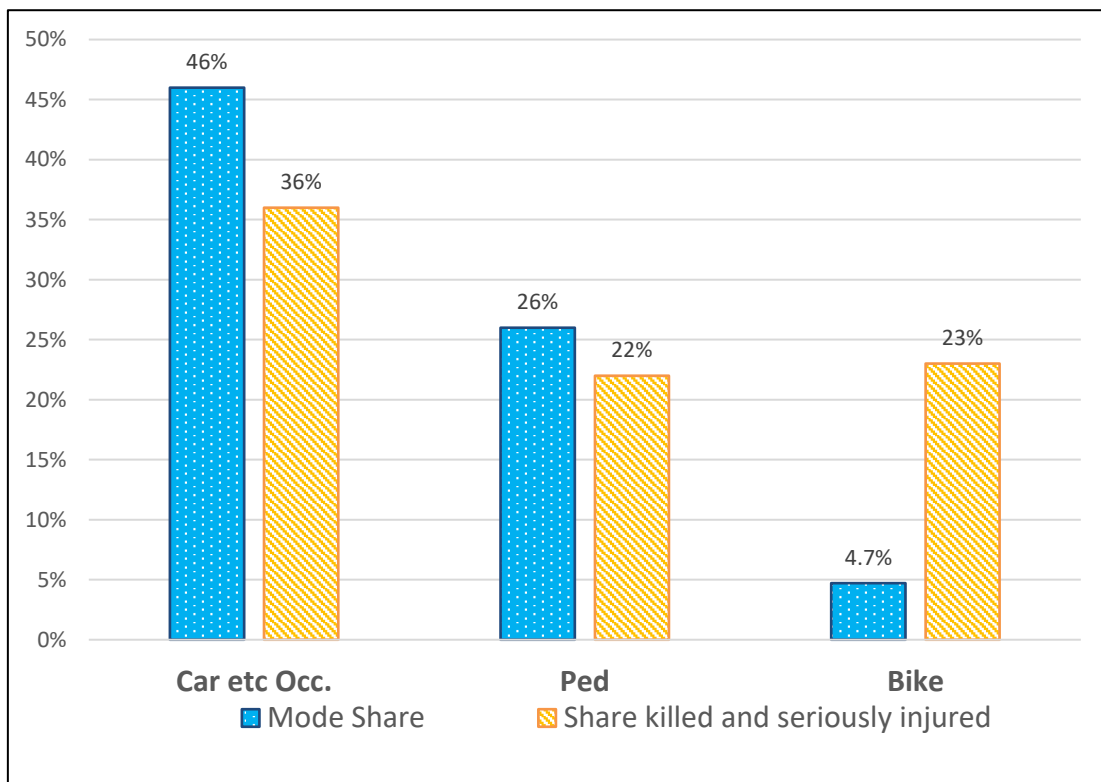
The land-use arrangements (density and mix of land-uses) for the inner areas of each city continue to provide a built form that is highly accessible by bicycle. For example, travel within the inner municipalities of Melbourne involves much shorter trips than in the outer suburbs of Melbourne (Department of Economic Development Jobs Transport and Resources, 2015).

A national contextual difference is however that while both The Netherlands and Denmark see themselves as cycling nations, Australia, with over 90% of households operating motor vehicles, understands itself as a car-dependent nation (ABS, 2011). The key difference for this research is, however, the much higher percentage of trips by bicycle in Amsterdam and Copenhagen than in Inner Melbourne, which suggests much higher levels of safety (rider comfort or low perceived danger) in these European cities.

4.2 Comparing risk

For an initial broad appreciation of differences in safety for each case study site, risk, the number of injuries as reported to the Police related to the amount of travel, as estimated by the travel surveys, was calculated. Differences in the many factors that influence the probability of an injury, and perceptions about safety, are subsequently explored in Chapters 5, 6, 7 and 8.

For the IMAP area, crash injury data – persons injured – was extracted from CrashStats for each of the five local government areas (VicRoads, 2012b). The trip estimates²¹ by mode, between and within zones, were obtained from the VISTA data, as shown in Table 4-2 (Department of Economic Development Jobs Transport and Resources, 2015). The share (percentage) of trips, compared with the share of reported road injuries by mode, shows that people on bicycles made the smallest percentage of trips, 7.4%, yet bicyclists experienced disproportionately high trauma, 23%, see Figure 4-4 below.



Sources: VISTA and CrashStats 2012-13

Figure 4-4 Inner Melbourne, mode share and injuries

In Inner Melbourne, where less than 5% of trips were by bicycle – objectively the cheapest and quickest mode for many short trips – low levels of bicycling suggest that

²¹ Based on a sample of 428 Inner Melbourne household travel diaries kept for the VISTA 2013 survey.

for many adults, bicycles were 'ruled out'²² for travel in favour of safer cars, walking or public transport.

The disparity between mode share and injury share for bicycling use compared to car use, shown above, is however not unique to Melbourne. In the Netherlands, an index calculated by SWOV, based on all known serious injuries and distance travelled (not trips) suggested that the comparative risk for bicyclists increased from 2000 to 2009, and by 2009 the risk was almost double that of car occupants (SWOV, 2013). The change in the difference in risk had two components: the risk for car occupants decreased by more than 40% while the risk for bicyclists increased by almost 40%. Curiously, an increase in the relative risk of bicycling did not reduce the amount of bicycling in the Netherlands, which may reflect the power of travel habits.

For city comparisons, estimates of trips for Amsterdam and Copenhagen were obtained from published sources, see Table 4-2.

Table 4-2 Travel exposure: Mode share (percentages of trips)

Mode:	Inner Melbourne		Amsterdam	Copenhagen
	All ages	Adults		
Priv. Motor Vehicles	46.6	55.8	27 - 29.	33.
Public Transport	21.2	12.5	18 - 21.	20.
Walk/other	26.6	24.8	24 - 11.	17.
Bicycle	4.7	5.2	28 - 38.	30 - 32.

Sources: (Fietsberaad, 2010), (City of Copenhagen, 2015; KiM Netherlands Institute for Transport Policy Analysis, 2014),

In Inner Melbourne, 4.7% of trips (all ages) were by bicycles, compared to more than 28% of trips by bicycles in Amsterdam and 30% in Copenhagen²³. The Inner Melbourne data also showed a high proportion of adults used private motor vehicles,

²² That is, safety is a threshold issue, considered before other practical issues like where to leave their bicycle.

²³ Recent (2018) estimates of bicycle mode share are significantly higher in Amsterdam and Copenhagen.

which emphasises the importance, for improved city sustainability, of targeting adults for a mode shift to bicycling.

To compare objective safety between modes and cities, a risk index (R) was developed that considers the number and severity of injuries, adjusted for the size of the population, and travel exposure (percentage of trips):

Risk index (R) by mode (m) = Persons killed and injured (KSI) for mode(m)/Population who made trips by that mode (population in 100,000's (P)/ percentage of trips by mode (T_m).

$$R_m = KSI_m / P / T_m$$

Equation 1 Risk Index

The variables in the risk index for a mode 'm', (R_m) have risk reducing as:



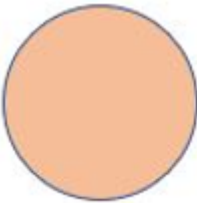
- share of trips (T_m) increases
- population (P) increases, or
- the number of deaths and injuries (KSI) reduces.

The risk index R was consistently calculated across case study areas using the number of serious injury crashes involving motor vehicles reported to the police, (the metric used in several studies summarised in section 2.2 above), and travel surveys that estimate mode share as a percentage of all trips²⁴.

For travel in the IMAP area, the calculated Risk index by mode 'R_m' shows that car use and walking have a low risk and are objective safe choices, with car use having one-sixth the trip risk compared to bicycling, see Table 4-3.

²⁴ An assumption implicit in this index for comparisons between cities is that the average number of trips per person are similar in each city (Hydén et al., 1999).

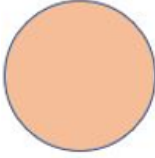



Table 4-3 Serious Injury (KSI) Risk by Mode in Inner Melbourne (2013)

IMAP (Population 446,000)	Motor vehicle Occupants (c)	Pedestrians (p)	Bicyclists (b)
KSI (CrashStats)	251	156	163
KSI/100,000 population	56.3	35.0	36.6
Mode share (VISTA)	47%	27%	4.7%
Risk index 'R' $R_m = KSI_m / P / T_m$ (The area of the disc is proportional to the risk 'R')	1.2 	1.3 	7.8 

The risk index 'R' also shows that most people travelling in Inner Melbourne, when choosing between motor vehicles, walking and bicycling, use modes with a low risk of injury. In Inner Melbourne, car occupants had one-sixth the risk of people making trips by bike; this compares with a risk of less than one-twelfth, based on distance travelled, calculated by Garrard et al. for the whole of the Melbourne metropolitan area, (Garrard et al., 2010). However, by both measures, trips and distance, the risk to bicyclists was understated as the number of injuries to bicyclists was much higher than the number reported to the Police. Based on the injury experience of those who have ridden in Inner Melbourne, could-be riders were wise to walk or travel in motor vehicles instead of riding.

To compare bicycling risk between Inner Melbourne, Metropolitan Melbourne, Amsterdam, and Copenhagen, the R index was calculated, see Table 4-4 below.

Table 4-4 Bicyclists traffic ‘Risk’

Urban Area	Metro Melb	Inner Melb.	Amsterdam	Copenhagen
Population (100,000)	40.87	4.46	8.20	5.59
Bicycling mode share (M)	<2%	4.7%	28 - 39% (say 30%)	30%
(Recorded) Bicyclists Killed & Seriously Injured (KSI)	363.	163.	130.	111.*
KSI per 100,000 population.	8.8	36.5	15.8	19.9
Risk index (R _b)	4.5	7.8	0.53	0.66
The area of the disc is proportional to the risk)				

Sources: Melbourne, CrashStats 2009-2013, reported crashes involving motor vehicles; City of Amsterdam and SWOV 2014; City of Copenhagen, 2014)

The above analysis indicates that the risk of riding in Inner Melbourne is almost twice that of riding in Metropolitan Melbourne – supporting the perceptions reported in findings of the 2010 survey for VicRoads (Hall and Partners, 2010); also, that the risk is eighteen times higher than in Amsterdam, and fifteen times higher than in Copenhagen.

Using reported serious injury crashes involving motor vehicles provides reasonably comparable data as the number of injuries to bicyclists are likely to be underestimated to a similar degree in each city. For example, a 2017 report by the Institute for Road Safety Research (SWOV) estimated that only some 4% of total bicyclist casualty crashes were reported to the police (Boele-Voss 2017). This is very similar to the 5% reporting estimated for Melbourne (Harman, 2007).

Deeper risk comparisons would, if data were available, consider injuries by travel purpose – sport, recreation, commuting or shopping – as purpose may influence rider

behaviour, such as from different time pressures and satisficing²⁵ behaviour. Trip purposes are, however, not obtained for Police records. The lack of data that distinguishes by trip purpose, therefore, limits what may be concluded on policies and programs to improve safety for transport riding.

Also, for the comparisons, there may be proportionally more riding for recreation and sport reflected in the Melbourne crash data than for the other cities. Melbourne in-depth injury studies found transport riding ranging from 22% to 33% of all trips, with the higher percentage applying to serious injury data, see Table 2-1 above, which is consistent with the 30% recorded in the Cycling Participation Survey for Victoria (Munro, 2015). The Melbourne VISTA estimates (2014-16) for an average week in the Inner Area, however, suggested that almost 70% of trips were for transport, but this may be a consequence of respondents treating the survey as a 'travel' survey, and not recording riding for sport or recreation. By contrast, data quoted from 2010 by Pucher and Buehler estimated that the percentages of riding for transport were 63% in the Netherlands and 90% in Denmark (Pucher & Buehler, 2012, p. 13).

The findings above, based on the 'Risk' index, support the assumptions for this research that the risk of riding in Amsterdam or Copenhagen was much lower than Inner Melbourne. Inner Melbourne was only considered safe enough by the minority who were riding but not safe enough by the absent majority.

4.3 Conclusion

This chapter notes that travel (mode share) surveys indicate that bicycling is not perceived as safe-enough for most people in Inner Melbourne, in contrast to Amsterdam and Copenhagen where many people ride. To compare objective safety between modes and cities, the risk index (R) that related injury data to travel exposure, indicated that objective safety for bicyclists in Inner Melbourne is far from being 'good enough' in

²⁵ Satisficing is what occurs during a self-paced activity, where a rider makes moment to moment adjustments, balancing between competing objectives such as: comfort, satisfactory progress, and perceived safety (Summala, 2007).

comparison to using motor vehicles or walking in Melbourne, or riding in Amsterdam or Copenhagen.

For decision-makers to responsibly contribute to city liveability and sustainability by encouraging the transfer of short trips from cars to bicycles, it will be necessary to reduce risk. For an effective transfer of adult travel from car to bicycle it will also be necessary to ensure that measures are designed to improve the perceived safety of bicycling.

This chapter has set the scene for a deeper qualitative exploration of why it is that ‘good enough’ safety has been provided for a broad demographic in Amsterdam and Copenhagen, but not in Inner Melbourne. The exploration in the following chapters looks at how context, decision processes and the content of measures has contributed to safety in each city.

.

Chapter 5 Amsterdam, where people on bikes are the ‘queens’ and ‘kings’ of the road

Amsterdam is the first of three case studies, explored using the methodology and methods described in Chapter 3. Each case study chapter follows a similar format. First, the study area is described and safety issues for bicyclists outlined. Then, findings are provided from the interviews, document analysis and observations, structured around the themes of context, process, and content (the CPC model developed in Chapter 2). Later, in Chapter 8, these findings are compared with findings for Copenhagen (Chapter 6) and Inner Melbourne (Chapter 7).

Chapter 4 showed that compared to Inner Melbourne, in Amsterdam, the per capita mode share for bicycling was six times higher, and the risk of serious injury for riders was one-tenth. For a deeper understanding of why there is this difference, I first consider the context for bicycling in Amsterdam, recent safety statistics, and local issues. I then look back to the historical antecedents for bicycling. Next, I interpret the social and technical attributes that appear to have contributed to the safety of bicycle riders, starting with government arrangements, and some of the cultural factors that have encouraged people to use bicycles for transport. Finally, the content of safety measures is explored using the *Safe System* themes of infrastructure, vehicles, and road user behaviour.

5.1 Amsterdam

I visited Amsterdam in September 2012 and again in June 2014. On both occasions, I was struck by the diversity of the traffic: the bicyclists, pedestrians, trams, and the motor vehicles that did not dominate – including the absence of large sports utility vehicles (SUV's). Trucks when unloading, parked in the motor traffic lanes, not the bicycle lanes. Bicycle riders were mostly adults on the classic upright Dutch bicycles dressed for their destination, not for riding, from a broad demographic and with more women than men.

The traffic played-out at low speed and I came to appreciate that movement was ordered by the detailed design of the infrastructure. For example, separate space was provided for pedestrians, for bicycles, and for motor vehicles, distinguished by different pavement colours and textures. At busy signal-controlled intersections bicyclists making small turns were protected by 'blister' kerbing. What I at first saw as chaos, came to be understood as bicyclists being dominant and confident about their safety as the 'kings and queens of the road'.

Source: Author's notes, 2014

Cycling has long been a key part of Amsterdam's character, with more people choosing bicycles for transport than any other mode, with twice as many trips made by bicycle as by public transport (City of Amsterdam, 2012a).

In the late 1970s, Amsterdam, and the Netherlands inspired the early work in Melbourne on bicycle planning²⁶ that started with the Geelong Bicycle Plan (Scott et al., 1978), and that was followed by the Melbourne Bicycle Plan – *Melbourne for Bicycles* (Victoria. State Bicycle Committee, 1986).

The Netherlands continues to be recognised as a leader in providing for safe bicycling, for example, the London Cycling Campaign theme: *Love London, Go Dutch* (<https://lcc.org.uk/pages/go-dutch>). In the Dutch context, however, Amsterdam is considered a 'below average' city for bicycling, partly because of the challenges of old infrastructure and motor traffic generated by its capital city function (Wagenbuur,

²⁶ I worked on both the Geelong and Melbourne Bike Plans.

2018a). It is, however, a living capital city ‘laboratory’ where the challenges of adapting to the automobile, while maintaining a high level of bicycling, can be observed.

Amsterdam data

The Amsterdam data was drawn from some 17 documents as listed in Appendix 2.1 and as referenced in the text, and interviews with the six informants as listed in Table 5-1 below.

Table 5-1 Amsterdam informants

Code	Description	Government Practitioner	Interest Group	Researcher	Date
A1	Nat. Gov. Expert & Researcher	★		★	16/6/2014
A2	Regional Planner	★			17/6/2014
A3	National Agency Researcher	★			17/6/2014
A4	Senior Cycling Consultant	★	★		18/6/2014
A5	National Motorist Executive		★		18/6/2014
A6	Munic. Policy Officer	★		★	8/7/2014

How safe is Amsterdam for bicyclists?

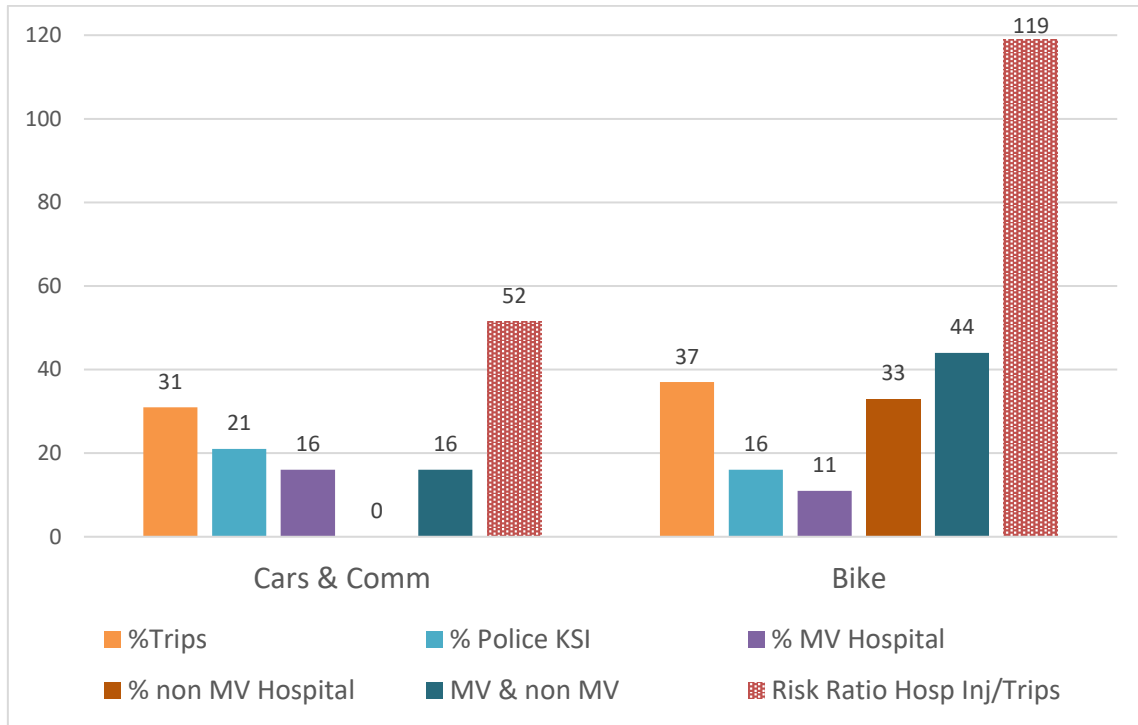
From the simple comparison of trip risk for bicyclists given in Chapter Four, it could be mistakenly concluded that injuries to bicyclists and road safety, in general, were not issue in Amsterdam. A concerning picture was, however, revealed in the analysis by Stipdonk and Bos (2014) who found that only about one-fifth of injuries treated at hospitals were reported by the police. Also, the majority (78%) of the increasing number of serious road injuries in Amsterdam were suffered by road users on two wheels: 44% bicyclists, 16% mopeds and 18% motorbike riders.

Policy Officer A6 and the Government Expert A1 both spoke of the severe limitations of using police data to understand crash and injury patterns. Injury data from hospitals gives a better indication of the size of the problem but does not record where injuries

happened or other crash details. A1 also said that the severity of hospital injuries is classified to the medical ‘maximum abbreviated injury scale’: the severity of what the doctor must deal with, not the severity of impact on the patient. Therefore, injuries like many wrist, elbow, and shoulder fractures, which are not counted as serious by hospitals, can have medium to long-term debilitating effects on the injured bicyclists. There are, therefore, more injuries that are serious for bicyclists than are classified as medically serious at the hospitals.

A further issue is that road safety reporting and thinking has focused on crashes involving motor vehicles. For the years up to 2000, there were typically 600 serious road injuries to bicyclists per year, with two thirds from crashes involving motor vehicles, and another one third from crashes in which no motor vehicle was involved. By the 2010s however, the number of serious injuries in road crashes not involving motor vehicle collisions, that is bicycle-only crashes, had doubled to almost seventy per cent (Stipdonk & Forest, 2014). Municipal Policy Officer A6 said single bicycle crashes are now recognised as a big issue compared to previous concern over injuries from crashes involving motor vehicles. Regional Planner (A2) agreed that the large number of bicyclist-only ‘accidents’ is an issue for Amsterdam and the whole of the Netherlands.

To examine the comparative risk of motor vehicles and bicycles, data on injuries from SWOV was related to mode share estimates from KiM (KiM Netherlands Institute for Transport Policy Analysis, 2016), as shown in Figure 5-1.



Prepared by Author from sources: (Stipdonk & Bos, 2014)
 (KiM Netherlands Institute for Transport Policy Analysis, 2016)

Figure 5-1 Trips and injuries in Amsterdam

Considering travel exposure, the risk ratio²⁷, the last (stippled) columns in Figure 5-1, illustrate that an injury from a trip requiring hospital attendance was more than twice as likely for a bicyclist as for an occupant of a car or four-wheel commercial vehicle (MV).

While Amsterdam has significant safety issues for its bicyclists, it is however possibly safer as a city than many other cities because of the large proportion of trips made by bicyclists who rarely injure anyone other than themselves.

²⁷ The risk ratio is simple the number of injuries related to the number of trips, unlike the Risk Index defined earlier, see p. 91.

5.2 Context

This section begins the analysis based on the CPC framework, focusing first on context: the history of bicycle use and the development of a culture in which bicycling is part of everyday life.

History

Amsterdam as a city dates from the 13th century. In the 17th century, it had its ‘Golden Age’ as a world centre for trade and shipbuilding. City logistics were supported by the extensive canal system that occupied half the city’s surface area. Floating markets also provided consumables for the population’s daily needs²⁸. The canals and barges thus spared residents from the dangers of goods and material traffic that would have otherwise moved by horses and carts on the streets. From the 1870s, when Amsterdam lost primacy for port trade to Rotterdam, the streets of Amsterdam were even quieter and conducive to bicycling. Bicycling was initially seen as a recreation, and in 1883 various local clubs supported the formation of a national association of cycling clubs, the Royal Dutch Touring Club (*Algemene Nederlandse Wielrijdersbond*, ANWB) that became the national motoring organisation (Buiter, 2013). From 1886, the ANWB promoted the ‘Safety Bicycle’ and from the 1890s the ANWB campaigned for the work-related use of bicycles (Buiter, 2013). As rider numbers increased, bicycle infrastructure was provided, initially to separate riders from pedestrians (Buiter, 2013). The attraction of bicycles can in part be understood by the limited public transport in the city, as, for many decades, Amsterdam had limited trams and no metro²⁹ (see Figure 8-1 below in Chapter 8). Bicycles grew in importance for personal mobility from the late 19th century onwards.

28 Staying in the Castello district in Venice, Italy, for several weeks in 2014 I saw how a city served by canals works. At the canal at the end of the main street of Via Garibaldi, fresh fruit, vegetables and fish could be purchased from barges. Barges also continue to be used, instead of trucks, for many tasks, like furniture delivery, building materials and refuse removal.

29 The early train lines served areas outside the city centre and metro trains did not operate until the 1970’s. The subway system, for local (intra) city travel, was not completed until 2018.

From the 1910s, when the price of bicycles dropped by half and tram fares tripled, there was a dramatic increase in bicycle use (Jordan, 2013). However, motor vehicles also became affordable and with the growth in motor traffic that followed, from the 1920s plans were implemented across the Netherlands to modernise the road network for motor vehicles, usually with adjacent cycle paths. Motoring interests supported the separate facilities for bicycling to remove the extremely ‘bothersome’ cyclists from highways (quoted in the Dutch Directorate-General for Passenger Transport, 1999). In the face of the rising tide of automobiles across the Netherlands, however, Amsterdam, with 80% of the rush hour traffic being traffic people on bikes – including workers, and business people of both genders – planned to be a bicycle-friendly city (Buiter, 2013).

During World War 2 (WW2) under the 1940 – 1945 Nazi occupation, many bicycles were commandeered, and the traffic rules changed to require cyclists to give way to motor vehicles at intersections. After WW2 with gradual recovery and greater motor vehicle use across the Netherlands, cycling deaths increased, and bicycle use declined (Pucher & Buehler, 2008). With post-war economic growth, new dormitory suburbs developed, and trips became longer. Mopeds and passenger cars replaced many bicycle trips and the focus for infrastructure on new roads and parking facilities. The Dutch Government also adopted a planning policy to limit the size of Amsterdam and directed development to regional growth centres. An unintended consequence of the restriction on Amsterdam’s growth was the preservation of its fine-grained urban fabric with diverse activities, readily accessible by short trips (Directorate-General for Passenger Transport, 1999).

Government Expert (A1) said that the support of bicycling was not a goal in the 1950s and 60s as many politicians, planners and traffic engineers in the Netherlands thought that the car was the best thing for the future and bicycling would disappear. For example, in the 1960s the Amsterdam City Council and its Traffic Committee briefly abandoned the separation of the various modes of traffic as there was ‘no room’ for

bicyclists, justified by a policy that traffic participants had equal rights to road space³⁰. This policy ignored the vulnerability of bicyclists, effectively sanctioning ‘might is right’ intimidation by motor vehicles at intersections, and exposed bicyclists to a greater risk of serious injury (Directorate-General for Passenger Transport, 1999 p.37). In some other Dutch municipalities, however, traffic engineers saw the need to continue support for bicycling and continued the practice of constructing separate bicycle lanes on busy roads. Also, in the 1960s, the concepts of the *Woonerf* pedestrian priority residential street and other mixed-use streets with low (20 km/h maximum) speed limits were developed by municipal engineers (Buiter, 2013). Government Expert (A1) suggested that experience of *Woonerfs*³¹ may have been a countervailing force to car domination, as people had experienced and liked the peace and safety of the *Woonerf*. The *Woonerf* is an example of forward-thinking individual engineers implementing design changes that had far-reaching impacts on amenity and safety.

During the 1960s and early 1970s, as cars became the most frequent mode of transport, wide arterial (‘Distributor’) roads were built to the city outskirts. Within central Amsterdam, the number of bicyclists and pedestrians declined, although bicyclists remained the dominant traffic (Buiter, 2013). In the Netherlands, as elsewhere, environmental concerns over automobiles grew, informed for example by the Club of Rome report *The Limits to Growth* (Meadows et al., 1972). The mounting road trauma, in one year, a total of 3264 people killed (17.1% bicyclists) and 70,000 seriously injured (12.7% bicyclists), caused community alarm; (Welleman, 1995). With more than 400 child bicyclists and pedestrians killed the pressure group, ‘*Stop de Kindermoord*’ (‘Stop the Child Murder’), campaigned for the national government to re-emphasize the building of segregated, safe, and attractive bicycle paths. In 1973 the economic risk for the Netherlands of car dependence was also dramatically highlighted by the OPEC oil

³⁰ This equal rights philosophy is like the ‘vehicular cycling’ approach advocated by John Forester in America, and followed in Australia throughout the 20th century (Forester, 1994; Furth, 2012)

³¹ *Woonerf* is a street that is a shared living space where pedestrians and bicyclists have priority over motor vehicles. Motor vehicles must not exceed 15 km/h. <https://www.swov.nl/en/facts-figures/fact/30-kmh-zones-what-difference-between-30kmh-zone-and-woonerf>

embargo. Petrol rationing and car-free Sundays gave the people of Amsterdam the experience of a city that was not dominated by cars (Welleman, 1995).

In 1975, the Amsterdam *Road Plan* by the Dutch Economics Institute called for road infrastructure to be expanded over the next 25 years at a cost of 15 - 22 billion guilders (equivalent to € 20 - 30 billion in 2016). A political showdown occurred between advocates 'for people' and advocates 'for cars'. The high monetary cost was not the only issue as many people remembered from the 1960s, the urban destruction caused by major roads, particularly the loss of low-cost housing. The pro-bicycle Provos³² played a leadership role in the community opposition to the road plan, with large-scale and violent protests to keep their city liveable and safe and the *Road Plan* was narrowly rejected (City of Amsterdam, 2014).

Throughout the 20th century, bicycling in Amsterdam was in part maintained by National policies, including high taxes on new cars and fuel. From 1976 growth in car use was further constrained when national policies were adopted that included:

- traffic regulations that prioritised people over motor vehicles
- improvements to public transport
- restricted parking
- parking fees imposed in city centres

(Directorate-General for Passenger Transport, 1999)

National policies and practices thus supported bicycle use and stemmed the tide of mass automobilisation that progressively marginalised cycling in most cities around the world (Buiter, 2013). The Netherlands was, however, not anti-car and had the highest density motorway network (controlled access and grade-separated roads) of OECD countries (OECD, 2013). By providing for cars in a way that reduced harm to other road users,

³² In 1965, in response to concerns over air pollution and congestion in Amsterdam, the anarchist inspired group, the 'Provos' (the provocatives or provotariat) launched the ambitious but ill-fated initiative of free 'white bicycles'.

the Netherlands demonstrated that cars could be provided for without increasing traffic risk for people on bicycles. By the 2010s, however, as noted above, the systemic safety improvements for motorists had outstripped those for bicyclists and the proportion of people injured in bicycle-only crashes had increased.

Strong cycling culture

The ANWB Motoring Executive A5 said that as cycling remains a key part of Dutch life, the ANWB has continued to support cycling ‘as this is in the best interest of members’. The Netherlands Expert A1 also reflected that:

if you are born here it's completely different than if you were born in a place when you can't even see a cyclist and there is nothing to help them...

Expert A1 wondered if his generation (born in the 1970s) is looking at cities and cars differently to the older generation who saw the car as something great and an innovation: ‘maybe people appreciate that the whole street just looks nicer without many cars’. The Regional Planner A2 further noted that

one of the main differences between the Netherlands and other countries is that cycling is normal for us, so everybody knows about cycling and knows to notice them.

Motoring Executive A5 said that by putting walking and bicycling first, most of the time, for over a hundred years, a very stable environment was established in Amsterdam. He noted that since the mid-1990s, bicycling has become more and more important, for safe, healthy, and liveable cities:

Dutch people like cycling, they like being outside and like the freedom. Walking and cycling are economical and an interesting way to move. As people know that cycling is now the fastest and healthiest way to move; they also know that providing for cycling is in their interest. People also want to do enjoyable things, and cycling is enjoyable, and they want to do more of it.

The Motoring Executive also observed a recent trend in Amsterdam for reduced car ownership, with about 50% of younger inhabitants in the city choosing not to have a car. With bicycles as the increasingly dominant traffic, he wanted to see more road space allocated for bicycles – a most enlightened position for a motoring association executive.

Municipal Policy Officer A6 foresees bicycling becoming increasingly popular for transport:

not because of political change (e.g. low carbon cities), not because of car and parking restrictions, not for health reasons (because cyclists have concerns about air pollution), but because it is easier than taking a car or public transport and because cycling is so embedded in Dutch culture.

Since the 1980s Regional Planner A2 noted all levels of government had supported safety for bicycling. Infrastructure provision by both national and municipal governments, combined with national road rules that prioritise bicyclist safety and the cost advantages of bicycling over motorised transport, produced more cycling and a ‘safety in numbers’ effect (Jacobsen et al., 2015).

In Amsterdam, for most of the last 100 years, national culture and local policy and planning measures supported safe cycling by:

- comprehensive national measures to moderate car dependence
- separation of high-speed traffic
- land-use planning that preserved a fine grain of local activities³³
- investment in separate bicycle facilities
- traffic calming on local streets (e.g. *Woonerfs*)
- quality, bicycle-friendly metropolitan region rail services with extensive bicycle parking at stations that both moderated city road traffic and enabled people to undertake longer trips with reduced exposure by combining rail and bicycle

5.3 City processes

The analysis now turns to processes, including government decision-making and the actors involved in influencing safety outcomes for bicyclists.

³³ For example, in 2014 the average distances to a supermarket, doctor, pharmacy, sports facilities, or café was about 1 km (Central Bureau of Statistics, the Netherlands from Table 1 in (Krizek & Marten, 2015).

Government structures and decision making

The Netherlands government has led European innovation and regulation in transport matters influencing safety for people on bicycles. For example, the government advocated for EU vehicle design rules to improve truck driver field of view by better mirrors and windows. At the national level in the 1980s, explicit pro-bicycling measures were directly funded, including for many new cycle paths. In the 1990s, funding was provided for intersection and crossing designs that explicitly recognised cyclists. The City of Amsterdam has also typically invested over €20 million per year on improvements to cycling infrastructure. Consequently, by the end of the 20th century and with support from the regional authority, a quality environment had been created that was very supportive of safe cycling (Directorate-General for Passenger Transport, 1999). With improved safety, a bicycle renaissance occurred (Buiter, 2013).

Since the early 2000s, the Dutch government has moved to devolve decisions on funding transport works to regions and municipalities (A2). Regions now get a block grant for everything, including public transport, road safety, traffic policy and cycling. The national government is thus no longer involved in decisions on how money is spent, including on cycling safety, but continues to hold responsibility for road rules, such as where and how mopeds may use bicycle facilities.

The regional authority, *Stadsregio*,³⁴ plays a positive and supportive role. It fosters coherent regional policies, seeks administrative synergies, and coordinates the provision of infrastructure for the ‘city region’ including transport, main roads, public transport, traffic safety and cycling. Regional transport infrastructure is understood to include bicycling and with road safety they work with all three elements of the ‘*Safe System*’ – infrastructure, road users, and vehicles. The Regional Planner (A2) explained that with bicycling, *Stadsregio*’s main interests are in safety, regional routes, and parking. They

³⁴ *Stadsregio*’s responsibilities include works to ‘improve and expand the regional infrastructure for cars, public transport and bicycles’, ... including ‘the development of traffic junctions, transport management and road safety’ (*Stadsregio* Amsterdam, 2014).

have assisted with safety innovations like the installation of ‘Trixi’ mirrors³⁵ at city intersections, education, and subsidies for the retrofitting of better mirrors on trucks. *Stadsregio*, however, has no legislative or regulatory role.

The City of Amsterdam has wide-ranging transport and land use responsibilities including for metropolitan public transport (trams, metro, and buses) and shares responsibilities with *Stadsregio*, and the national government. Unlike in Victoria, there is no separate main road authority or separate public transport authority.

Administrative arrangements in the City of Amsterdam were described by A6 as complex, with the municipality one of several levels of government. Internally, the municipality has eight *stadsdeel* (boroughs or internal districts) each with a local committee of management who make decisions, like the design of streets and squares that affect bicycling. Looking ‘outwards’, the City is one of 16 municipalities in the *Randstad* or *Stadsregio* (City Region), which is one of four regions in the province of North Holland, which is one of the twelve national provinces. The Netherlands is also one of the twenty-eight-member nations of the European Union (EU).

Municipal councillors are elected, but the Lord Mayor is appointed by the national government and has typically been a senior national politician. The Lord Mayor's appointment has the advantage of providing for an ongoing strong personal working relationship between the City and the National Government. The elected 45 councillors come from a diversity of political parties (McDonald, 2014). Most party policy platforms since the 2010s have included statements of support for cycling but to varying degrees. Municipal policy development is led by ‘aldermen’, most often councillors, who advocate for their party's policy position, including on cycling.

Motoring Executive (A5) believes that as municipal governments share responsibility for public transport with regional and the national governments, they will all come to

³⁵ A Trixi mirror is a large convex mirror attached to a traffic signal posts so drivers, especially of trucks, can see beside their vehicle to check for the presence of people on bicycles, particularly before 'small' turns.

see the bigger picture, that supporting bicycle use through improved safety saves them money – ‘every person on a bicycle can be one less subsidised public transport fare’, that lowers health costs and reduces environmental impacts.

As noted above, A6 said managing relationships and decision processes within the city organisation were complex. A6 worked in the Centrum (centre) transport and traffic section and the seven other *stadsdeel* semi-autonomous districts, each with 80,000 to 150,000 residents, and each with elected management committees who make their own decisions on providing for cycling. The relationship between professional officers and politicians in the municipality recently changed to a ‘Dual’ system, whereby civil servants work for the Mayor and several aldermen (deputy mayors) who lead functional areas, for example, Traffic and Transport. The *College van Burgemeester en Wethouders* monitors and influences the policies and decisions made by the Mayor and the Aldermen.

The city has a significant technical capacity, extensive experience, and the ability to develop tailor-made and innovative solutions with some 900 people working in the infrastructure, transport, and traffic department. Policy Officer (A6) explained that if the politicians have an idea, the officers investigate and inform politicians, including if they think the idea is good or not, apparently without fear or pressure.

A6 said major proposals, such as changes to traffic operations and designs for new infrastructure are formally considered by the Amsterdam municipal Central Traffic Committee (CVC), a group of government officers who meet every two weeks. The *Stadsregio* Policy Officer, A2 advised that the CVC have their own guidelines (City of Amsterdam, 2007) that are sometimes stricter than the national CROW guidelines (CROW, 2007). Treatments that are not in accordance with the CROW guidelines are closely scrutinised because if a person is injured or killed in a design departure from the CROW guideline, the design may need to be defended in court as not negligent. There is thus some caution in trying new ideas, even in variations to the phasing of signals.

Other government agency actors included in the CVC are the police, public transport, and fire service providers (A2). The police want infrastructure designed so that people can see how to use it correctly without relying on enforcement. Before formal

consideration by the CVC, there is consultation on proposals with non-government stakeholders, including Fietsersbond (the bicyclist union) and motoring interests through the ANWB. Prior consultation with others, such as motorist interest groups, tends to be only for larger infrastructure projects. Fietsersbond and the council officers have a good relationship, and there is usually agreement on what needs to be done as most officers' ride bicycles and share the desire for safe outcomes for bicycle riders. Amsterdam Cycling Consultant A4 said Fietsersbond are usually happy with the outcomes and she has the sense that officers, and to some extent politicians, are strongly influenced by Fietsersbond.

Improvements to bicycle safety are funded from the traffic safety budget, typically around € 10 million per year (Fietsberaad, 2010 p.84). Partners and supporters in the process of road safety include the effected *stadsdeels* (districts), the regional council (*Stadsregio*), and the Police. For example, in the *Stadsregio* multi-year plan, a wide range of measures was proposed for cycling involving € 7.4 million annually, half of which was to be provided by the council, with contributions from the districts and the region (City of Amsterdam, 2012b, 2012c).

Decisions on road safety enforcement strategies are agreed between the City, the Police, and the Prosecutor, known internally as the 'triangle'. The 'triangle' set enforcement priorities for cycling, such as lights on bicycles at night and riding through red lights. The primary emphasis is, however, on design that reinforces correct behaviour. For example, where cars turn right and bicycles go straight ahead, safety depends on engineering designs such as to make cyclists paths more visible, using red tarmac and white markings, rather than enforcement measures.

When asked about how technical changes are implemented, Expert A1 said there is a real effort made by the government to bring people along, by funding demonstration projects and by involving research organizations like SWOV. CROW use a similar approach: they have working parties, involving individuals from municipalities and engineering companies, leading to better acceptance of innovations. A1 said that in this process 'local governments are really important, and they have always been... an important support'. This approach to consensus-based policymaking is known as the

Polder model³⁶, fostering coordination, cooperation, and sharing for mutual benefit (Price, 2013). The *Polder* approach also appears very compatible with the co-production approach discussed later.

On the sources of change, Expert A1 recalled a conversation with a colleague where they reflected:

when they are changing something, it is more often input from outside the Ministry than from inside. So, even though the Ministry has its position, you never know what kind of outside coalition may cause a change.

Examples of ‘external’ driven change are the growth in e-bikes and autonomous vehicles. To avoid safety performance being dictated by suppliers, Researcher A3 saw the need for national governments to be part of the process of jointly setting design standards for e-bikes and autonomous vehicles.

In summary, government arrangements that support bicycle safety in Amsterdam are thus multi-layered and complex, with each level of government largely working positively to co-create safety for bicyclists.

Actors

Actors who influence policy and operational decisions on bicyclist safety in Amsterdam include:

- ANWB, the road user support club with a long involvement in improving bicyclists safety:
- CROW Fietsberaad: the national technological centre for transport, infrastructure, and public space, where government and businesses work together on research and knowledge transfer, with the Fietsberaad group working on all matter relating to bicycling
- Dutch Traffic Safety Association: (Veilig Verkeer Nederland - VVN) a citizen’s organisation dedicated to traffic and road safety
- Fietsersbond: the Dutch Cyclists' Union who campaign for better cycling conditions

³⁶ The Polder is the low land protected by the dykes, which everyone has an interest in maintaining.

- Police: national
- SWOV: National Scientific Institute for Road Safety Research
- TNO: the Netherlands organisation for applied scientific research to aid business and government to apply technical knowledge
- University researchers

Source: (Institute for Road Safety Research (SWOV), 2016)

Informants from ANWB, Fietsersbond, SWOV and the TNO were included in this research. The CROW *Design Manual for Bicycle Traffic* was a key reference and material from the Dutch Traffic Safety Association was examined.

Expert A1 explained that the activities of CROW, who prepare cycling infrastructure guidelines, are financially supported by a small percentage of the money that goes into infrastructure works, topped-up as required by additional funding from the National government. CROW provides significant technical expertise to local authorities on cycling matters.

Regarding municipalities, A1 was of the view that while in the past, central government, research organisations, and municipalities worked together to understand emerging problems and to overcome them, since devolution there is a reluctance by people in central government to be involved with municipalities.

Motorist Executive A5 observed that old inner cities like Amsterdam are constantly looking for cost-effective ways to get people in and out of the city without creating problems of congestion and pollution or conflict between modes. He said the ANWB is a voice of optimism for better management of existing inner-city roads to allow cars and bicycling to co-exist and to avoid undesirable transfers by people with safety concerns, to motor vehicles or public transport, or for freight to trucks from cargo bicycles.

It was not possible to obtain precise information on expenditure on bicycling in Amsterdam. A 2015 estimate by David Hembrow was that in 2010 about €30 per person was spent, which, while more than many countries, is minuscule compared to expenditure for motor traffic and public transport in Amsterdam. Also, €30 per person

appears to include significant expenditure on bicycle parking, while expenditure on shared-use bicycle priority streets is unlikely to be counted as 'bicycle expenditure'.

What has been achieved in Amsterdam by strategic decisions and with steady follow through and modest expenditure is impressive. Nevertheless, reflecting on comments by Executive A5, I was left with an uneasy feeling that perhaps some decisions makers in Amsterdam may see bicycles as a nuisance that they do not want to encourage. Increased expenditure appears to be needed to improve safety by finishing the separation for bicycle lanes on distributor roads, to respond to the problem of old infrastructure contributing to bike only crashes, and to declutter footpaths – to improve safety and conditions for pedestrians.

5.4 Content

In this next section, I explore the content, what has been done to make Amsterdam safe enough for travel by bicycle, as well as some of the challenges the city faces to improve safety. In the Municipal Road Safety strategy 2012-2015, areas identified for attention included the need to clarify by design, who has the right of way at intersections, protection of bicyclists on distributor roads, removal of more bollards in local streets, and attention to hazardous surfaces. Motoring Executive A5 explained that the ANWB has taken a strong interest in road safety since the late 19th century and is an active participant in the Netherlands road safety programs. He said that road safety programs have moved-on from the 'Black Spot'³⁷ approach, to a system-wide approach, with the emphasis on system measures like lower speed limits – that have incidentally and proactively reduced 'blackspots'.

Findings on content are categorised under the three *Safe System* themes of infrastructure, vehicles, and behaviour. In the discussions on each that follow, it is understood that they interact in influencing safety.

³⁷ 'Black spot' programs are reactive road safety treatments at locations where serious injury crashes have been recorded.

Infrastructure

The Netherlands' road designs and traffic treatments have been highly developed over many years by several agencies. Better and separate infrastructure was a key demand of the big 'sit-in' demonstrations in Amsterdam of the 1970s. Melbourne Activist M9 described the Dutch as being 'unconsciously skilled' in providing for bicycling compared to Australian practitioners, whom he described as 'consciously unskilled'. From his observations, when confronted with a design challenge, the Dutch have so much experience to draw on that they can comfortably experiment or take a 'lucky dip' from their basket of many possible solutions.

Dutch Government Expert A1 said that the quality of the Amsterdam cycling environment has in part resulted from the expertise provided to local authorities by the Centre for Traffic Transport and Infrastructure (CROW, 2007). In the view of Municipal Policy Officer, A6, however, the extensive in-house expertise of their large number – some 2000 – of technical staff has also made a significant contribution. Policy Officer A6 said that the municipal Central Traffic Commission (CVC) had developed design guidelines adapted to the specific road types of Amsterdam. The CVC guide covers all modes and is used in designing and checking every road design in the city; A6 said:

We have the capacity to find the best solution to the problems we have. In every design, the cyclists³⁸ are always taken into account.

In Amsterdam (and the Netherlands), the aim is for safety by design – that is through engineering – rather than relying on subsequent enforcement. For example, to manage potential conflict where cars turn right (a 'small' radius turn³⁹) and bicycles go straight ahead, the municipality identifies the path used for cyclists by red tarmac and white lane markings. This design approach aims to increase driver awareness of the potential for

³⁸ Informants in Amsterdam and Copenhagen usually referred to 'bicyclists' simply as 'cyclists' and I have followed their usage where appropriate.

³⁹ For simplicity of comparisons of turns between countries where drivers use the right (eg Europe and USA), and countries where drivers use the left (eg Australia and UK), I refer to turns by the size of the turning radius: 'small' radius for right turns in Europe and left turns in Australia; and 'large' radius for left turns in Europe and right turns in Australia.

bicyclists to be present and to place them, predictably and visibly, in their designated space. Policy Officer A6 said infrastructure designs that are ‘self-explaining’ through design detail, like pavement type and markings, mean people recognise how to use it correctly, including the maximum allowed speed, rather than relying on signs and enforcement. My experience in Amsterdam was that once the detailed design clues, like pavement types, location, road widths, road markings and parking arrangements are understood, the speed limit for any road type could be ‘read’ from the design detail – the ‘self-explaining’ road principle in action (see Table 2 3); which is, in effect, a framework for co-production of safety.

The Netherlands road hierarchy is an integral part of the *Sustainable Safety* approach. Both the Netherlands Expert A1 and the Cycling Consultant A4 drew my attention to this hierarchy⁴⁰ which relates design measures to three functions: access, distribution, and flow, as summarised in Table 5-2 below. Key features include the explicit consideration of bicyclists at each level, low speed limits – based on the human limits to tolerate impacts – for streets and at intersections used by bicyclists.

Table 5-2 Netherlands road hierarchy

Road Type and <i>Function</i>	Road Section Max. Speed Limit	Provision for Bicyclists
Local Access	30 km/h	Mix with other traffic
Distributor Neighbourhood Principal Access	40 km/h* but 50 km/h on some tram routes	Separated by marked lane or separate path
Urban Arterial - <i>Flow</i>	50 km/h*	On a separate path or protected lane
Through (Motorway) - <i>Flow</i>	70 to 120 km/h	Not permitted Grade-separated crossings

Note: * 30 km/h limit on approaches to intersections and crossings

Adapted from: (CROW, 2007; Schepers, J. P. et al., 2014), (Furth, 2017)

Policy Officer A6 said that except for the high-speed Through Roads (Motorways), which are the responsibility of the National Government, all other roads in Amsterdam are the municipality’s responsibility. While there are difficulties in translating

40 I did not immediately appreciate the specifics of the Netherlands approach as I mistakenly assumed it was like the road hierarchy for Melbourne with which I was very familiar. (Pattinson, 1982).

infrastructure ‘level names’⁴¹ this does not detract from the underlying safety-by-design principles, including the exclusion of cyclists from high-speed roads. Expert A1 also warned of some traps (potential for misunderstandings) in infrastructure descriptions – such as paths and lanes – when making infrastructure comparisons between countries⁴².

As the possibility of interactions (and conflicts) between motor vehicles and vulnerable cyclists and pedestrians is a key design consideration, a key feature of infrastructure design is that separation is related to speed limits for motor vehicles (CROW, 2007) (Furth, 2017). On road sections between intersections, with speed limits above 30 km/h, bicyclists (and pedestrians) under *Sustainable Safety* are each to have separate paved surfaces in consistent and predictable locations: pedestrian paths closest to the buildings, then (usually) a one-way bike path, then car parking (if permitted), then motor traffic lanes. The area for each group of road users is also distinguished by texture, for example, square paving blocks for bicyclists, bricks for pedestrians, and by colour, for example, a different red for the bike path pavers, see Figure 5-2 below. In 2011 however, 23% of the bicycle network was still on 50 km/h distributor roads without separation, and these sections had twice as many crashes per kilometre as the protected lengths.

⁴¹ The documents examined indicated potential for confusion in translating road category names from Dutch to English. The English version of the CROW manual (2007) names the high-speed category as Distributor Roads, (CROW, 2007) p. 35-36, but the description matches what are generally understood to be Motorways (high speed and access controlled). Schepers et al. name the high-speed category ‘Through’ roads and the intermediate category as ‘Distributor’ roads (Schepers, J. P. et al., 2014). Furth, in translating the Dutch approach to America, describes five categories, adding in the low speed (10 km/h) ‘Shared space’ (Woonerf); then Local Streets, 30 km/h; Neighbourhood Principals, 40 km/h; Urban Arterials, 50 km/h; and Regional Flow, 70 + km/h (Furth, 2017).

⁴² For example, in Germany ‘bicycle tracks’ are often just a 1 m wide area marked by a line on a pedestrian path; it is therefore not appropriate to compare the safety of bicycle tracks in Germany to bicycle tracks in the Netherlands.



Photo: Author

Figure 5-2 Road space allocation, Amsterdam

Government Expert A1 observed that building of segregated bicycle lanes and bicycle paths in Amsterdam over the last 20 years had largely avoided the worst of bicyclist injury problems that occur in cities like London. Policy Officer A6 said the separate infrastructure of high quality was central to the bicycling experience in Amsterdam. Her experience in Amsterdam stands in contrast to her experience in other cities outside of the Netherlands, where she found inadequate infrastructure was the norm:

there are not any cycling paths, and if there is any space provided, it is not separated from the main road. It is very unsafe, so I would not be tempted to ride my bicycle in other countries.

A major infrastructure safety problem, however, emerged from crashes involving bollards – the traffic calming measure favoured 30 years ago to stop motorists travelling or parking on facilities for cyclists and pedestrians. Bollards changed driver behaviour but became a significant hazard for bicyclists, particularly at night. The bicyclists union, Fietsersbond, surveyed the City and found some 3000 locations with about 5000 bollards, about half of which the City had removed by 2014. Treatment of the remaining

bollards provides a study in compromise. One option was to have flexible bollards, but while these would have reduced injuries from impacts with bollards, they would have continued to cause bicyclists to fall over. Because the crash data suggested bollard conspicuity was a problem, the remaining bollards were to be made more conspicuous. Pavement markings and red and white bands on the bollards were, however, opposed by city planners and urban designers on aesthetic grounds. The compromise was stainless-steel bollards with LEDs on the top and one or two reflective bands.

Policy Officer A6 said a more complex picture of infrastructure safety problems was revealed by hospital records that indicated that many of the injured cyclists were in crashes involving infrastructure, not only bollards but also poles and potholes, and from falls onto hard surfaces. A6 said many such incidents appear to have often been caused by unexpected interactions, such as overtaking by other cyclists or moped riders, or alarm caused by close-passing motor vehicles, rather than from collisions with other road users. These unexpected interactions appear to lead to loss of control with the rider subsequently striking an infrastructure feature. Most such incidents occur on bicycle paths and lanes, and not at intersections and crossings (where most collisions with motor vehicle occur).

Informants A1 and A6 each said that an additional factor in the severity of the injuries was the age-related fragility of some bicyclists and the unforgiving nature of most infrastructure. Both A1 and A6 said they and others are coming to re-examine the safety of the bicycle infrastructure for people over 50 years of age. As noted earlier in Table 2 3, it was recognised in 2013 that the *Sustainable Safety* approach needed to be further developed to explicitly address bicycle-only crashes, falls and bicyclist fragility (Weijermars et al., 2013b). That is, the earlier approach placed excessive reliance on the control of motor vehicle speed.

Turning to the other key element of infrastructure, intersections, and crossings, these are of two broad types, either controlled by traffic signals or uncontrolled – other than by markings, signs, or road rules. At controlled intersections it is normal for pedestrians, bicyclists and motor vehicles to each have separate and distinctly marked areas to wait and to move across in predictable locations, see Figure 5-3 below.



Photo: Author

Figure 5-3 Controlled intersection, Amsterdam

To improve visibility and provide enough space for pedestrians and cyclists to cross using separate paths, motor vehicles are held well back at a 'stop' line. Waiting bicyclists are also usually given a timed 'head-start' to clear the intersection. To prevent conflict between a right (small radius) turning vehicles and people on bicycles, the bicyclists 'path' for turning is also often separated in time, for large radius turns, or, for small radius turns, protected by 'blister' kerbing.

At intersections and crossings, speed management is crucial for self-regulation and to make compliance with regulations feasible ⁴³; an approach that reflects equitable road

⁴³ From an approach speed of 60 km/h as it takes around 45 metres to stop on a dry road and some 54 metres on a wet road, a driver cannot physically stop until they have passed over a crossing or through

use and contributes to the co-production of safety (see Chapter 2). That is, with drivers' approach speeds restricted to a maximum of 40 km/h, or more recently 30 km/h; this acknowledged that it was not simply the responsibility of vulnerable road users to keep out of the way of drivers. At lower motor vehicle speeds communication and co-operation are possible between road users; for example, a bicyclist who has the right of way over a turning motor vehicle can slow and check that they have been seen and acknowledged by the motorist before they put themselves in the path of the motor vehicle. The lower speed limit at intersections and crossings also recognises four safety factors: the human limits to undertaking complex tasks, the physics of stopping, the kinetic energy imparted during crashes, and human fragility.

For uncontrolled intersections, a municipal document revealed that motor vehicle crashes with bicyclists were a significant concern (Gemeente Amsterdam, 2012). Government Expert A1 said that the understanding what had contributed to these crashes had been hampered by police reports that often incorrectly assumed that the bicyclists might have been in the driver's blind spot and/or that the bicyclist believed that driver could see them. In-depth follow-up studies, however, found that bicyclists had been struck by motor vehicles when bicyclists were visible but had not been seen by drivers crossing from minor roads or turning into minor roads. By wrongly attributing causes to vehicle blind spots or rider perceptions, the systemic problem of drivers looking but not seeing was missed.

At uncontrolled intersections and crossings without traffic lights, the aim is for traffic interactions to be kept within feasible human cognition and response limits. For example, at many 'Zebra' crossings, two crossing paths are provided, one for pedestrians and one for bicyclists, so drivers interact with pedestrians and then bicyclists, not both at once. At uncontrolled intersections, approach 'legs' only have one motor traffic lane from each direction, or on two-way roads opposing legs are separated

most intersections. Even from a speed of 40 km/h on a dry road it takes around 26 metres to stop and 30 metres on a wet road (assuming a 1.5 second reaction time) <https://www.qld.gov.au/transport/safety/road-safety/driving-safely/stopping-distances>.

by a central island refuge so that bicyclists and pedestrians can cross in stages. Decision making required of road users is thus kept to one decision at a time.

Where minor roads intersect with a connector or main road, the City makes extensive use of footpath level, elevated plateaus across the minor road pavement, see Figure 5-4:



Photo: Author

Figure 5-4 Elevated entrance

Elevated entrance or gateway treatments at intersections are done with a consistent design approach, and as with most Dutch infrastructure, is ‘self-explanatory’: to remind people, including riders, on the minor road to slow-down and give way to cross traffic (Schepers, 2013).

Several infrastructure challenges, however, remain. Policy Officer A6 drew my attention to the four-year bicycle plan and the four-year traffic safety plan which included:

- Short-term priorities:
 - upgrading the most dangerous sections on the cycle network (including busy routes, some without separate paths)
 - re-surfacing routes with red asphalt and widening where possible
 - at intersections, improving traffic flow and safety by adjusting the timing of traffic lights and using countdown timers
- Medium-term priorities, by 2020, to take bicycling facilities to a standard beyond '*Duurzaam Veilig*' (*Sustainable Safety*):
 - provide enough width for the anticipated increase in the number of cyclists
 - develop a comprehensive network of spacious, safe, fast routes through the city centre on which cyclists will, where possible, have priority at intersections

Adapted from: (City of Amsterdam, 2012c)

Motoring Executive A5 said the ANWB see it as important to guard against inconsistencies in local design practices and to press for increased expenditure on infrastructure, including to upgrading existing infrastructure, with better lighting and removal of more bollard; and increase infrastructure capacity, as bicyclist traffic jams lead to risk-taking such as speeding and running red lights at intersections

Regional Planner A2 agreed infrastructure needs to improve but commented that with some crashes involving infrastructure, bicyclist behaviour is also a factor and needs to improve. For example, excessive cyclist speed by people on 'racing' bicycles, and sometimes people riding in groups at night not paying attention to what is ahead. He cautioned that safety is not going to be improved by infrastructure improvements alone.

In summary, this research, and the work of Schepers et al. (2014) shows that the broader urban system and infrastructure factors at work in Amsterdam that have resulted in infrastructure that is safe-enough city for travel by bicycle include:

- safe sharing of space on local access streets and at intersections, through lower speed limits (at or below the 40 km/h), for motor traffic

- access roads in local areas made attractive for travel by bicycle, by ensuring permeability and connectivity, and that local roads provide alternative routes to the Distributor Roads used by motor vehicles
- on travel corridors with Distributor Roads, (where motor vehicles operate at or above 50 km/h), provision of separate (protected) bicycle lanes or off-road paths
- the dense network of ‘Through’ roads (‘Motorways’), for motor vehicles on which bicycles are not allowed, and crossings of which are grade-separated, which draw motor vehicles from other roads, thus improving conditions for bicyclists by virtually eliminating their exposure to high volumes of through traffic
- reasonably attractive public transport that is competitive with private motor vehicle travel, thus reducing motor vehicle travel and the associated exposure for bicyclists to such traffic; and secondly, that also provides safer multi-modal (bicycle and public transport) travel for those who need to make longer trips
- the virtuous and self-reinforcing effect whereby with many people bicycling instead of driving, there is less motor traffic and riding is safer – as in the ‘safety in numbers’ effect (Jacobsen & Rutter, 2012)

It is something of a puzzle that more of these infrastructure measures have not been adapted to and adopted in Melbourne. There are also lessons to be learnt, including upgrading infrastructure before overcrowding causes safety problems, and, when safety is improved, providing funding for bicycle parking to cater for the increased demand.

Vehicles

The classic ‘Dutch bicycle’, still used by most riders in Amsterdam, is very similar to the ‘safety bicycle’ designed circa 1885. The utilitarian design of the safety bicycle, built for rider safety and reliability, with a sturdy frame, an upright riding position, no gears, front and rear lights, and an integrated lock on the rear wheel, has maintained the broad appeal of bicycling to women of all ages and older men, see photo Figure 1-1 above. Widespread use of bicycles designed for safety, stability, manoeuvrability, and ability to stop, has contributed to co-production of safety.

Two areas of vehicular conflict have caused concern in Amsterdam: first the conflict with low powered mopeds – that until 2019 could legally use bike paths and bike lanes (Gemeente Amsterdam, 2012); and secondly the interaction with large vehicles (trucks and buses). The mopeds that were allowed on bike lanes were supposed to have their

speed limited to 25 km/h, but most did not. Moped numbers increased from 2010 and had high crash involvement. They were loathed by bicyclists, partly because of their polluting engines (Bicycle Dutch, 2014; van der Horst et al., 2014). The solution sought by the City, finally achieved in April 2019, was to require all mopeds (both types⁴⁴) within the A10 ring road (see Figure 5.1) to be ridden on the roads and for moped riders to wear helmets.

With trucks or other large vehicles, as observed by Government Expert A1, there is no safe speed for a bicyclist to be hit, see also Morgan et al. (2010). Possibly the worst scenario for a bicyclist is to be hit by a heavy vehicle (truck or bus), falling and then being run over and crushed under the wheels – with loads of over 3 tonnes (Morgan et al., 2010) (Pattinson & Thompson, 2014). In Amsterdam the potential for low-speed conflict with trucks was reduced by heavy vehicle design changes – to improve near field vision for truck drivers; and infrastructure design – such as Trixi mirrors; by route restrictions; and by retrofitting of side under-run protection to trucks, see Figure 5-5 below.

⁴⁴ Mopeds are registered as either red or green number plates, depending on their notional top speed (Bicycle Dutch, 2014)



Photo: Author

Figure 5-5 Truck with improved vision, mirrors, and side under-run

The side under-run protection, intended as a ‘secondary’ safety measure, appears to have been an effective primary safety measure by encouraging bicyclists to stay well away from trucks; that is, the perceived danger was increased (Pattinson & Thompson, 2014). Amsterdam and the Netherlands are continuing to work with EU regulators to improve near field visibility for truck drivers.

Interactions with larger vehicles operated at speeds above 30 km/h are minimised by separation and route controls in Amsterdam. However, the potential for some low-speed conflict in shared space continues. In the future, Netherlands Researcher A3 envisages bicycle-vehicle technological options (ITS) improving safety by, for example, front object detection, a rearward view system for bicyclists to warn of approaching motor vehicles, and navigation aids to direct riders to safer routes. A3 was also working with the Delft University of Technology (TU Delft) on improving bicycle stability and autonomous braking for bicycles as if bicycles are travelling too fast, they may become unstable. A3 said that major safety benefits could follow from intelligent speed control for bicycles as unsafe bicycle speed is believed to be a ‘very big problem’ in pre-crash situations. Researcher A3 also suggested that in future, with intelligent interaction

between infrastructure and motor vehicles, and between vehicles, physical measures like speed humps – which can be a hazard to bicyclists – may not be necessary.

For the future, Policy Officer A6 also sees a challenge from the increasing diversity of vehicles:

we will not only have cyclists and mopeds, but also bicycles that are electrically driven, horse carriages, many types of transport, and growth in the numbers of fast cyclists.

People and behaviour

Policy Officer A6 said bicycle safety in Amsterdam benefits from transport safety education, focused on bike riding, that starts at pre-school, and continues through all school years. Road user education is also ongoing, and the Amsterdam Traffic Safety Plan includes instruction for a wide range of road users, from children to the elderly. Consequently, as most Dutch motorists have received traffic safety education that has an emphasis on bicycling, there are relatively few compliance problems.

Dutch motorists are very used to cyclists being around everywhere and especially in Amsterdam...except where cars cross cycling paths. (A6)

The exception at crossings is a serious problem, as while network design aims to minimise the number of such crossings without traffic lights, crossings cannot be totally avoided and crashes at crossings are a significant cause of injuries to bicyclists. It appears that as 'kings of the road' many Dutch bicyclists expect motorists to stop for them, even though the riders may be on a crossing before drivers realise. David Hembrow discussed this problem in a blog (2014a) and argued that for Dutch design practice to work – such as for the separate outer bicyclist ring at Dutch roundabouts – before bicyclists cross motor traffic they need to check with drivers by making eye contact to ensure that they have been seen, and are able to stop to avoid crossing the motor vehicle path if they are not recognised by drivers. That is, bicyclists should not cross a road assuming that they have been seen and will be given priority (Hembrow, 2014). Riders and drivers doing visual cross-checks is an example of the co-production of safety.

An emerging problem user group for bicycle injury crashes is seniors, exacerbated by their fragility. For example, in 2017 Statistics Netherlands reported that two-thirds of all fatalities to bicyclists were experienced by people –mostly men – over 65 years of age, who were estimated to undertake only 3% of the total distance travelled by bicycle (Wagenbuur, 2018b). Executive A5 said ANWB are working to reduce the number of bicycle ‘accidents⁴⁵’ involving older bicyclists, many being single-vehicle crashes. For male seniors, over-involvement in crashes is likely to be a consequence of balance problems, slow reaction times, lack of operational competency when turning left (big turns) at intersections and crossing roads with poor visibility or busy traffic. For older riders, Regional Planner A2 said *Stadsregio*, together with other organisations was considering a program to give people who buy an e-bike, free training to improve rider handling skills. Executive A5 said the ANWB see the safety issues for seniors as a cruel dilemma: they do not want bicycling considered as too dangerous for older people, but they do present additional challenges for system safety.

Municipal Policy Officer A6 also sees new problems in managing interactions with cars, as the Municipality responds to the demand by some bicyclists to ride faster:

it is going to be a challenge to make cycling faster without making it unsafe as the faster a cyclist rides, the less time there is to react to something on the road.

5.5 Conclusions

This chapter has identified many factors contributing to the safety of bicyclists in Amsterdam. In the early 20th century, large numbers of bicyclists became a feature of city streets and by their numbers, achieved early recognition of the need for separation. Limited and expensive public transport services helped make bicycles the mode of choice for personal transport through to the 1950s. Then, after a rise in road trauma to bicyclists and a decline in bicycle use by the 1970s, the importance of bicycling was

⁴⁵ It was common for northern European informants to refer to ‘accidents’ which is a term avoided in Australia where ‘crashes’ is the preferred term as part of Safe System thinking.

reaffirmed by community demand and the government's response to the OPEC oil crisis.

Amsterdam, a large municipality, with wide-ranging responsibilities and significant resources, has evolved as a city for bicycling, supported at multiple levels by the EU, national, and regional governments. What gets done for bicyclists – the content – is based on expertise developed over generations. Most people involved in planning for and providing infrastructure are also bicyclists, with a deep understanding of bicyclist needs.

The *Sustainable Safety* approach developed in the Netherlands is acknowledged as international best practice by Victoria's Transport Accident Commission, has proven effective in improving safety for motor vehicle users, but not as effective for bicyclists. Also, cycling is so ubiquitous in Amsterdam and designs have been so thoughtful in terms of minimising risks from motor vehicles, that some bicyclists appear to take their safety for granted, rather than contributing to their safety.

The challenges for creating bicyclist safety in Amsterdam include:

- managing competing priorities in a historic city
- the growing numbers of injuries that do not involve collisions with motor vehicles and require new measures
- injuries at uncontrolled intersections
- the frailty of older riders who are riding more but are more prone to serious injury
- incomplete data on injuries that understates the problem

The emerging challenge - bike only crashes - contests earlier motor vehicle-centric understandings of system safety and the nature of risks. The *Sustainable Safety* approach is, however, being refocused to encompass a greater diversity of vehicles, greater attention to infrastructure, and to provide a system that is safe for people with a wide range of abilities, using a diversity of vehicles.

One puzzle is the apparent mismatch between mode use, capital investment and safety improvements. With bicycles used for more than 40% of trips and with injury to

bicyclists exceeding those to motorists, bicyclists receive comparatively small investment. Perhaps some decision-makers in Amsterdam are uncomfortable with the abundance of bicycles and are ambivalent about improving safety that would encourage even more people to use bicycles?

There are many lessons to be learnt from Amsterdam, including:

- the advantage of developing community capacity to understand bicycling provided by the education system through all school years
- steady and long term support from the motoring association (AMWB)
- the range and high quality of design solutions developed and monitored by CROW from a dedicated funding stream
- the financial support from the Netherlands and Regional governments for safety improvements to infrastructure
- recognition of the need to upgrade infrastructure in advance of demand – before overcrowding causes safety problems.

To avoid significant amenity and safety issues for pedestrians, cities' need to attend to the problem of bicycle parking as demand for parking inevitably increasing after safety improvements for bicycling are implemented.

Chapter 6 Bicycles and cars in Copenhagen

This chapter explores why Copenhagen is a safe-enough city for extensive travel by bicycle. Chapter 4 showed that the risk of reported serious injury for bicyclists in Copenhagen is less than one-tenth that for inner Melbourne. In this chapter, through interviews, document analysis and observation, I interpret the social and technical factors that have contributed to the safety of Copenhagen for bicycle riders.

I begin with a brief description of the study area, list the informants, then provide an overview of the objective safety (risk) of bicycling compared to other modes in Copenhagen. I briefly explore the historic and cultural factors that have encouraged people to use bicycles for transport. The decision-making processes that have made Copenhagen an exemplar capital city for bicycling are also considered. Finally, the content of safety measures is examined – using the interrelated *Safe System* themes of infrastructure, vehicles, and road user behaviour.

6.1 Copenhagen

For this research I visited Copenhagen in June 2013 and in June 2014. On leaving the Kongens Nytorv metro station, the first thing I noticed was the bicyclists, the majority being women, riding on the wide uni-directional separate lanes. The people riding were from a very broad demographic and it was common to see adult couples cycling together, side by side. Some wore helmets, but none wore sports gear, except some wore ‘runners’. Compared to Amsterdam the traffic was orderly, less traffic bustle and no mopeds. On my second visit, I was very surprised to see the caution exercised by drivers when making right turns (small radius turns, like left turns in Australia); drivers would stop, look for and give-way to cyclists, (see Figure 6-10).

Author's notes 2014

The City of Copenhagen is the leading city for cycling in Denmark and one of the leading ‘big cities’ for bicycling in the world (Pucher & Buehler, 2012). Bicycle use in Copenhagen is socially inclusive, with, for example, 53% of bicyclists being female.

In Copenhagen, bicycle use is double the Danish average, with bicycles used for 26% of all trips of less than 5 km, and bicycle ownership more than double car ownership (90% compared to 40%) (Danish Cycling Embassy, 2017). Car use has been somewhat

discouraged, as for over a century the Danish Government has imposed high taxes (180%) plus 25% VAT on the purchase of cars; although taxes on smaller and fuel-efficient cars were reduced in 2007(The Danish Ecological Council, 2016).

Copenhagen has been described as a city for 'bikes and cars', and 'a cycling island in a more car-oriented region' (Kayser, 2017, slide 29). The ongoing tension between providing for cars and bicycles is a tension relevant to Melbourne. As observed by the Motoring Advocate, C3, in greater Copenhagen, which includes the area outside the study area, about 67% of trips are by car, and car users want to be able to easily drive into the city. The Danish Motoring group (FDM)⁴⁶ are concerned that politicians and bicycle organisations use road safety to argue for limitations on road and car traffic. Senior Academic C1, however, said:

sometimes people who want to drive or provide for drivers forget that having less cars makes life in the city more pleasant and that there is no real balance between the wish to have and use a car, and the wish to live in an environment not dominated by cars.

Copenhagen data

The Copenhagen data was drawn from some 31 documents as listed in Appendix 2.2 and as referenced in the text, and interviews with seven informants as listed in Table 6-1 below.

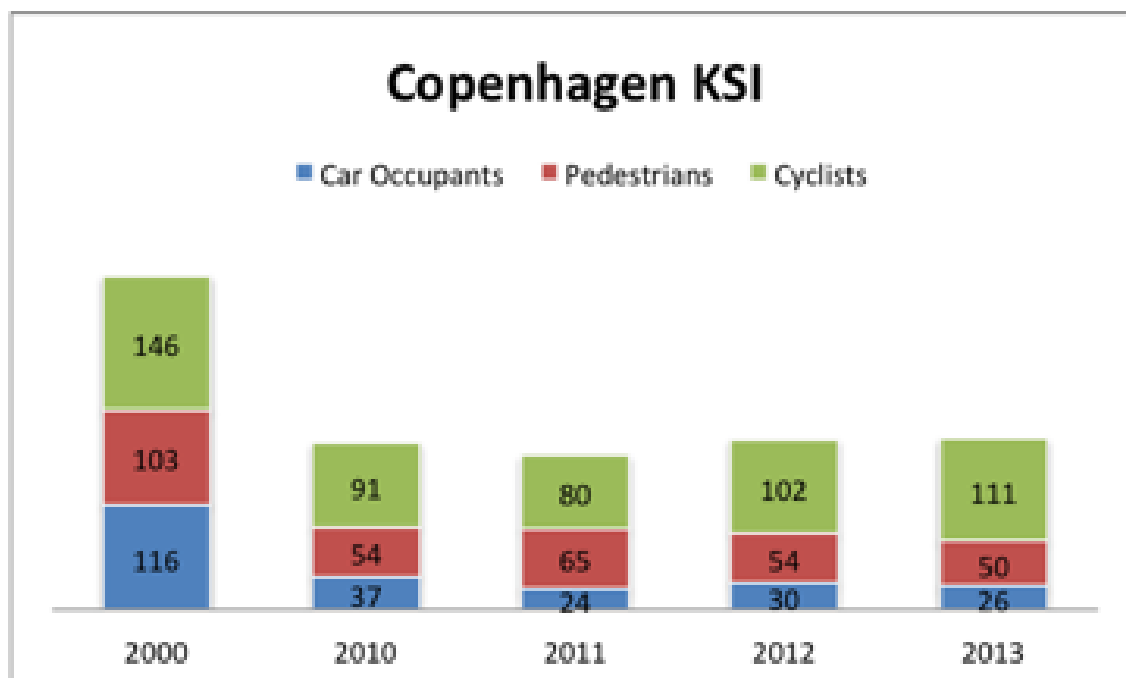
⁴⁶ The National Motoring Association, Federation of Danish Motorists (FDM) was created in 1909 by automotive interests who published the magazine *Motor* (Danish for Engine). It did not evolve from a bicycling club as was the case in the Netherlands ANWB and Victoria's RACV.

Table 6-1 Copenhagen informants

Code	Description	Government Practitioner	Interest Group	Researcher	Date
C1	Senior Academic			★	22/6/2014
C2	Municipal Cycle Planner	★			23/6/2014
C3	National Motoring Advocate		★		23/6/2014
C4	Behavioural Researcher			★	25/6/2014
C5	Municipal. Safety Engineer	★			26/6/2014
C6	Municipal ITS Expert	★			25/6/2014
C7	International Consultant (Ex Municipal Exec.)	★	★		27/6/2014

How safe is Copenhagen for bicycling?

In Copenhagen, over the ten years to 2010, the reported numbers killed and seriously injured (KSI) decreased across all three main road user groups, as shown in Figure 6.1, with a remarkable 65% decrease for car occupants, a 48% reduction for pedestrians, and a 38% reduction for bicyclists.

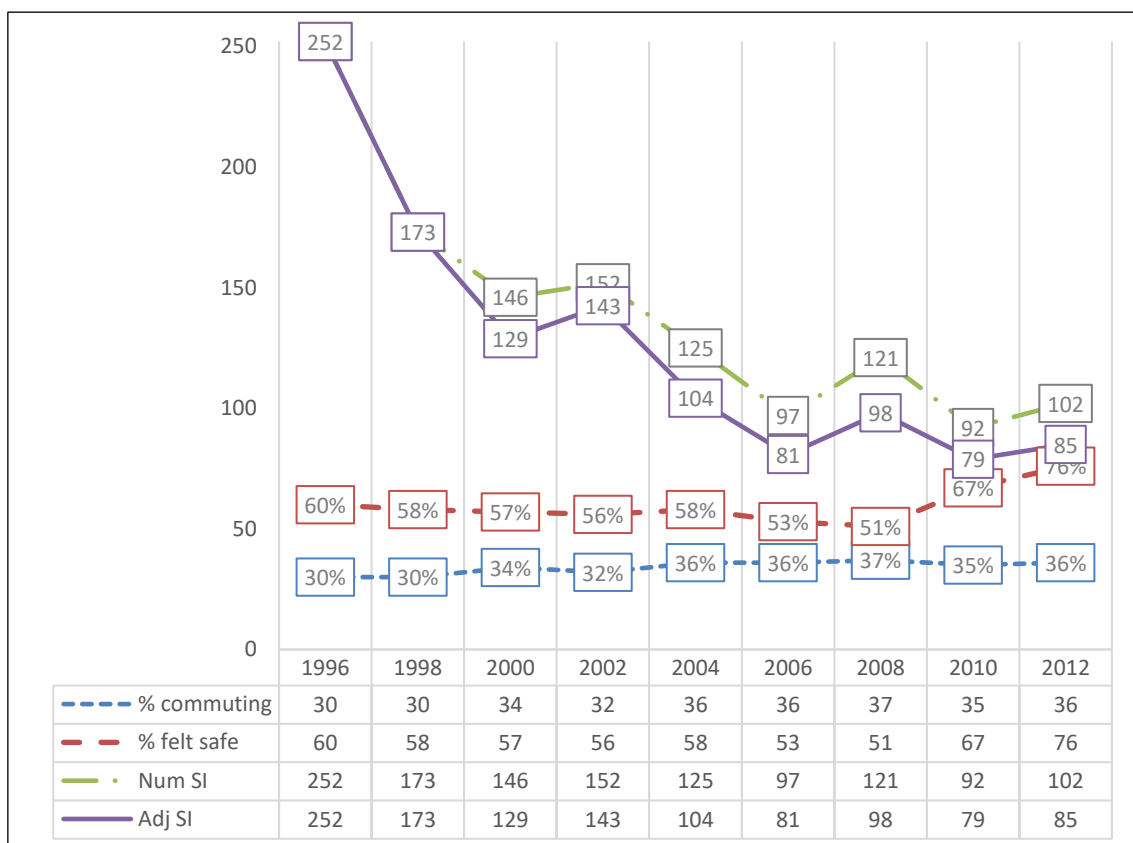


Source: City of Copenhagen

Figure 6-1 Road trauma trend in Copenhagen

The above data shows an increase in KSI's for bicyclists from 2011 to 2013 which may be because of an increase in the number riding, but this may also understate injuries to riders because of limited reporting. The Safety Engineer C5 was concerned by the numbers injured and believed more attention and new thinking was needed to reduce injuries.

The planners in Copenhagen monitor bicyclist safety in two ways: the number of reported injuries, and the percentage of bicyclists that feel safe (secure) (Andersen et al., 2012). The emphasis is, however, on increasing the percentage feeling safe, subjective safety, important for more people to switch from cars to bicycles (Danish Road Directorate, 2012). An improvement in subjective safety for bicyclists, shown in Figure 6.2 below, was apparently achieved.



Prepared by Author from (City of Copenhagen, 2012).

Figure 6-2 Safety trends in Copenhagen

The substantial reduction in reported injury numbers, from 252 to 97 by 2006, had no immediate effect on perceptions of safety, with little change to the percentage that felt safe until 2010. The paradox of a lag between improved objective safety and flat levels of commuting suggests that improved perceptions of safety were more closely linked to subjective satisfaction with the condition of cycle tracks. The Motoring Advocate (C3) also noted that even though a significant percentage of riders say in surveys that they do not always feel safe; they still ride, sometimes feeling unsafe, which reflects the strength of the biking culture.

Senior Cycling Consultant (C4) said a focus on perceived safety has the advantage that perceptions can be easily measured by surveys instead of having to wait for injury statistics. Motoring Advocate (C3) agreed that for people to cycle, they need to feel safe:

People on bicycles in Copenhagen can feel safe because there are now less cars; car use has been moderated, and there is separate cycling infrastructure. The extensive cycle lanes with separation from motor vehicles are now the norm, and the rare instances of a bicyclist being very badly injured or killed when sharing road space with cars is a reminder of how important separation is for safety. Without separation motorists and bicyclists seem to misunderstand or not see each other.

The approach of promoting the positive advantages of bicycling and making bicycling central to the contemporary culture of Copenhagen has clearly been successful, with bicycles used for trips by 63% of residents and 45% of all people who work or study in Copenhagen (City of Copenhagen, 2015). The Behavioural Researcher C4's view was that cyclist safety had been improved by the network of protected bicycle lanes and bicycle paths, which people use as they feel very safe. Academic Researcher, C1, sees 'new safety problems related to inadequate capacity and the different speeds of bicyclists' leading to a shift of focus, from bicycle safety per se to providing more capacity, with a debate about who has the right to street space. Thus, the city's emphasis on encouraging commuting by bicycle may have created a safety issue between fast commuter bicyclists and other riders. For example, C4 said parents do not want their children to ride with fast commuters, and some older riders are not comfortable riding with fast commuters.

There is also debate about the importance of bicyclists in future road safety improvements. The motoring association (FDM) see the main residual road safety problem as ‘people driving too fast or under the influence’(C3). Senior Academic (C1), also believes that with road safety, the Police are more interested in cars, except for concern over injuries to bicyclists from trucks turning right.

As noted above, under-reporting of bicyclists injuries may mask the seriousness of the problem of objective safety for bicyclists. The Behavioural Researcher (C4) said that police are diligent in recording the bicyclists crashes they attend, but they do not attend many of the crashes where injured cyclists have gone straight to hospital. The Municipal Traffic Safety Plan (2013) also acknowledges the limited nature of police injury information.

Safety Engineer (C5) also noted that the road accident data collected by the police is held by the Danish Road Directorate, who, due to privacy concerns and distrust of municipal politicians, do not provide detailed data to the municipality. Professor Prato from the Technical University of Denmark advised that not only is there underreporting, but there is also imprecision in reporting, such that useful conclusions cannot be drawn from the available data (Prato, 2014).

The Director of the Traffic Department said Copenhagen aspires to have the best safety record of any city in the world⁴⁷, but from other informants, it seems that this aspiration is problematic. With very low levels of injuries to motor vehicle occupants and very few bicyclists killed, the challenge will be to reduce the actual number – as distinct from the reported number – of injuries to bicyclists. Safety Engineer C5 noted that after the very significant reduction in bicycling deaths, typically to one or none per year, the municipal politicians seemed less motivated to reduce the number of injuries to bicyclists.

The Copenhagen *Traffic Safety Plan 2013 – 2020* aims to halve by 2020 the number of seriously injured bicyclists from the 2009-2011 annual average (City of Copenhagen,

⁴⁷ Niels Torslov, Director, Traffic Department (who briefly joined the discussion with C5 in 2014)

2013a); however, this target is based on the limited number of reported injuries. The municipal target is also less ambitious than the Danish target, set in 2013 by the Road Safety Commission, to halve the numbers of deaths, serious and minor injuries by 2020. But a reduction in the recorded number of seriously injured bicyclists was not on track (City of Copenhagen, 2015). Cycle Planner C2, however, believes it is important to consider risk – injury numbers related to exposure – as the total exposure has increased. The Safety Engineer C5 also said municipal officers are finding it hard to devise effective measures to reduce serious injuries to bicyclists.

For Copenhagen to become the world's best bicycle city, a greater focus will be needed on the safety needs of bicyclists, who have different injury dynamics compared to pedestrians or motor vehicle occupants (City of Copenhagen, 2013a). For example: with car occupants, big improvements have come from in-vehicle safety features; for pedestrians, most injuries occur on road sections; but for bicyclists, there are more injuries at intersections

Bicycle safety in Copenhagen is thus complex. Improvements in objective safety were sought, but the policy emphasis was on gaining the positive benefits of the mainstream use of bicycles for commuting – which required improved perceptions of safety and avoidance of negative messages about the dangers of bicycling. Colville-Anderson (2018) observed that the City of Copenhagen prefers to make cycling safer and let people figure out for themselves that it has been made safe, rather than preach about safe behaviour.

6.2 Context

In this section, I provide an overview of the history and cultural context, followed by findings on contemporary culture, government, and planning. Copenhagen grew from a small Viking fishing village in the 11th century, to become by the 15th century the capital of Denmark, then a significant European power (Copenhagen Portal, 2018). In the 18th century, much of the old city was destroyed by several fires, with further damage in the early 19th century from a severe bombardment by the British Navy. From

the 1860s (when Melbourne was developed), Copenhagen was slowly⁴⁸ but extensively rebuilt with wider roads, and with housing and industries moving beyond the medieval walls, but development was constrained by walking distances and the limited on-road horse-tramcar network.

With the invention of the 'safety bicycle' in the UK circa 1885 and its subsequent import to Denmark, the population gradually took to bicycling. The Danish Government claims that bikes were used as transport in Copenhagen from the 1880s, but from Researcher C4's reading, cycling was initially mostly a sport or a leisure time activity, like horse riding. C4 said his research indicates that it was not until the early 20th century that bicycles were used as everyday transport by working people. Bicycles provided new possibilities for housing and work outside the central core, not restricted by the limited tram network or the absence of suburban trains, which did not operate until 1934, see Figure 8.1 below.

The shape and nature of post-war city development also aided the development of bicycling. The Danish Town Planning Institute's 1947 *Finger Plan (Egnsplan)*, set out to guide development along the five fingers, the corridors containing existing or planned suburban railway lines (Knowles, 2012) and city commuters were able to use trains instead of cars. From the 1920s to the 1950s Copenhagen's population more than tripled to 770,000, and bicycles were used by most people (Fietsberaad, 2010). On several downtown streets, in the 1940s and 1950s, large numbers of bicyclists took over the whole street, see Figure 6-3 (Jensen, 2009).

⁴⁸ In 1813 the Danish state was bankrupt, and the City of Copenhagen also lacked funds for public works



Source: Nationalmuseet on flickr

Figure 6-3 Amagerbrogade Copenhagen 1945

Then, however, during the 1960s, bicycle use fell dramatically as Copenhageners replaced their bikes with mopeds and automobiles. In the 1960s and 70s cars dominated the thinking of politicians and city planners. Bicycling was at a historic low, and most infrastructure changes were for car traffic (Jensen, 2013). Researcher C1 recalled the 1960s and 70s as the worst period for bicycle riders, with, for example, cycle tracks stopped before intersections to increase intersection capacity for motor vehicles. Bicycle Planner C2 added that street-trams were removed, and narrow inner-city streets reconfigured for one-way traffic operation⁴⁹. Copenhagen of the 1960s, like many older cities, faced the challenges of the automobile age, including congestion, pollution and deterioration of safety and amenity – see, for example, Figure 6-4, showing Strøget, the main shopping street, before being redesigned for pedestrians.

⁴⁹ The inconvenience of the one-way streets for bicyclists, with contra flow riding now banned, was observed, and experienced on my visits in 2012 and 2014.



Source: Pinterest, photographer unknown

Figure 6-4 Strøget, Copenhagen, 1962

The Copenhagen approach to managing the car boom in the 1960s was however exceptional⁵⁰, as measures were taken to both provide for 'automobility' and to protect city amenity. For example, Strøget was made car-free, the volume of cars allowed into the city was limited by the signal timing on main roads, and public car parking was reduced. C2 said the City Engineer of the time, Jens Rørbeck, thought that:

it would be a good idea to get rid of the cars (parked) on squares. Every year he suggested to the politicians to take parking away from one or two squares and over many years a lot of the city was given back to the citizens.

By 1970, the bicycle share of city travel was estimated to have fallen from 50% in 1950 to less than 30% (Directorate-General for Passenger Transport, 1999). But there was

⁵⁰ The 1960s motor traffic control in Copenhagen was taught as exemplar city planning at Purdue University, USA where I attended in 1974/75.

also a dawning of understanding that the city should be for people, not motor vehicles. Political and planning enthusiasm for cars peaked in the 1970s when a very expensive motorway, that would have destroyed a very attractive part of the downtown, was planned through 'The Lakes' to the city centre, but the plan was rejected (Ruby, 2014). Several factors then came together: the 1973-74 OPEC oil embargo and energy crisis, the protests against the motorway plans, and a local financial crisis, factors which 'rescued Copenhagen from being completely destroyed by cars' (Jensen p. 130). Also, during the oil crisis, 'Car-Free Sundays' were introduced and enjoyed by many people, and bicyclists demonstrated for a 'Car Free Copenhagen'. Senior Academic C1 remembers attending large demonstrations organised by the Danish Cyclists' Federation demanding more cycle tracks. The demonstrations drew overwhelming support from ordinary citizens and, to C1's surprise, from the local media. The resurgence in bicycling in Copenhagen was also supported by the national response to an economic recession in the 1970s. Also, even in the times of car domination, a significant minority (almost 30%) of Copenhagers kept cycling (C1). Riders also took direct action, like riding contra-flow on the one-way streets in the central area⁵¹.

By the 1980s, the numbers cycling had again reached a critical mass. National Motoring Advocate C3 said she recalls the messaging in the 1980s, the popular songs that said cars were polluting, and that people did not want cars in their cities. There was pressure from those who had continued to cycle, but there was also latent support for bicycling from the non-cycling silent majority who remembered enjoying bicycling and had an emotional connection to bicycling. Copenhagers came to understand and support the idea of a 'clean' city with bicycles better suited to the fine-grained pattern of mixed development focused on railway stations. More wanted the convenience of using bicycles instead of cars (Knowles, 2012). With significant legacy infrastructure – the

51 Contra-flow cycling, which was endorsed by a simple road marking at the entry point, serves as an example of three things:

direct action by bicyclists

that providing for bicyclists need not take anything away from car users, and

the ultimate demise of a simple local measures through an unsympathetic response from Police who enforced National traffic standards.

bike lanes and tracks from the 1900s – people also understood that with separate infrastructure, bicycles and cars could coexist. Ambitious pro bicycling change was driven by the Mayor of Technology, Klaus Bondam, often in the face of vocal minority resistance. After decades of political neglect and at times opposition from the City Council, the persistence of those who had kept riding was eventually rewarded by political support for new cycle 'tracks' (C 2).

A common way to provide cycle lanes was to take one metre away from each sidewalk and remove the car parking on one side; this gave room for two kerb-protected lanes, often called 'tracks', each about 2 m wide. An advantage of the re-design was that car traffic was also reduced, for example, by 40% on Nørrebrogade. In the 1990s and early 2000s finance was tight, protected lanes could not always be provided, and the unsatisfactory low-cost painted lanes were again used⁵².

The Motoring Advocate (C3) said her impression is that moderation in car use in Copenhagen, and improved perception of safety for bicycling, was not achieved by radical measures, but by many small steps over a long period. A change in planning philosophy also occurred, as described by Ruby:

Gradually it became clear to most people that the solution to the problems had to be city planning that gave space to cars, bicycles, pedestrians, and public transport. Out of this realisation grew the Danish model with its extended network of cycle lanes along the roads

(Ruby, 2014, p. 2)

⁵² Painted lanes are being progressively upgraded to protected cycle lanes ('tracks').

*Culture: I bike Copenhagen*⁵³

Bicycle use has long been embraced in Denmark and Copenhagen as an integral part of identity, as illustrated in the vintage posters in Figure 6-5 below and is embraced, as in the tag-line used in municipal documents.



Source: fixiebuzz.tumblr.com



Source: University Library Ghent
Permission - BIB.AFF.C.000575
<https://lib.ugent.be/catalog/rug01:00143432>
9 Stockmarr, E. (1936).

Figure 6-5 Danish travel posters circa 1940

The 'fit' of bicycling with Danish culture so powerfully established in Copenhagen, can be understood in part by the value Danish people place on 'design for people', that is, design that is practical, functional and elegant – attributes that apply to both the bicycle and Copenhagen bicycle infrastructure (Colville-Anderson, 2018). There is also the sense of satisfaction, which Professor Jan Gehl spoke of, that 'Copenhagers' get from

⁵³ 'I 🚲 CPN' is a tag line used in municipal documents, and a possible play on 'I ♥ AMS'

seeing gradual and continuous improvements in city amenity and liveability, of which improvements for bicycling are a key part (Melbourne, 2013).

Behavioural Researcher C4 also noted the cultural importance of bicycling:

the bicycle is very strong in the Danish context for everyday use it is weekday transport for the employed and for students, half of the adult population use bicycles at least once per week.

Researcher C4 said most Danes are competent bicyclists with skills built up from when they were young. Bicycling is an everyday activity, particularly in Copenhagen, which has the highest level of bicycle use in Denmark. He said, on a bicycle:

you can do what you want, on your way to and from work, you can quickly get off. It requires little space to park, so people are very flexible in terms of taking part in whatever is happening on the street. It is the flexibility that people who cycle appreciate, the reason they choose it as a mode of transport in Copenhagen (C4)

As bicyclists are mainstream and not a special group, provision of bicycle facilities now has strong political support as these facilities are relevant for most of the population. Cycle Planner C2 also observed that, as cycling is socially acceptable, his work as a professional bicycle planner is seen as mainstream.

The Danish Motoring Advocate C3, believes several factors have made Copenhagen a cycling city. She sees the land-use arrangements as a key factor, with a wide range of activities within 5 km of where most people live, and which are served by the network of cycle lanes. It is also very expensive to drive or go by public transport. Politics is also seen as a factor, the 'eco' story⁵⁴ and the influence of 'leftist politicians', who wanted to see streets used for things other than cars – although this is a view that is not shared by the Federation of Danish Motorists.

Over the last ten years, Motoring Advocate C3 senses that the public conversation has changed, from being negative about cars to being positive about bicycles, with people

⁵⁴ See for example *Eco-Metropolis - Our Vision for Copenhagen* (City of Copenhagen, 2007a)

saying they want more bicycles, a view also formed by Gössling (2012). C3 believes that in politics, Danish people like to ‘connect things up’ and bicycles are intimately connected with the ‘green growth’ agenda. Senior Academic C1 agreed that bicycling is embraced as a key part of Copenhagen’s sustainable identity. The green and sustainable storyline, as in the *Eco Metropolis vision for Copenhagen 2015*, explicitly included bicycling (City of Copenhagen, 2014b). Behavioural Researcher C4 added that having people cycling in the city helps social cohesion as bicyclists connect and share inherent vulnerability with pedestrians who walk beside the bike lanes⁵⁵. Connection, sharing, and mutual care are key social themes in Copenhagen. However, although bicycling is a key plank in the multi-faceted municipal vision for city sustainability, Cycle Planner C2 said the city’s research has found that people do not ride because of the environment, but for travel efficiency, convenience, and ease.

Government capacity

Copenhagen’s municipal government is powerful, and that enhances the city’s ability to make strategic decisions that span decades and mayoral terms. The capacity of the public sector is strengthened by an educated workforce with deep technical knowledge. And collaboration across political parties, levels of government, and sectors of society is common and consistent. (Katz & Noring, 2016, p. 1)

As noted in the Brookings Institute Review by Katz quoted above, Copenhagen is in part successful because of the capacity of its government (Katz & Noring, 2016). The City of Copenhagen has significant professional capacity with some 45,000 employees of which about 2000 are in the Technical and Environmental Administration, including the Centre for Traffic and City Life which has responsibility for road safety. An example of the city’s role in transport integration is that it is a 50% shareholder in *The Copenhagen Metro*.

The Administration aims for an integrated approach, but informant Safety Engineer C5 said integration has not always worked in practice for bicycling. For example, in a recently completed major road project, the need for pedestrians and bicyclists bridges

⁵⁵ Where they are not separated by parked cars, as in Melbourne.

were completely ignored and required additional funding. Also, with a reorganisation in February 2014, some of the functions relating to cycling were dispersed to separate areas, much to C5's frustration.

Senior Academic C1 said there is an ongoing tension between the interests of motorists and of bicyclists over the allocation of road space. For example, the City's service goals for bicyclists (City of Copenhagen, 2014c) were at odds with the Congestion Commission (2013) who, at an important inner-city intersection, wanted to replace a dedicated bicyclist lane with a shared lane to improve motor vehicle capacity.

Behavioural Researcher C4 observed:

politicians will say that pedestrians and bicyclists are the most important ones and then public transport and then cars, but this is not reflected in the economy (funding) for the infrastructure.

Researcher C4 also recalls a municipal bicycle planner saying:

Two hundred million Danish Kroner is not a lot of money when it comes to making something for cars but if you suggest spending the same amount of money on bicycle infrastructure, then you are considered more or less mad.

Planning and policy

The responsibility for land-use planning in Denmark is divided between the Environment Minister, five regional councils and 98 district councils. The national government (through the Minister) sets the general guidelines for planning, and the local authorities translate the general guidelines and vision into local plans. The five regions have responsibility for regional development plans to ensure coherent strategic planning across municipal borders. Municipalities are required to prepare four-year plan strategies in consultation with local stakeholders and are also required to set out a framework and guidelines for urban and traffic planning.

The Danish approach to traffic planning, as stated in the *Manual of Traffic Planning in Cities*, explicitly links sustainable transport to economic, social, and environmental needs. Each municipal traffic plan supports sustainable development and includes

targets, such as to reduce the number of injuries and increase the number of trips by bicycle (Danish Road Directorate, 2012).

The Cycle Planner C2 explained that in 2005 -07 the Deputy Mayor for the Technical and Environmental Administrations, lead development of the *Eco-Metropolis* vision for Copenhagen (City of Copenhagen, 2007b), which included three goals relating to cycling:

- 1) 50% bicycle share for commuting
- 2) 50% reduction in the numbers of killed and seriously injured cyclists, and
- 3) 80% of cyclists to feel safe in traffic

(City of Copenhagen, 2007b)

The Municipal strategy, *Good, Better Best Bicycle Strategy 2011-2015*, attributed the increase in numbers bicycling since the mid-1990s to an improved sense of security in traffic for bicyclists (City of Copenhagen, 2011). It aimed to further develop Copenhagen as a bicycle city, ‘from good, to better to best in the world’ (City of Copenhagen, 2011, p. 5). That is, for Copenhagen, good enough means ‘the best’ and they see more bicycling as a ‘highly-prioritised tool for creating a more liveable city’ (City of Copenhagen, 2011, p. 3).

A key target is to reduce ‘rush-hour’ car traffic within the borders of the City, by having at least 50% of commuting trips made by bicycle (City of Copenhagen, 2011). Attention is thus on improving the competitiveness of the bicycle as a form of transport, by improving travel times, sense of security and year-round comfort (City of Copenhagen, 2011).

Traffic in Copenhagen between 2012 and 2018 faced severe disruption with the city ‘one big construction site’ for works on several major projects including the Metro City Ring, and the redevelopment of Nørreport Station. Bicycles played a central role in maintaining city accessibility (City of Copenhagen, 2011). Researcher C4 noted that more bicyclists, and perhaps less car travel had also resulted from the new Copenhagen Metro which has special bike carriages and provides a combined bicycle and PT network making it easy to get around the city.

Researcher C4 has however noted some tensions in the thriving central area as the desire for continued economic growth has given rise to some inconsistency in policy implementation towards cycling. That is, the city wants to attract creative people and high-income earners, whom they believe want to own and use cars. C4 said the City was trying to provide for everyone and all modes, but the desire to accommodate car use in new developments was causing problems:

politicians seem to think that allowing more car parking will not matter. But obviously, with major redevelopment⁵⁶, more traffic will be created, and the policy connection needs to be made between maintaining accessible cycling facilities and car parking provision.

6.3 City processes

The following section provides an overview of the ‘process’ influences on bicycle safety in Copenhagen.

Government structure and process

As a member of the European Union (EU), Denmark is subject to EU regulations, including vehicle design rules that influence road safety. Denmark supports the European Union road safety target to, by 2020, halve the number of 2010 road deaths (European Commission, 2010) but Denmark has not formally committed to ‘*Vision Zero*’ for road safety.

In Denmark, under the National Planning Act (2007), comprehensive and coordinated planning to support sustainable development is required of all levels of government. Municipalities are required to translate the general guidelines and the vision of the Planning Act, into local development and traffic plans, prepared in consultation with local stakeholders (Danish Road Directorate, 2012) (Ministry of the Environment, 2007). Municipal traffic plans are required to include targets to reduce the number of injuries and increase the number of trips by bicycle.

⁵⁶ Like *Carlsberg Town*, a \$2 billion redevelopment on the old Carlsberg brewery site where the argument for limited parking eventually won out.

Since 1999, municipalities have taken the lead role in the development of Denmark's cities as bicycle-friendly (Anderson et al., 2012). Planning and providing for bicycling are very much a local process, with support from other actors like the Danish Cyclists' Federation, The Cycling Embassy of Denmark and limited ongoing support from the Danish Road Directorate.

The City of Copenhagen is one of 29 municipalities in the Capital Region and one of 85 municipalities in the Greater Copenhagen regional collaboration between Eastern Denmark and Southern Sweden for economic growth (Greater Copenhagen Committee, 2018; The Capital Region of Denmark, 2017). The Capital Region and the City of Copenhagen have diverse responsibilities, including health and education, and are large, with more than 40,000 employees. Denmark is unusual in that the municipal governments command the largest resources of the three tiers of government, with the National and Regional governments having smaller levels of expenditure (OECD, 2009).

The City Council is governed by 55 members, elected by residents every four-years (OECD, 2009). The Municipal Safety Engineer C5 said the way the council works is complicated. The lord mayor and the six mayors for each functional area are full-time politicians. A deputy mayor and some eleven councillors are appointed to standing committees for the administration of each functional area. On the committees, councillors seek to ensure representation across all parties in proportion to the level of political support for each party; however, the policies implemented are those of the Council and not necessarily those of the party to which the mayor belongs (OECD, 2009). The mayor of the Technical and Environmental Administration functions as the head of a board of professional officer directors, with each director having responsibility for specific areas such as the environment, roads and traffic, district planning, urban renewal and processing of building projects, parking control, and maintenance of the roads and parks. The Director, Traffic, handles day-to-day management of traffic matters, including bicycling, with higher-level policy decisions made by the committee of councillors.

An important influence on the process of providing for bicyclists is *The Copenhagen Bicycle Account*⁵⁷. Planner C2 believes that the *Bicycle Account* has significantly advanced the cycling agenda and improved accountability for implementation of policy as it provides citizens and bicycle riders views on cycling conditions, facts on the development of infrastructure, crash data and monitors achievement of goals in the cycle policy.

A further influence on policy is the experience of nearby jurisdictions such as the Netherlands and Sweden. Cycle Planner C2 said that in 2002 when an officer developed cycling policy was accepted by the council, a delegation of eight Copenhagen cycle planners visited colleagues in Dutch cities for ideas. One surprise was that some of the Dutch cities had moved away from quantitative targets like those agreed upon in Copenhagen.

It was, however, not until 2005 that bicycling explicitly featured in councillors' election campaigns. The two politicians most involved in the pro-cycling campaigns were elected as Lord Mayor and Mayor of the Technical and Environmental Administration. The Lord Mayor's campaign was novel in that he campaigned on providing both more car parking and supporting cycling, consistent with the approach noted by Gössling to not alienate motorists (2013).

Until 2008 the typical annual budget for cycling was in the range 25 to 35 million kroner, it then increased to around 75 million kroner per year. Planner C2 said, however, there are enough projects to 'easily double the current budget'. Also, as Researcher C4 observed:

Some politicians will say that pedestrians and cyclists are the most important, then public transport (users) and then cars, but this is not reflected in the economy (funding) for the infrastructure.

Over 2010 -14, after four decades of decreasing cycling mode share, bicycling mode share increased, following the funding of projects worth € 134 million through a

⁵⁷ The Bicycle Account was a staff initiative, started in 1996, an idea later adopted by the City of Melbourne.

National Cycle Fund. The National Funding was established after representation by a coalition of actors that included the Danish Cyclists' Federation, the Danish Road Safety Council, transport sector leaders, and the Danish Road Directorate (Danish Cyclists' Federation, 2018).

Frustration with low levels of funding, however, continues, given that 'the money spent on cycling is next to nothing when compared to what a metro or a motorway costs'(C2). Bicycle program staff are also frustrated when they see the cycling budget used to fund bicycle facilities in major projects, like redesigns of major intersections, rather than the general project budget.

A further source of frustration is that the Police have a virtual power of veto in the project review process. For example, in a recent intersection design, Cycle Planner C2 said the city designers had to work through nine designs before the police agreed. He sees the police influence as excessive; 'exercised by people without technical expertise or public election'.

Actors

The actor groups identified for this research who influence bicycling include:

- Academic researchers
- Bicycle planning consultants
- The City of Amsterdam (as described above)
- The Cycling Embassy of Denmark (CED), which fosters collaboration and knowledge sharing between private companies, municipalities, and other organisations both within Denmark and internationally
- Danish Cyclists' Federation, founded in 1905, is an interest group with 16,000 members who advocate for bicyclists with national and municipal politicians and officials (Danish Cyclists' Federation, 2018). The CEO is Klaus Bondam, who was one of the political leaders of the City of Copenhagen's support for bicycling. The Federation works to make the bicycle the natural and safe everyday choice for all
- Danish Road Directorate (DRD), with about 900 employees, is part of the large Danish Transport Ministry (with over 40,000 employees) (Ministry of Transport, 2018). The Directorate is responsible for the national road network and works to advance the safety and ease of movement of all road users (Danish Road

Directorate, 2017). The Directorate is also responsible for the collection of traffic accident statistics, and for road safety work on state and municipal roads (Ministry of Transport, 2018). It administers funds for bicycle-friendly projects in the municipalities along the national road network, and the establishment of bicycle super-highways in Copenhagen

- Federation of Danish Motorists - *Forenede Danske Motorejere*, (FDM)

Historically, individual professional initiative and community activism were key influences on improvements for bicycling in Copenhagen. For example, it was the city engineer (Jens Rørbeck), who in the 1960s took the initiative to meter the number of motor vehicles entering the city, reduce car parking on public squares, and pedestrianize the Strøget. His was not an isolated action, and for many years it was the civil servants who drove Copenhagen policies and planning for cycling, independent of political leadership.

Melbourne Activist M9, noted the contemporary leadership of Niels Torslov, Director, Traffic in the city administration:

Niels has got everything we need to know; he favours the experimental paradigm as it means you can be more radical and he is about an integrated approach, with cycling supporting land use and public transport, and is very good at both the long game and staying under the radar.

Niels Torslov's approach can thus be understood as a continuation of the approach of the professional engineers and planners from the 1960s. A recent example of both working on the 'long game' and keeping below the radar (so actions did not draw unwanted attention) was to use the extended disruption caused by the construction of the metro to ration space for motor vehicles while making generous provision for bicyclists, as can be seen in Figure 6-6.



Source: Author

Figure 6-6 Providing for cyclists during Metro construction

Bicyclist activists have also been significant actors, dating from the large protest demonstration in 1979, but it was not until the 1990s that elected officials voiced support, but not financial provision, for new cycling infrastructure.

The biannual Bicycle Account, the initiative of the planning staff, was also influential as it showed politicians that Copenhagen was and should be a ‘city of cyclists’, a realisation that was crystallised in the election of bicycling advocate, Klaus Bondham as Mayor for Transport and the Environment.

In the above section I have briefly outlined some features of the institutional context and the actors who have influenced how safe the city is for bicyclists, noting that this has involved individual initiative and a relatively low level of financial support.

6.4 Content

This section discusses ‘content’, what is done, the overlapping *Safe System* measures applied to infrastructure, vehicles, and road user behaviour.

Infrastructure

The need for separation of bicycle traffic, initially from horse and foot traffic was recognised by the end of the 19th century. Horse riding on separate equestrian tracks had long been a feature of city life in Copenhagen, and with the advent of bicycles, some people rode their bicycles on the sides of the equestrian tracks. Researcher C4 said that there was early debate about allowing the use of equestrian tracks by bike riders. Some equestrian tracks were converted to cycle tracks, while on major roads the Danish invention of curb-separated one-way cycle tracks on both sides of roads, located between the footpath and parked vehicles was developed circa 1905 (Jensen 2013); a design concept used to this day, see Figure 6-7 below.



Source: Author

Figure 6-7 Modern Copenhagen bike lane

In 1910 a separate bicycle path was constructed around The Lakes (the medieval city’s moats) and then, in 1915, bike lanes were painted on city roads to provide separation from horse-drawn vehicles (Schonberg, 2009). By 1922 the Danish Cyclist Federation were demanding, initially unsuccessfully, physically separate bicycle lanes (Schonberg,

2009). In 1924, to reduce the number of bicyclists being run down by motor vehicles, bicycles were required to be fitted with red rear reflectors. By the 1930s it became apparent that rear reflectors on bicycles and separation by painted lines were not enough to protect cyclists. In 1932, the traffic law was revised to require bicycle riders to use separate infrastructure when provided (Schonberg, 2009). Thus, in Denmark, cycling has long been recognised as an independent transport mode with designated (separate) areas for circulation, as was done for motor vehicles, public transport, and pedestrians (Andersen et al., 2012).

Copenhagen now has some 426 km of separated bicycle facilities, including lanes, tracks, paths, and green routes (City of Copenhagen, 2013a). The cycling infrastructure provides a convenient, quick, safe, and pleasant experience (Andersen et al., 2012). With infrastructure solutions, a subjective sense of security and objective safety are sought for bicyclists (Andersen et al., 2012).

The Danes, like the Dutch, aim for road design that is self-explanatory. Detailed design communicates intended traffic functions by physical features such as road surface, signage, markings, for the locations and speeds of road users (Andersen et al., 2012).

The Danish road classifications recognise two basic functions, 'local' or 'traffic', and subcategories, as shown in Table 6-2.

Table 6-2 Danish Road Types

Urban Road Type	Road Section Target Speed	Provision for Bicyclists	Parking on road (if allowed)
Local: Residential (Incl) Cycle streets	30 ¹	None	Parallel kerbside
Local Shopping, Schools and Institutions	30 km/h - 40 km/h	Separated by lane or kerbed track	Parallel parking only, adjacent to motor traffic
Local: General	50 km/h	Separated by kerb (some interim by line) Called 'cycle track'	
Main Roads - Distributor - Through Traffic	50 km/h 60 km/h	Separated by: - kerb or marked lane - kerb, or - separate 'green path'	No parking (off-road only)

Notes: 1) 20 km/h max if angle parking
Trucks are limited to 50 km/h in urban areas

Sources: (Danish Road Directorate, 2012) (City of Copenhagen)

In Copenhagen, local roads make up most of the road length, totalling 7000 km. Local roads have 'target' speeds of 10, 20,30, 40 or 50 km/h depending on factors such as the abutting land uses, for example, 40 km/h or less where people will be present on roadways. There are some short sections of roads, with a speed limit of 40 or 50 km/h, with painted 'cycle-lanes', but these are the exception. The national urban default speed limit of 50 km/h is, however, contentious in Copenhagen on local streets where bicyclists share road space with motorists as speeds above 30 km/h are not consistent with a *Safe System*. The City of Copenhagen was denied the power to designate lower speed limits on local roads, and lower speed limits require police agreement on traffic calming measures for lower speed limit. Traffic calming, using speed humps, are the preferred calming treatments and are promoted as improving general amenity and safety for all unprotected road users.

In Copenhagen, there is about 700 km of main roads to serve 'through traffic', with speed limits between 50 and 70 km/h. Bicyclists are only permitted on the limited lengths of main roads when there are separate protected facilities (City of Copenhagen, 2013a). Separate on-road bicycle facilities are not allowed on the 279 km of motorways (TomTom, 2016). The separated bicycle network, on designated local and main roads,

is in total 426 km, using less than 6% of the road network and consists of 359 km of on-road 'lanes' and protected cycle track⁵⁸, together with 24 km of separate paths, and 43 km of 'green' off-road cycle routes.

Internationally, to 'Copenhagenize'⁵⁹ has come to mean the systematic addition of infrastructure – mostly protected lanes for bicycles – to an existing city. Ad hoc ideas from Copenhagen have been adapted in several cities, including Melbourne⁶⁰ but a few ideas from Copenhagen applied in a limited number of locations does not 'Copenhagenize' a city. Colville-Anderson, of the international Copenhagenize Design Company, suggests a city needs to comprehensively apply only four designs for bicyclists, defined by the degree of separation, speed limits and motor vehicle parking (Colville-Anderson, 2018). The four designs are:

- 1) shared space on local roads with speed zones up to 30 km/h
- 2) separate painted lanes, protected by parked motor vehicles, in speed zones 30 – 40 km/h
- 3) separated on-road 'tracks' protected by kerbing and often by parked motor vehicles, in speed zones 40 – 60 km/h
- 4) separate, off-road paths in corridors where roads are zoned at 60 km/h and above.

Regarding the unprotected use of main road space by bicyclists, the Cycle Planner (C2), who has consulted to the American NACTO cities, said:

it is understandable that in some countries with really lousy facilities for cyclists, the cyclists want to be on the road

Motoring Advocate C3 said support has continued for the provision of the limited lengths of separate infrastructure for bicycles, and motorists expect cyclists to be on the

58 The on-road, separated and protected facilities, are called 'tracks' in Copenhagen but in Melbourne and other cities are often called 'Copenhagen lanes'.

59 In the 2016 survey by the international 'Copenhagenize' Design Company, Copenhagen ranked first among 200 world cities (that is, cities with over 600,000 people), for their efforts to establish acceptance of the bicycle for transport (Rigitano, 2016).

60 For example, the 'Copenhagen' bike lane in Swanston Street, Melbourne, discussed in Chapter 7.

separate cycling facility, as required by the traffic regulations. C3 said where cyclists do not comply with the expectations about separation and ride on the road, drivers may not see them, and cyclists have been killed or very badly injured. Planner C2 said ‘it would be a nightmare if cyclists were to ride amongst the cars instead of choosing the cycle track’. Some bicyclists had however started to ride on the road, to maintain the same speed as the cars and catch the motor vehicle ‘green wave’ through traffic lights. Consistent with the philosophy that if the bicyclists are breaking the rules then this signals a design problem, the cities response has therefore included additional fast lanes for bicyclists (City of Copenhagen, 2011) and to create a 'bicyclist green wave' through the traffic signals on the bicycle network (Anderson et al., 2012, p. 132).

The movement system of separate lanes, green paths, and shared space on low-speed local streets is, however, only part of the safe infrastructure picture. The network nodes, the intersections where road user paths may cross, is where most of the traffic ‘accidents’ occur and it is at intersections where bicyclists often feel insecure (City of Copenhagen). The City of Copenhagen *Guidelines for the Design of Road Projects* (2013) gives intersection safety priority consideration, with three basic design intentions, that is to:

- 1) minimise the points of potential conflict
- 2) clearly indicate where the remaining potential conflict points are – that is, identify the points where road users need to cross each other’s paths
- 3) ensure that road users travel at an appropriate, low, and safe speed to avoid conflicts

To minimise the points of potential conflict, most uncontrolled local road intersections are T junctions, and there are very few roundabouts. Separate areas for pedestrians, bicyclists, and motor vehicles are also typically provided to minimise the potential for conflict and provide a road environment where people know where to expect different road users. Potential conflict areas, such as on the approach to signalised intersections, are often highlighted by ‘blue’ pavement, an idea invented and used in Copenhagen since 1981, see Figure 6-8 below.



Source: Author

Figure 6-8 Blue paved, potential conflict area

Some designs shown in *Focus on Cycling* (City of Copenhagen) were hard to understand, and the Safety Engineer (C5) said that designs could not be explained by just translating Danish words to English. For example, to understand intersection designs in Copenhagen it is necessary to know the context provided by the Danish road standards and traffic regulations:

some things are just like, so obvious and other things cannot adequately reflect the knowledge in the administration like practical minimum standards, which are very difficult to put in simple terms, keeping in mind the consequences for pedestrians, for cars and the whole spectrum of road traffic (C.5)

The Danish road regulations support predictability of rider location by requiring riders to stay to the right, to keep out of the central area at intersections, and move through the corners of intersections within an outer 'box'. To make a left (large radius) turn, cyclists

must go to the far corner before turning left ⁶¹. The Danes call this the 'left turn rule' and a very high level of compliance was observed amongst bicyclist.

Safety Engineer C5 said they have found that they need to be 'very careful in the design of the intersection; otherwise, you get into trouble'. The City has developed several solutions for intersections, and Cycle Planner C2 holds the view that most intersection problems can be solved from their toolbox of solutions. These include, at signal-controlled intersections, by extending areas for cyclists to wait to cross intersections⁶², by specific bicycle signals with pre-green – providing cyclists with their own lane for right (small) turns, and by moving 'stop lines' back for cars. Safety Engineer C5 said, however, as conditions differ from place to place, standard solutions are not always possible. For example, safety issues for bicyclists have arisen at intersections when traffic management has given priority to other road user groups, such as to improve bus travel times.

City Planner C4 said that as bicyclists often feel less safe at intersections, a lot of effort goes into safe intersection design. The initial focus was on objective safety, but it became obvious that to reduce risk-taking at intersections such as running red lights to avoid waiting, to encourage more travel by bicyclists' their convenience also needed to be considered. Improvement in perceived safety became the priority. Another example was that as cyclists did not feel safe on truncated bicycle lanes on intersection approaches; the policy was changed to where possible not use truncated and unprotected bike lanes on intersection approaches.

⁶¹ Like a right 'hook-turn' required in Inner Melbourne at controlled intersections with trams.

⁶² Copenhagen has also experimented with forward traffic lane 'bicycle boxes' located just in front of the inner car lane 'which worked quite well'(C2), but as they 'want to keep cyclists to the right side of the road' (C2) they are not used much. I raised the problem with bicycle boxes, observable in Melbourne, of poor near-field visibility for trucks with long bonnets which are not seen on inner city local streets in Europe. C2 agreed this would be a problem and was an example of why you cannot just copy and paste some solutions.

To find new solutions to improve safety for bicyclists, Safety Engineer C5 sees the need to depart from the traditional engineering improvements that work for motor vehicles. Infrastructure solutions, complimented by regulations, are devised to promote safety, and avoid unpredictable behaviour by cyclists, for example, working with bicyclists who want to maintain efficiency and avoid stopping at intersections. C5 also said that at some intersections, potential conflicts between cyclists and motor vehicle are managed without separation, ‘as we do not always have the space for islands and other things’ such as channelization or separate signals. In practice, however, measures for cyclists at controlled intersections only have a positive safety effect for the first cyclists and not those who arrive later. To minimise this problem, signal timings are set, and intermediate real-time advisory signs have been devised to encourage cyclists to ‘platoon’ and travel in the safety of a group. Copenhagen is also trialling technological solutions such as in-pavement bicycle activated LED indicators on the outer edge of bicycle lanes, to alert drivers to the presence of cyclists.

Safety Engineer C5 said the safety of intersections had also been improved by the comprehensive use of traffic safety audits, at each phase, from design through to construction. Challenges, however, persist, particularly with turning motor vehicles. As observed by C5:

There is a clear pattern from the data, with many accidents at intersections where the cyclist is going straight, and the car is turning either right or left; a problem seems to be that car drivers have to be aware of so many different things that they may overlook cyclists⁶³.

Detailed crash data examined by C5 for four inner-city intersections showed that half the serious injury crashes occurred at times of reduced visibility: dusk, dawn, and night, suggesting that not being visible or not being seen are problems for cyclists. A problem exacerbated by the national general urban speed limit of 50 km/h and the resistance of the Danish Government to legislate for lower intersection speed –as apply in The Netherlands. That is, motor vehicles approach intersections at the road section speed

⁶³ The Dutch are aware of this problem and aim to simplify decisions for drivers to encounter one type of road user at a time.

limit, which is often 40 or 50 km/h. At 50 km/h, the potential for fatal impact for car occupants is minimal but very high for bicyclists. To reduce the risk to bicyclists and pedestrians the Road Safety Principles that draw on the Swedish *Vision Zero* and the OECD/ITF *Safe System* Approach, state that motor vehicle speed needs to be 30 km/h or less (Danish Road Directorate, 2011). Safety Engineer C5 observed that when traffic speeds are low, road users can usually work things out for themselves. A lower motor vehicle speed allows drivers more time to avoid collisions, to visually take in and process the intersections environment, reduces stopping distances, and lessens the severity should an impact occur. In 2013, in the absence of legislation, the City of Copenhagen was promoting for all intersections a maximum speed of 40 km/h, the speed limit that applies at school zones and other areas with vulnerable road users (City of Copenhagen website 09/08/2013).

As with other cities in snowbound regions, there are infrastructure hazard and maintenance challenges from heavy snow and the possibility of the formation of black ice. In Copenhagen, up to 50% of riders will not ride under adverse winter conditions⁶⁴. The City of Copenhagen, however, gives priority to snow clearing and salting of the bicycle tracks, but on the local roads, snow and low temperatures may require bicyclists to walk.

The main findings from Copenhagen are that a highly effective, formal, designated and protected (from motor traffic) bicycle network can be established that affects less than 6% of the total road length. The designated network needs to be complemented by safe local streets where bicyclists can operate in mixed, low-speed traffic environments. Also, intersection safety is a big challenge and needs dedicated attention.

⁶⁴ From my experience, riding through winter in Northern America, fresh snow is not a major problem, the main hazards are puddles that freeze and the very cold air that can damage a rider's lungs.

Overall, as observed by Ruby (2014), increasing bicycle use by commuters is most readily achieved by providing infrastructure, but improved and *Sustainable Safety* requires more than infrastructure:

Cycling – especially in a wealthy country like Denmark – is for most an active additional choice which can easily change. So, the only way forward is to make it safe, easy, and attractive to cycle, and that does not happen solely by changing the infrastructure. (Ruby, 2014, p. 2)

That is, the other elements of system safety, the vehicles and behaviour of road users also need to be considered, as discussed below.

Vehicles

This section discusses the safety implications of diverse vehicles in mixed traffic and the safety of the bicycle as a vehicle. A feature of traffic in Copenhagen was the absence of large 4WD/SUVs, so popular in Melbourne (Johnson et al., 2010). A diversity of bicycle types is a feature of Copenhagen, ranging from Dutch-style upright bikes to hybrids to the famous cargo bikes. The popularity of cargo bikes, with many variations, and the Danish sense of fun, is illustrated by the ‘sperm bank bike’, see Figure 6-9 below. An interaction with infrastructure is that to safely accommodate the diversity of bikes of various widths and manoeuvrability; the bicycle lanes need to be wider, 1.8 m minimum for one-way lanes.



Image source © Larry vs. Harry
Used with permission, 14/05/2018

Figure 6-9 Danish Sperm Bank bike

The Danes take pride in the design of their bikes. They have four major bike brands, several smaller brands and companies that specialise in cargo bikes. Danish companies have also produced cycling innovations including a battery-free light that operates in the day and at night, powered by electrodynamic induction. The FDM is concerned that the high motor vehicle taxes, which apply to all components, may impede the adoption of safety technology that would improve safety for bicyclists by inflating the cost of motor vehicles equipped with cyclist detection and autonomous braking.

The potential for problems between cyclists and trucks was noted by two informants. The risk from trucks has, however, been reduced by separate bicycle tracks, truck route restrictions and EU regulations that have improved visibility from trucks (Pattinson & Thompson, 2014).

People and behaviour

The Danish government has been reluctant to change National regulations to advantage the safety of bicycle riders, and some informants considered the police as inflexible in enforcement by claiming unproven safety concerns. To overcome National legislators refusal to make regulations to improve safety for bicyclists, the City has turned to community education campaigns, such as asking that drivers turning right (small radius), stop, look for and give way to through cyclists, and for drivers to slow down on local streets and through intersections – examples of co-production. Most drivers were observed checking for bicyclists before turning right, as shown in Figure 6-10 below.



Source: Author

Figure 6-10 Turning car stopped to let cyclists pass through on the right

Such co-production changes are achievable as adults have a good understanding of traffic safety and have attained competence in bicycling over the nine years of compulsory school⁶⁵. The influence of competence and practice was noted by Cycle

⁶⁵ In 0-3rd grade the focus is on walking and managing a bicycle, in 4-6th grade, the focus is the bicycle and the traffic rules, and in years 7-10, they learn about risks in traffic and the dangers of alcohol, other drugs and excessive speed.

Planner C2 who has observed that for individual bicyclists there appears to be an inverse relationship between distance travelled and experience of injury; that is, the more kilometres a bicyclist travels, the lower their risk of injury⁶⁶.

Motoring Advocate C3 said that most people in Denmark are at various times pedestrians or cyclists or motor vehicle users but associate with the traffic group they are in 'at the moment'. In her view, drivers in Denmark have created a road culture that is characterised by tolerance. From FDM members she hears that as pedestrians they get good treatment from car drivers but not from the cyclists; that is, bicyclists are not seen as contributing to safety. As a person who rides daily, she sees a lack of tolerance between cyclists and of cyclists for pedestrians, with some male cyclists particularly intolerant⁶⁷. She believes these behavioural problems 'are not going to be solved by bigger cycle lanes, which will mean more bicycles, which could lead to a situation of anarchy' (C3).

Copenhagen bicyclists, however, have a reputation as the best behaved in the world (Colville-Anderson, 2018), a reputation supported by my observations. For example, they keep to the right and often stop to talk on their phones, as in Figure 6-11 below.

⁶⁶ The idea that there was an inverse relationship between injury risk and distance travelled had previously been put to me by a motorcycle instructor. His view was that the challenges of safety on two wheels are very high, including reaction times and motor skills, that require constant (daily) practice under a variety of conditions.

⁶⁷ C3 was a commuter cyclist who lived in central Copenhagen and travelled to an outer suburb for work.



Source: Author

Figure 6-11 Woman with infant, stopped to talk on her phone.

The Copenhagen Academic C1 said that it is part of the culture that drivers take care of the pedestrians and cyclists. In Researcher C4's experience, however, care by Danish motorists is not to the standard expected by Dutch visitors. For instance, at intersections, when the Dutch see left-turning cyclist routinely making the two-stage 'hook' turn; they think that Danish cyclists do not trust drivers to take care of them, otherwise they would use the middle of the road to turn. An alternative interpretation is that Danish cyclists are more disciplined and follow rules that help cyclists and motorists co-exist with the bicyclists' movements predictable and consistent.

Safety Engineer C5 sees the future road safety focus for the city as vulnerable road users, including finding ways to improve the behaviour of drivers and other road users. However, she finds it very difficult to know what message to direct to road users as

campaigns that involve exhortations like ‘go slowly’ seem ‘very fluffy’. She would prefer straight-forward messages like ‘signal when you turn’ and sometimes these can be supported by fun measures like rewarding people who signal properly with chocolate, like the ‘karma campaign’ when the issue of poor behaviour by some bicyclists was addressed in a very Danish way. When the Municipality had control of the Police, it sent 50 ‘karma-policemen and women’ out on the bike lanes to promote the good Danish cycle culture and positive ‘cycle-karma’, giving apples to cyclists who showed good behaviour and created positive ‘cycle-karma’ towards their fellow cyclists⁶⁸.

C5 also anticipates the need to target specific groups, such as tourists and people new to using electric bicycles⁶⁹ with education campaigns. C5 expects that issues will arise with electric bikes as people will do longer commutes and may be able to travel at speeds up to 35 km/h.

⁶⁸ See <http://www.cycling-embassy.dk/2010/09/01/spread-the-good-bike-karm>.

⁶⁹ An issue with E-bikes is that riders can increase exposure as they can travel further with minimal effort at up to 25 km/h.

6.5 Conclusions

Several factors have come together to make Copenhagen a bicycling city including integrated land use development, preservation of city amenity by senior civil servants, a solid minority of citizens who kept bicycling, community support for bicycling as transport, a legacy network of separate bicycle tracks, and more recently, comparatively modest investment in additional separate bicycle infrastructure. Bicycling in Copenhagen also works because of well-disciplined (predictable) bicyclists and road users who understand bicycling, who together have co-produced a city safe enough for many people to bicycle.

Copenhagen is a city for bicyclists, with a strong bicycling history and aspirations to be a 21st century exemplar green and sustainable city in which bicycling is to have a major role. Realising the aspiration to be objectively the best and safest city will, however, require additional actions and investment by the municipality and legislative support from the Danish government. For credibility, comprehensive injury data will be needed. A re-balancing of priorities may also be needed to what appears to be an undue emphasis on accommodation of motoring interests and development of showpiece transit.

Copenhagen shows that it is feasible, with community support, to co-produce a city safe enough for mainstream bicycling, building on community desire for liveability, with people-centred design and modest levels of expenditure.

Chapter 7 Inner Melbourne, much safer by car than bicycle

This chapter explores why, in Inner Melbourne, fears about safety deter many adults from travel by bicycle.

My concerns about safety when riding in Melbourne have increased as I got older and after two 'serious injury'⁷⁰ crashes, where poor infrastructure was a major contributing factor. The first, in the 1990s was a high-speed fall, with the major contributing factor being poor road maintenance (a large pot-hole). In 2013 I received a complex elbow fracture, from a low-speed fall when cautiously making a left turn, with the main contributing factor being a wet patch of uneven (poorly maintained) road surface. Several of the informants and correspondents for this research, who were very experienced, cautious, and highly skilled riders, also volunteered their experiences of serious injuries caused primarily by infrastructure. I have therefore formed the view that with the current infrastructure in Inner Melbourne, it is not possible for a rider to assume that they will be able to dependably create good enough safety - that is comparable to walking, using public transport, or driving.

The Author, 2015

I begin this section with a brief description of the study area, list the informants and provide an overview of the objective safety (risk) of bicycling in Inner Melbourne. Then I provide my findings from documents and interviews on the social and technical factors that influence safety for trips by bicycle. Under context I briefly explore historic, cultural and policy influences, under process, I consider the roles of institutions and other actors. Content measures are explored using the *Safe System* pillars of infrastructure, vehicles, and road user behaviour.

⁷⁰ Both my injuries were fractures, one of which was not medically serious, but both were serious to me as they restricted my activities for several months.

7.1 Inner Melbourne

Inner Melbourne developed in the pre-car 19th century with rapid growth served by public transport. With mostly flat terrain⁷¹, few natural barriers, a mild climate, and a well-connected and legible road network, Inner Melbourne appears suited to bicycling (Pucher et al., 2011). On a typical weekday, however, only 3.7% of all travel was by bicycle, compared to 16.2% by public transport, 25.3% by walking, and just over half (53.2%) by private motor vehicles (VISTA 2014-16). While many people own bicycles, because of traffic danger, most bike owners restrict their riding to low intensity and infrequent trips (Hall and Partners, 2010).

Melbourne data

The Melbourne data was drawn from some 31 documents as listed in Appendix 2.3 and the reports, plans and guidelines – as referenced in the text, and interviews with the 18 informants listed in Table 7-1 below.

⁷¹ Much of inner Melbourne is on a floodplain, as are Amsterdam and Copenhagen, and as was demonstrated to the early settlers by extensive floods in 1849 and 1863 (Blainey, 2013).

Table 7-1 Melbourne informants

Code	Description	Government Practitioner	Interest. Group	Researcher	Date
M1	Municipal Traffic Engineer	★			12/12/13
M2	Melb Cycling Trainer	★			1/1/2014
M3	Senior Environmental Activist		★		6/2/2014 & 6/3/2014
M4	Early career Academic Researcher			★	19/2/2014
M5	Gov. Cycling Expert	★			20/2/2014
M6	Gov. Transport Accident Manager	★			25/2/2014
M7	Senior Victorian MP	★			27/2/2014
M8	Ret. Police Exec.	★			4/3/2014
M9	Experienced Cycling Activist		★		1/5/2014
M10	Senior Inner-City Councillor.	★			5/5/2014
M11	Police Executive	★			25/7/2014
M12	Operational Police officer	★			25/7/2014
M13	Senior Safety Consultant	★		★	12/6/2014
M14	Motorist Assoc. Exec. & Ret. Gov. Exec.	★	★		9/5/2014
M15	Agency Executive	★			12/5/2014
M16	Research Officers* (two)	★			30/4/2014
M17	Health Academic	★		★	20/05/2014
M18	(Retired) Justice Department Manager	★			5/6/2014

*Declined to have the interview recorded.

How safe is Inner Melbourne for bicyclists?

The five municipalities in the study area, which together have less than 1/12th of the State's population, accounted for one-third of all TAC state-wide claims by bicyclists for in-hospital treatment. The VISTA travel survey data from 2012-13, (see Table 4.2 above), showed that in the Inner Area bicycle use was by far the least favoured mode of

travel. Data extracted for the Inner Area showed that people on bicycles made the smallest percentage of trips at 7.4% yet a reported disproportionately high share of trauma – at 23%.

From CrashStats data extracted for the Inner Area by persons injured⁷², bicyclists were over-represented, with more bicyclists seriously injured than pedestrians, as shown in Table 7-2.

Table 7-2 Persons Killed and Seriously Injured by Mode in IMAP, 2013

IMAP (Pop.446,000)	Car & similar vehicles	Bicyclist	Pedestrian
Killed Males	3.	0	7.
Killed Females	1.	0	1.
Seriously Inj. Males	126.	104.	86.
Seriously Inj. Females	121.	59.	62.
Total KSI	251.	163.	156.

Source: CrashStats, 2013

The risk index calculation in Chapter 4 that allowed for exposure showed that the risk of a reported injury for bicycle trips was six times that of car trips (see Table 4-3 above).

Previous studies in Melbourne – that is the larger area that contains the study area – provided findings relevant to the study area, including that:

- for injured bicyclists seen at hospitals, motor vehicles were involved in less than half of the crashes, hence CrashStats, which mostly records crashes involving motor vehicles, gives an incomplete picture
- where motor vehicles were involved, greater trauma occurred and was worse in speed zones above 50 km/h
- there were more injuries at intersections than on road sections, and most were at intersections not controlled by traffic lights

⁷² Counting the number of persons involved in injury crashes is different to counts of the number of crashes in which at least one person is injured, as used by VicRoads and the TAC.

- contributing factors beyond the riders' control included other road users (42%), and debris in their path (18%) (Biegler et al., 2012)
- possible contributing factors that were under the rider's control included: fatigue, speeding, distraction, riding when unwell, poor bicycle maintenance and lack of rider training – although most held a driver's licence

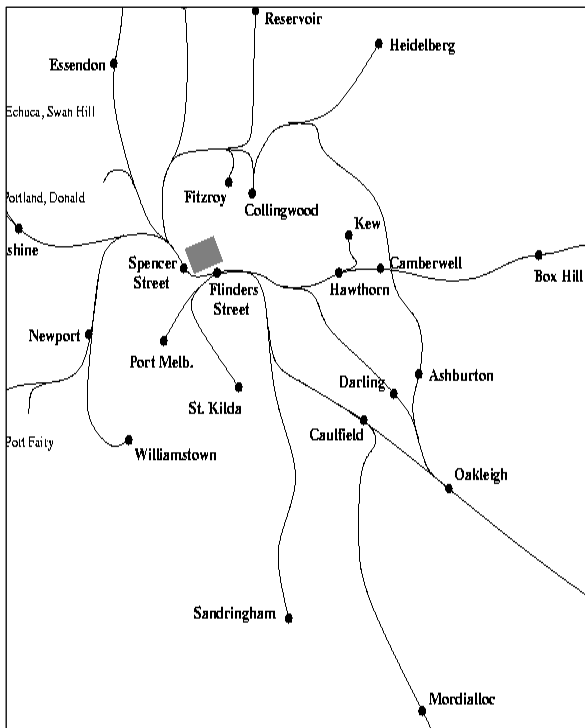
7.2 Context: History, culture, and policies

This section outlines why Melbourne's history of transport and land use development, culture, and approach to policy may have limited safety for bicyclists.

History

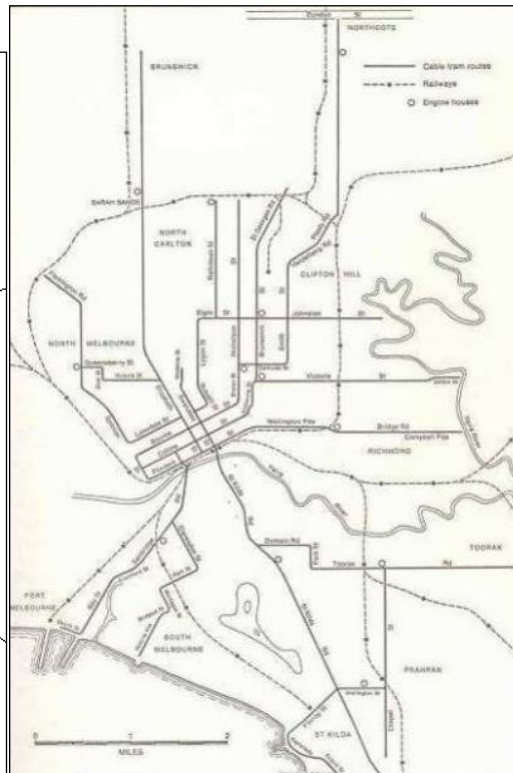
Melbourne is a relatively new city, first settled by British squatters in the 1830s. The settlement was on Kulin nation land, home of the indigenous Wurundjeri people, who travelled by foot on bush tracks. The growth of the colony was rapid, fuelled by the discovery of gold and a hinterland with abundant areas for the grazing of livestock. City development was relatively unconstrained, with wide roads set out to allow suburban land development supported by trams and suburban trains in a speculative market without any strategic plan.

The British colonists had an enthusiasm for steam-powered railways and quickly developed an extensive network of suburban railways and tramways, as shown in Figure 7-1 and 7-2, (Cannon, 1967).



**Figure 7-1 Melbourne Trains
c.1891**

Source: Tony Morton PTUA
Used with permission



**Figure 7-2 Melbourne Trams
c.1901**

Source: Mind the Curve by John D Keating
Used with permission

By the time of the appearance of the 'safety' bicycle (circa 1890), Melbourne was an established 'transit city', with land use and travel patterns based on its train and tram lines. By the end of the 19th century, each week one million passenger trips were made using public transport, a testament to the importance of the trains and trams were to Melbourne's development (Cannon, 1967; Davison, 1978, 1979 - 2004).

To gain a sense of city travel in the 19th and early 20th centuries over 160 illustrations and photographs of street scenes were examined⁷³. It was apparent that bicycles were

⁷³ See also <https://www.pinterest.com.au/wazza50/?eq=Waz&etslf=18460>, the author's 'Board' of *Melbourne Street Scenes*) with 161 photos.

used, see for example Figure 7-3, which shows the sharing of road space, including by about ten people on bicycles.



Figure 7-3 Swanston St corner Flinders St c.1900

Source: Stonnington History Centre, Ref. PH239

Only a minority travelled by bicycles, but bicycle use was not unusual, as, for example, future prime minister Alfred Deakin started riding in the late 1890s and rode his bicycle at every opportunity, including the five kilometres from his home in South Yarra to Parliament, then located in Melbourne (Brett, 2017).

Melbourne's car and road culture developed from the 1920s and shared the American enthusiasm for motor cars (Davison, 2004). By mid-century bicycles still accounted for over 10% of journeys to work, however, the motor vehicles that visually dominated the

road environment were used for less than 20% of journeys to work, with most travel by trams and trains (Moriarty & Mees, 2006).

During the second half of the 20th century, Melbourne faced the twin challenges of traffic congestion and increasing road trauma. Until the 1990s, more bicyclists and pedestrian were killed than car occupants (Davison, 2004). By the end of the 20th century, however, bicycling had declined to only 1% of trips to work (Moriarty & Mees, 2006).

Road trauma was initially constructed as a behavioural problem. The victims were at fault, the careless pedestrian and bicyclists who got in the way of motorists, the road users who did not obey the road rules, and the motorists who drove when intoxicated and who drove too fast (Davison, 2004). With hindsight, the road safety problem, and the road congestion problem can be understood, in part, as neglect of travel by the more efficient and low-harm modes – bicycles and public transport.

By the early 21st century, much of Inner Melbourne's 19th century urban fabric remained. Accessibility was not inherently dependent on motor vehicles as the city still had the neighbourhoods and mixed-use activity strips served by street trams and trains (Davison, 1979 - 2004).

Road culture and government policies

In this section, I draw on documents and interviews to interpret how the road culture and government policies shaped safety for existing and could-be riders. Document analysis revealed that the potential for more bicycling to deliver a wide range of co-benefits was largely ignored. Agencies that influenced city transport through major road infrastructure, public transport, and land use planning, operated in independent silos and were in the thrall of automobility (Lowe et al., 2015).

As outlined in Appendix 3, Melbourne has a history of Victorian Government strategic plans and policies that held promise but were rarely implemented. A small number of effective programs that supported bicycling but were also abandoned⁷⁴.

The *Victorian Transport Integration Act (2010)*, appears to provide a supportive context for action on cycling. Part 13 *Safety and health and wellbeing*, subsection (2) of the Vision Statement in the Act, promotes integration and the *Safe System* principles, stating that:

...the transport system should –

(a) seek to continually improve the safety performance of the transport system through:

(i) safe transport infrastructure

(ii) safe forms of transport

(iii) safe transport system user behaviour

(b) avoid and minimise the risk of harm to persons arising from the transport system

Source: (Parliament of Victoria, 2010)

But, as with many promising plans and proposals for Melbourne, the intent of the Act remains unrealised. For example, Informant Executive Planner M13 said that at VicRoads, the Act was yet to be followed⁷⁵.⁷⁶ Also, the Victorian Auditor-General in a report on *Developing Cycling as a Safe and Appealing Mode of Transport* noted the failure by agencies to comply with Act (Victorian Auditor-General, 2011). The report found that the then Department of Transport and VicRoads had:

- not developed an adequate implementation plan and the mechanisms needed to prioritise and coordinate actions across government

⁷⁴ Examples are the Victorian Bike Ed program in Primary Schools which was severely cut back in the 1980s; and the Victorian Ministry of Transport, Local Area Access Program, which funded linking infrastructure but which when assigned to VicRoads was effectively abandoned.

⁷⁵ There are no penalties for ignoring this legislation, unlike the Occupational Health and Safety Regulations that back up the Occupational Health and Safety Act 2004.

⁷⁶ In 2019 however the Act was given new cogency with the creation of a new Department of Transport.

- not adequately addressed weaknesses in understanding current and potential cycling journeys or how barriers affect potential cyclists
- not addressed the need for consistent and minimum standards for the design, operation and maintenance of bicycle paths and lanes

(Victorian Auditor General's Office, 2011)

For bicycling, over the 2012-2018 period of this research, there were four 10-year strategies:

- *Victorian Cycling Strategy 2009*
- *Cycling into the Future 2013 – 2023* (2012)
- *Victorian Cycling Strategy Update* (2015)
- *Victorian Bicycle Strategy 2018 – 28* (2017).

Informants and documents examined revealed that by 2018 very few components of these strategies had been implemented. The feeble approach to bicyclists safety by successive Victorian Governments stands in contrast to substantial efforts to improve service and safety for motor vehicle occupants. Government decision-makers, such as retired police Commissioner M8, take justifiable pride in the road safety measures that achieved a significant state-wide decline in road deaths between 1970 and 2018; however, the number of recorded injuries to bicyclists increased. Policies that were effective in reducing deaths for car occupants – the strict regulations and vigorous enforcement to change road user behaviour (such as speeding and drink driving – supported by public education); safer vehicles; and safer roads had not resulted in improved 'primary' safety for bicyclists (Muir et al., 2018). Compulsory wearing of bicycle helmets, required under regulations introduced in 1990⁷⁷ that improved 'secondary' safety by reducing head injuries (Cameron et al., 1994), and decreased

⁷⁷ I was a member of the State Bicycle Committee that sought the introduction of compulsory bicycle helmets. My recollection is that the decision was based on two considerations: the number of head injuries to young bicyclists, and the availability a new generation of bicycle safety helmets.

injury numbers as fewer people bicycled, can be interpreted as reducing pressure on successive Victorian Governments to improve ‘primary’ safety.

With the neglect of primary safety by the Victorian Government, improvement of primary safety for bicyclists has mostly been left to individual municipalities (discussed further below in Sections 7.2 and 7.3). In the Inner Area, each municipality has prepared bike plans, and implemented measures within their limited resources, mostly focused on infrastructure on local streets (City of Maribyrnong, 2014; City of Port Phillip, 2011; City of Yarra, 2010a; Oke & Robinson, 2013) (City of Melbourne, 2016). From the viewpoint of the *Safe System* paradigm and the need for systemic change, however, the influence of each small municipality is limited. For example, they can do very little about road user behaviour or vehicle design standards.

7.3 Process

In this section, I discuss the structures, processes, and the actors and agencies that influence the safety of Inner Melbourne for bicycling. The levels of government in Australia are:

- Federal, the Australian government
- State, in this case, the Victorian government, and
- Municipal, the Local Councils

Tomlinson (2017) draws attention to the severe vertical fiscal imbalance in Australia with most legislative power and command of resources resting with the Australian government, less with the state governments –such as the Victorian government, and the least with the municipal councils. For example, of total taxation, the Federal Government collects 81%, state governments 15.6%, and local government 3.4% (Drew & Grant, 2017). Municipalities are thus the level of government with the smallest tax base yet have responsibility for safety and convenient mobility in local areas.

The potentially most powerful actor, the Australian Government, has done little to improve the safety of inner cities for bicycling. At the national level, there are multiple agencies, each with some responsibility for roads, transport, and cities, that dilute any focus on safety for bicyclists. These agencies include the Department of Infrastructure,

Regional Development and Cities; the Bureau of Infrastructure, Transport and Regional Economics (BITRE); and the National Transport Commission (NTC). The Australian Government's transport and land use actions often appear to be opportunistic rather than strategic; for example, the place-based partnerships – 'city deals' – to bring together the three levels of government, the community and private enterprise, offering coordination without a guiding strategy.

The Department of Infrastructure's road safety activities include a 'Black Spot' program and participation in international forums on the harmonisation of vehicle regulations. The Departments Action Plan 2018-2020 for the National Road Safety Strategy recognised the vulnerability of bicyclists and identified measures, but a 2018 inquiry into the strategy found serious implementation failure, including:

- road trauma (reduction) targets not met
- the *Safe System* approach, often not honoured
- a disconnect between: 'noble intentions, resourcing actions and road safety practice'
- lack of focus on harm elimination with sub-optimal results
- 'improvement', that is making elements safer, often regarded as sufficient, but roads, vehicles and users not being made 'safe'
- costs of trauma from road crashes, borne in the health, social and productive economy, could be reduced and provide across portfolio returns of up to 20:1.
- lack of leadership from the top of government

(Woolley et al., 2018, pp. 5,15,16)

The Australian Bicycle Council, (ABC) which in its yearly reports drew attention to the failure of government's to implement promises on bicycling, was replaced at the end of 2017 by *Cycling and Walking Australia and New Zealand* (CWANZ), whose role is to articulate the need for investment by others without providing any funding⁷⁸.

The national non-government associations (NGO's) based in Melbourne include Bicycle Network who aspire to make Australia a bike riding nation, and the Amy Gillet

⁷⁸ <https://www.cwanz.com.au/>

Foundation, whose mission is to reduce the deaths and injuries to cyclists. Both these associations have considerable expertise in cycling matters but appear to have had limited influence on the Australian or Victorian government decision making processes.

The Victorian Government has direct responsibility for many functions that influence the safety of bicycling in Inner Melbourne, including the land-use arrangements through metropolitan planning, policing, arterial roads, road safety, driver licensing, motor vehicle registration and no-fault injury insurance, primary and secondary school education, the courts, and penalties. The delivery of programs remains complex and fragmented (Curtis et al., 2010). Victorian Government agencies typically operate as functional silos, that is, there is often a lack of horizontal integration across areas of common interest, although the need for coordination is acknowledged (Department of Environment Land Water and Planning, 2017; Transport for Victoria, 2017).

For inner Melbourne, there is no regional level of government and little recognition of the inner urban area as a unique constituency (Tomlinson, 2017). The recently reconstituted Victorian Planning Authority (VPA) has an Inner Melbourne Directorate, but the Directorate is focused on the development of major sites to support high-value jobs and new communities (Victorian Planning Authority, 2018). State administrative regions, based on geographic aggregations of municipalities, often split the inner area. For example, the area of the IMAP group of municipalities was split between two administratively autonomous metropolitan regions (the North-West and the South-East), for Victoria Police, Department of Justice and VicRoads.

The metropolitan planning strategy, *Plan Melbourne 2017-2050* (Department of Environment Land Water and Planning, 2017), recognises a potential role for bicycling, but as with many previous plans, there have been no new commitments for implementation. For example, for several years, the Victorian Government did not invest in any bicycling infrastructure in the Inner Area. Strategic cycling corridors, with links across the central city, were nominated for development by VicRoads and Councils, but with funding deferred for consideration in future budgets (Department of Environment Land Water and Planning, 2017). As noted by retired MP M7, support for bicycling may be overridden by the Victorian Treasury (Department of Finance) in budget processes. In planning and budgets, the safety needs of bicyclists are ‘buried’ by

‘bigger’ concerns. For many years there has been no ministerial champion to articulate the potential for bicycling to contribute to liveability and sustainability. The lack of strategic planning for bicycling and the failure to implement previous promises contrasts with the mega road and rail commitments totalling \$57 billion in *Victoria’s Big Build* (Victoria, 2019).

Since 2004 the Transport Accident Commission (TAC) has led road safety thinking in Victoria, based on the *Safe System* philosophy and *Vision Zero*, developed by Prof. Claus Tingvall and staff at the Monash University Accident Research Centre, (Tingvall & Haworth, 1999). The Transport Accident Commission (TAC) charter is, however, restricted to safety associated with registered motor vehicles (Transport Accident Commission (TAC), 2010). TAC leadership on road safety comes from the significant financial resources it commands. For example, in 2018 it received over \$1.9 billion in premiums, paid almost \$1.5 billion in claims to persons injured and invested \$283 million to reduce trauma, much of which was spent on reducing risk of serious injury for motor vehicle occupants on high-risk (mostly rural) roads (Transport Accident Commission (TAC), 2018). Road injuries to bicyclists (and pedestrians) that do not involve motor vehicles are not part of the formal remit of the TAC.

In 2008 the government adopted *Vision Zero* and set an initial target of a 30% absolute reduction in serious trauma (Arrive Alive 2008-2017). The 2008 strategy reflected a preoccupation with reducing road deaths to motor vehicle occupants and drivers using arterial roads with little attention to bicyclists in urban areas.

Victoria’s road safety strategy is based on CrashStats and with policy shaped and implemented through the Road Safety Partnership consisting of:

- Transport Accident Commission (TAC), whose charter is to reduce the trauma associated with the use of registered motor vehicles, funded by compulsory 'third party' insurance premiums, collected when motor vehicles are registered (Transport Accident Commission (TAC), 2010)
- VicRoads, who collect the insurance premiums for the TAC, administer vehicle safety standards, driver licensing, and manage arterial roads
- Victoria Police, who enforce the road rules and generate the crash reports entered in CrashStats

- Department of Justice, who administer the penalty points regime and the courts where infringements are prosecuted
- Department of Health, for hospital treatment of people injured in crashes

(Cockfield, 2011).

The crash statistics (CrashStats) collected by Victoria Police is the evidence base for roads safety but is focussed on injuries to or caused by drivers of registered motor vehicles. Crashes involving only bicyclists are rarely reported. The retired Commissioner (M8) acknowledged that crashes involving injuries to bicyclists are significantly underreported. However, these incomplete statistics are relied on as the evidence base to give a sense of what the road safety problems are, where, how big and the trends. Operational Police Officer M12 confirmed that the Police road safety focus is necessarily based on the injury crashes involving motor vehicles recorded by and readily available to the Police and the Road Safety Partnership

Analyses of Victoria's road safety strategy, *Vision Zero*, shows that road safety policy in Victoria was dominated by measures to reduce deaths and injuries to car occupants, which logically follows the TAC's primary role of reducing the cost of motor transport accidents to the Victorian Community (Cockfield, 2011). The whole of state approach also has diluted attention to inner-city problems. Further, as local government is not represented in the Road Safety Partnership, the extensive lengths of roads under the control of municipal governments received little attention. Infrastructure safety measures developed by VicRoads and funded by the TAC was strongly influenced by engineering thinking on safety for motor vehicle occupants operating at high speed, rather than for bicyclists in the urban areas (Cockfield, 2011; Jurewicz et al., 2014; Transport Accident Commission (TAC), 2010; Transport Accident Commission TAC, 2016). Recent TAC supported research on lower speed limits in inner-city residential areas is an exception (Fildes et al., 2017).

A fundamentally important issue with road safety policies and programs is that as they are based on police-reported crash statistics they are focused on symptoms of motor vehicle use, to the neglect of the deeper systemic causes, such as an imbalance in mode use and over-dependence on cars. Ineffective land use development controls have not reduced travel distances, and public transport improvements are not linked to or seen as

part of road safety programs. Traditional road safety programs, by improving safety for motor vehicle users, have probably encouraged greater use of private motor vehicles which has increased the potential for harm to vulnerable road users

With CrashStats, there is no way of distinguishing between types of riders (e.g. recreation or commuting), or of relating numbers of injuries to travel exposure. The Police cannot know what happened before many crashes, such as car doors opened into the path of riders, which, if recorded, may be reported as a bicyclist fall or a crash involving a passing vehicle. Intelligence on the need for actions in the other *Safe System* elements, such as vehicle designs, infrastructure, or issues with regulations, is not captured by the CrashStats process.

In the mid-2000s TAC recognised that at all levels in the partner agencies, there was limited understanding of, and expertise in, the *Safe System* approach and the *Sustainable Safety* philosophy. For example, the VicRoads engineers, who were to have a key role in developing the *Safer Road Infrastructure Projects (SRIP)* version 3 (2007 – 2016) for the *Arrive Alive* strategy, had little understanding of the profound change in engineering thinking that was necessary to support the *Safe System* approach (Cockfield, 2014). Instead of designing for mobility for drivers, with ‘secondary’ safety as an add-on, the engineers needed to give priority to designing for ‘primary’ safety, that is, to avoid injuries (Pattinson & Thompson, 2014).

Over almost two decades, the TAC has, however, developed significant expertise in *Sustainable Safety* and has sought to develop expertise in partner agencies. For example, the TAC has funded study tours to Sweden, the Netherlands, Denmark, and England (countries that were top global performers in terms of low traffic death rates per 100,000 population). The first tour group included two TAC professional officers, two VicRoads traffic engineers responsible for developing SRIP3 projects, and the MUARC professional who was to have oversight of project evaluations (Corben et al., 2009). The participants returned with many ideas, mostly for motor traffic, but including some ideas for bicyclists, such as 'bike boxes' at intersections (Corben et al., 2009). Transport Accident Manager M6 said that on their return the VicRoads traffic engineers were enthusiastic, but had difficulty convincing their executives to give

priority to safety measures over community and political demands for improved mobility.

Managers in TAC realised that managers and executives in partner agencies were talking about *Vision Zero* but had no idea what ‘*Sustainable Safety*’ meant. The TAC managers could see that for systemic change, a groundswell of support would be needed, particularly within VicRoads. M6 gave the example of the ongoing resistance to requiring drivers to approaching urban intersections at a safe (slower) speed, as distinct from the zoned speed on the preceding road section.

In 2012 the TAC hosted a second tour to expose senior managers to *Sustainable Safety* principles and practices (Cockfield, 2014). With an overt focus on improving the safety returns from *Safer Road Infrastructure Program* (SRIP) funded by the TAC, the tour covered road and roadside safety for all road users in both urban and rural areas; it included but was not focused on city cycling. The infrastructure measures for motor vehicles, such as wire rope safety barriers on high-speed roads, were readily understood. However, for urban areas, the northern European safety cultures, that prioritised the safety of people (bicyclists and pedestrians) in designs over the mobility of motor vehicle occupants proved difficult for participants to assimilate. The authors of the internal report on Victorian TAC 2012 Safer Road Infrastructure Program (SRIP) northern European study tour, noted the importance of leadership in the cities that transformed into a ‘calmer’ traffic environment. The TAC tour participants heard how, in Europe, leaders had persisted with new ideas against initial active community opposition, and that community sentiment did not support change until after the majority had experienced the changes for themselves (Healy et al., 2012).

In 2013 to build a supportive cohort for road safety and the pursuit of *Vision Zero* a senior executive study tour was arranged for leaders from each of the Victorian Road safety partner agencies, together with representatives from Local Government. Two of the participants from the executive study tour were interviewed for this research, and they demonstrated a very good understanding of *Sustainable Safety*. Unfortunately, however, they then moved on to other senior positions, pointing to the challenge of developing institutional depth and expertise in *Sustainable Safety*. It is also noted that in Europe at the time of these study tours it was not appreciated that the *Safe System* and

Sustainable Safety approach had been unduly shaped by an unconscious bias to injuries from motor vehicles (Stipdonk & Bos, 2014).

In developing the 2016-2020 *Towards Zero* strategy, the TAC canvassed local issues in community forums, such as one in the Melbourne CBD in 2015. Several possible improvements to bicyclists safety were raised in the *Towards Zero* consultation document and consultation sessions⁷⁹, including:

- raised pedestrian platforms across minor roads at intersections
- control of turning movements at intersections to separate cyclists from turning traffic
- traffic calming in local streets to slow motor traffic
- bicycle (only) paths
- separated/protected bicycle lanes on roads with traffic operating above 40 km/h
- advocacy for vehicle technologies to prioritise the safety of vulnerable road users over car occupants as occupant safety has already been greatly improved

(State Government of Victoria, 2015) p.21

None of the above measures were, however, included in the final (2016) strategy which focussed on vehicle occupant safety, acknowledged that bicyclists are very vulnerable, and promised ongoing research and education campaigns to promote cycling safety – but with no new funding. The strategy thus reflected a very narrow Victorian Government view on road safety and did not advance safety for bicyclists.

In the Road Safety Partnership, VicRoads had a key role in implementing road safety engineering measures on main roads and had control over speed zones on all roads, including on local (municipal) streets. VicRoads and its predecessor organisations (Country Roads Board, Road Construction Authority) were powerful champions for motorised mobility⁸⁰.

⁷⁹ In 2015 I attended the *Towards Zero* community consultation forum held at the Melbourne Town Hall.

⁸⁰ In early 2019 the functions and staff of VicRoads were absorbed by the new Department of Transport

VicRoads had however prepared and contributed to numerous guides and advisory material for bicycling. Some 461 documents were identified relating to bicycling, including over 50 technical guides (VicRoads website, 19/02/2018). VicRoads also contributed to national Austroads guides, covering: Road Design, Traffic Management, Road Safety, and Transport Planning, as well as construction, maintenance, and operation practice. Technical and research reports on bicycling had also been published, including a separate collection *Cycling Aspects of Austroads Guides* (2017). All these guides were, however, non-binding. Many guides also appeared to implicitly prioritise motorised mobility and safety for motor vehicle users, over the safety needs of non-motorised road users (bicyclists and pedestrians)⁸¹. Municipal Traffic Engineer M1 said he found the local guides of little use as they reflected out of date thinking and lamented that ‘there is no longer any specialist bicycle-related engineering support available from VicRoads’. Local guidelines were also found to offer some advice that conflicted with international research on bicyclist safety (Patterson, 2010).

As there was very little funding for implementation, the published guidance was rarely put into practice. For example, the VicRoads *Design Guidance for Strategically Important Cycling Corridors* (2016) acknowledged that on roads with motor vehicles operating at speeds above 30 km/h, that is most roads, it is desirable to provide either protected separated lanes or on-road segregated lanes and recommends off-road facilities, but these measures were rarely implemented. Over many years, the VicRoads Metropolitan regions with no specific budget allocation for bicycle infrastructure made little progress on the Principal Bicycle Network (PBN) in the Inner Area.

It has been observed that in Australia, bicycling as transport has been ‘short-changed’ (Pojani et al., 2018). The Victorian government’s investment processes in the Inner Area have neglected bicycling in the Inner Area, with expenditure on bicycle-related programs held to very low levels (Carey, 2016; Pojani et al., 2018). Senior Victorian MP (M7) said that with strong competition for funding from some 30 policy areas, across 22 different portfolios, without highly placed political champions it is very hard

⁸¹ In 2019 Austroads updated the guides to integrate and incorporated the Safe System approach.

for bicycling to get funding ahead of areas like social housing, prisons, freeways, public transport, and railway level crossing removals.

In the study area in 2010, the Victorian Government committed to only four projects as part of the \$11.5 million program. By 2014-15 the commitment for cyclists in the inner area fell to \$3.8 million for on-road provisions (equivalent to a per capita yearly spend of \$8.52), and only one separate (shared) path, the Darebin Yarra Trail (National Cycling Strategy Implementation Reports, 2012, 2015 and 2016). In the 2018 Victorian Government budget a mere \$22.7 million over four years was allocated for the whole of Victoria for bicycling and walking combined. Only one minor project, a bike crossing, was proposed for the inner area – representing a per capita expenditure of less than \$1 per year.

Other significant actors have however taken an interest in bicycling, including the motoring association, the Royal Automobile Club of Victoria (RACV); the business community through the Committee for Melbourne; and various university planning, design, engineering, medical and public health departments.

One promising action by stakeholders is to proactively provide for the safety of bicyclists around major construction sites in the inner area (Pattinson, 2017). In May 2017 the Melbourne Metro Rail Authority (MMRA) invited community consultation on caring for vulnerable road users during construction. The Director, Health and Safety of the MMRA saw the need to provide for safe access for pedestrians and cyclists around construction sites and was keen to learn from the experiences in Europe⁸². With several large projects in east coast Australian cities (Melbourne, Sydney, and Brisbane), truck safety was identified as a national issue. The MMRA Director said that the construction industry looked to the State and National governments to provide uniform requirements, for example, in the design rules for trucks, so that construction companies could cost-effectively improve the primary safety of the heavy vehicles used, without the unnecessary burden of different safety requirements between projects and states. Some

⁸² I provided a copy of my paper on Trucks and Bikes: Sharing the Road which included suggestions on improving safety around construction sites (Pattinson & Thompson, 2014)

of the early efforts of the MMRA and stakeholders were however met with political opposition. When the City of Port Phillip identified an opportunity to provide protected bicycle lanes in St Kilda Road – a key bicycling corridor in the south of study area where major works were to occur – the proposal was summarily rejected by Roads Minister Luke Donnellan and the Premier, Daniel Andrews⁸³. The Premier was very dismissive and said, on radio 3AW on 14 April 2017, ‘we won’t be having any of that’.

Municipalities

Municipalities are responsible for the extensive length of local streets, intersections, and parks, and have a key role in improving safety for bicycling. Every four years, after the election of a new council, a Council Plan is prepared that includes: strategic objectives, strategies for achieving the objectives, monitoring indicators and strategies for financing implementation (Victorian Local Government Act, 1989). Each council is also required to develop a plan to create safe environments, increase active living and wellbeing (Victorian Public Health and Wellbeing Act, 2008). Responding to the needs of bicyclists is, therefore, a small part of the wide-ranging responsibilities and competing objectives faced by councils. Individual councils also face significant funding constraints, including local pressures to keep rates low and ‘rate capping’ imposed by the Victorian Government in 2015. A further ongoing constraint is local politics, with preservation of on-road car parking a highly emotional issue. M1 explained that local politics effectively dictates that projects for bicycling must not involve any loss of car parking.

Most of the improvements for bicycling in the Inner Area have, however, been implemented by municipalities. For example, prior to 2010, the City of Yarra provided infrastructure improvements ‘to the on and off-road bicycle network through the annual capital works allocations under the Council Plan and other Council and State strategies’ (City of Yarra, 2010b). The Municipal Traffic Engineer (M1) said that Yarra started with easy measures such as painted bicycle lanes on wide streets, which brought more riders onto the roads. Since 2010 Yarra has also spent about \$300,000 per year on

⁸³ See: <http://www.portphillip.vic.gov.au/st-kilda-rd-safety-improvements.htm>

bicycle projects, plus continuing improvements through annual road maintenance, including reduction of motor vehicle lanes to 2.5 m width, and progressively upgrading bicycle lanes, including at some intersections.

Traffic Engineer M1 saw Yarra council, together with the City of Melbourne, as early leaders in change, showing what could be done for bicyclists. Traffic Engineer M1 cited the success of the City of Melbourne, who, after eight years of persistent campaigning, gained approval to reduce the speed limit on CBD streets to 40 km/h from the national default limit of 50 km/h. Then, in 2012, Yarra had no difficulty in getting approval from a relatively junior VicRoads officer for 40 km/h speed zones for streets which had been 'traffic-calmed'. More recently, the City of Port Phillip has also achieved significant improvements for bicycling through local area traffic calming and reduced speed limits. Municipalities have shown that significant change can happen, often led by individual councillors and officers. For bicycle-related expertise, municipalities are though often dependent on very few staff, sometimes only one person.

The IMAP⁸⁴ municipal grouping, established in 2005 by the then Victorian government, collaborates on shared interests, like the liveability of the inner area and improved conditions for bicycling. The group now includes the five inner Melbourne councils: Melbourne, Port Phillip, Stonnington, Yarra, and Maribyrnong, that make up the Inner Melbourne study area. A secretariat provides administrative support, but for technical staff it relies on the municipalities or consultants. For example, IMAP commissioned a *Review of the Priority Bicycle Network* (Bicycle Victoria, 2008) which found that significant additional infrastructure was required for bicycling, but no mechanism for funding the needed infrastructure was identified.

Within the IMAP municipalities there has been a decline in funding for bicycle infrastructure (Carey, 2016). In 2010 the municipalities were spending, per resident, between \$4.64 (Stonnington, lowest) and \$20.04 (Yarra, highest) (Bicycle Network,

⁸⁴ In 2005-06 I liaised with the IMAP group when working at the then Department of Infrastructure.

BiXE, 2011). By 2016, per resident expenditure had fallen to between \$2.56 (Maribyrnong, lowest) to \$13.32 (Melbourne, highest).

The current IMAP Action Plan 2016 – 2026 proposes wide-ranging actions across five goals with 26 strategies. Under Goal 2 for ‘a connected transport network (that) provides real travel choices’, there are several strategies that would improve safety for bicycling (Inner Melbourne Action Plan, 2016). However, with minimal financial support from the State government, funding for implementation must come from the individual municipalities, the level of government with the least resources, and any funding for bicycling must compete with other programs such as for parks and community services.

In summary, the process of decision making on safety for bicyclists is fragmented across the three levels of government, under-resourced, often marginalised, and based on questionable design standards and with inconsistent implementation. Strategies have proliferated but implementation has been poor.

7.4 Content

This section discusses three aspects of content, the *Safe System* elements of infrastructure, behaviour, and vehicles. The findings that follow discuss each element individually, but the three elements work in combination to produce safety outcomes.

Infrastructure

The infrastructure available to adult bicyclists in the inner area is predominately shared: road space shared with motor vehicles; and off-road paths where pedestrians usually have priority.

The two categories of roads available to bicyclists are:

- State arterial roads (except that bicyclists are excluded from freeways and tollways)
- Municipal local roads: local streets, including service roads beside arterial roads, and distributor roads.

A strategic network, a Principal Bicycle Network (PBN) was proposed in 1994, but 25 years later, remained largely incomplete, as can be seen from the many missing sections

shown in red, in Figure 7.5. Tracey Gaudry, the chief executive of the Amy Gillett Foundation noted in 2012 that only one-third of the network was complete (Cooper, 2012)



Legend: Blue are Existing, Red are Proposed

Source: VicRoads Open Data 2015

Figure 7-4 Inner Area PBN

Problems with the PBN, from a *Safe System* perspective, included that many routes were on arterial roads with traffic operating at or above 60 km/h; and off-road paths were typically to a low standard (narrow). The pre-occupation of VicRoads with a PBN based on arterial roads neglected the potential of and need for local routes, particularly on distributor streets, to provide a finer-grained network. The Police Coordinator M12 recalls how, after more than 20 years, the inner-city infrastructure was unprepared for the 21st centuries growth in cycling: ‘the demand expanded so quickly that the infrastructure was not there’. There are, however, no easy solutions on collector/distributor roads as some contain trams, some are bus routes, and most have kerbside parking and are zoned for 60 km/h. Also neglected is the systemic safety problems for bicyclists at local street intersections, where many injuries occur.

The slow progress on bike routes was described by Instructor M2 as: ‘unbelievable ... ‘green’ bicycle lanes would sometimes go for only about 30 m then stop in the middle of no-where’. Similar concerns over infrastructure were stated to researcher M4 by beginner-level women cyclists for whom:

bicycle infrastructure was a mess, very difficult and challenging to get from point A to point B without having to mix with traffic. If a path was available, it was very difficult to get to the path without mixing with traffic

Healy et al. (2012) proposed an alternative and comprehensive approach⁸⁵, involving a fundamental re-think of road infrastructure based on Dutch *Sustainable Safety* (see Table 2-3 above) suggesting road managers:

- describe how each road or street type should be ideally designed to ensure the safety of all its likely road users, considering road user vulnerabilities, common crash types and safe travel speeds
- make pragmatic decisions as to how best to move towards the ideal (prototype) road and street 'types'
- systematically implement change as resources become available, including the integration of safety improvements in cyclical road maintenance programs

Source: (Healy et al., 2012, p. 14)

Instead of the *Sustainable Safety* approach advocated by Healy et al., VicRoads continued with an arterial road management initiative, the *SmartRoads* plan (2011). The *SmartRoads* plan aimed to improve motor traffic flow and reduce delays for pedestrians by assigning priority to different modes of transport at different times of the day. ‘Safety’ was listed last of six objectives, there were no objectives for bicyclists, and the plan did not explicitly support *Vision Zero*.

As noted above, it is standard practice for infrastructure used by bicyclists in Inner Melbourne to be shared with other users. In the view of M1, shared pedestrian and bicyclists paths may have been suitable years ago when they were built, but not now. On arterial roads, bicyclists share space with motor vehicles, including trucks and buses,

⁸⁵ The approach proposed by Healy et al. appears to have been largely ignored but may be revisited as understanding of *Sustainable Safety* increases.

travelling at speeds at and above 60 km/h⁸⁶, often in lanes compromised by car parking or turning vehicles, as illustrated in Figure 7.5.



Source: Author

Figure 7-5 Inner Melbourne, arterial road bike lane

Some ‘Copenhagen lanes’ have been provided, with parked cars moved to adjoin the traffic lane and with the kerbside lane resurfaced, as shown in Figure 7-6⁸⁷. Such treatments have, however, met with community opposition because of the negative effects on streetscape amenity through the loss of heritage cobbled bluestone gutters.

⁸⁶ Impacts with motor vehicles travelling over 30 km/h are usually fatal for unprotected road users (McLean et al., 1994).

⁸⁷ The street shown, Swanston Street, is officially a local street (under the control of the municipality) but effectively functions as a main road and is a very busy tram route.



Source: Author

Figure 7-6 Melbourne 'Copenhagen'⁸⁸ bike lane

Cycling Trainer M2 observed: 'if we are going to 'Copenhagenize' why are we doing a half-baked version that neglects intersections'. In the Inner Area, wide local streets, and intersections with roundabouts present significant challenges. At intersections, safe sharing of road space is made difficult by high motor vehicle speeds and often aggressive driver behaviour that effectively denies bicyclists their legal status as road users. Municipal Traffic Engineer M1 said that in the municipality of Yarra, crashes involving bicyclists were concentrated at a small number of local road intersections, mostly with roundabouts, where it appears that most crashes are caused by motor vehicles hitting cyclists who had the right of way. Indeed, most recorded injuries to bicyclists occur at intersections, and most occur at 'local' uncontrolled intersections and roundabouts (Pattinson & Whitzman, 2013) (Boufous et al., 2010).

⁸⁸ The Melbourne 'Copenhagen' lanes are a local adaption, implemented at a fraction of the potential cost of an exact copy.

The enthusiasm of Victoria's Road Safety Partnership for roundabouts demonstrates the priority given to traffic movement and motor vehicle occupant safety over bicyclist safety. Conversion of more intersections to roundabouts in urban areas remains part of *Vision Zero*, because of the secondary safety advantages of reduced injury severity for occupants in a motor vehicle to vehicle collisions (State Government of Victoria, 2016).

The Municipal Traffic Engineer M1 and Consultant M 13 expressed concern over Australian design guidelines for roundabouts that provide large radius centres and prioritise motor vehicle speed over bicyclist safety. These concerns were confirmed by Cumming who found that in the inner area, 17 to 21% of all injuries to cyclists were at roundabouts, with most crashes (probably) caused by drivers not giving way to cyclists (Cumming, 2011). A subsequent Austroads Report (2014) found that Australian design practice results in roundabouts in urban areas that encourage drivers to speed and not check for other road users, compared to approaching with caution at an 'equitable speed' of no more than 25km/h (Wilkie et al., 2014). Consequently, Australian roundabouts are the most challenging form of intersection for cyclists (Wilkie et al., 2014).

Based on M1's experience, as motorists often do not give way to bicyclists, in Inner Melbourne:

it would be a very big gamble to provide crossings or other facilities on which cyclists have priority (under the traffic regulations), without separation in time or space.

Local streets in Australia are subject to a default speed limit of 50 km/h unless zoned otherwise, but many local streets are now zoned as 40 km/h or lower, while most collector roads are zoned at 50 or 60 km/h. Parked cars often present additional safety issues. The tension between lower (safe) speed and motorist mobility was illustrated in the 2011-2012 *Victorian Speed Limit Review* that recommended increasing the speed limit on most Collector Roads to 60 km/h 'to improve mobility' (VicRoads, 2012a, p. 22) The Victorian Government's 2015 *Vision Zero* discussion paper noted that the safe – maximum survivable – impact speed is 30 km/h for unprotected road users, a fact that had been known for several years (State Government of Victoria, 2015).

On local roads, the five IMAP municipalities have each sought to improve safety for bicyclists. For example, Councillor M10 said Yarra Council has demonstrated what can be achieved over a relatively short time through a ‘one community’⁸⁹ approach to their local roads which considers bicyclists in routine maintenance, rehabilitation, and area traffic calming. Hazards remain, however, including the ubiquitous blue stone kerb and channel, street trees, and parked cars, see Figure 7-8.



Source: Author

Figure 7-7 Kerbside Inner Melbourne local street

Local challenges M1 spoke of were extensive on-road parking, high-speed motor vehicles and a small number of bicyclist commuters who ride at high speed. For design ideas, Municipal Traffic Engineer M1 said he has looked to Copenhagen practice as documented for the USA Design Guide for cities (National Association of City Transportation Officials (NACTO), 2012) but adaption was not straight forward, particularly at intersections with trams, as Copenhagen has no trams and very few

⁸⁹ In the delivery of specific services, each council area aims to, where appropriate, support other Council services; that is, road maintenance and rehabilitation work is adjusted to support bicycle safety.

American cities have trams. He had found it most challenging to adapt the Copenhagen style protected bicycle lanes to accommodate the local constraints of preservation of car parking and providing safety for high-speed commuter cyclists who are placed at risk from turning vehicles if they suddenly emerge from behind and beside parked cars.

Despite these hurdles, over the period of this research, several councils have made progress on providing a lower speed environment on many of their local roads. For example, in the City of Port Phillip, about 70% of local roads have a 40 km/h speed limit (City of Port Phillip, 2018). The experience of Traffic Engineer M1 in the City of Yarra was, however, that 40 km/h was too fast to reduce injuries to bicyclists, yet there was community resistance to providing a safer (for bicyclists) 30 km/h speed environment. The City of Melbourne has some sections at 30 km/h, and in 2017, Yarra Council, with support from the TAC and VicRoads, commenced a local area trial of a 30 km/h speed limit, including the effect of 30 km/h signs alone, that is without traffic calming infrastructure⁹⁰. In 2019 it was reported to Yarra Council that speed reductions had been achieved:

residents affected by the trial increased their level of support by 15% and there was also an increase in resident's willingness to see the 30 km/h speed limit more widely adopted in local streets in the municipality'.

(Yarra City Council, 2019) Agenda p. 104.

Any permanent change to the speed limit, however, now requires the approval of the DoT.

Vehicles

This section discusses three aspects of vehicles that impact on bicyclists safety: the diverse mix of vehicular traffic; motor vehicle design for occupant safety; and bicycle design.

⁹⁰ The target group for the Yarra trials was pedestrians, although the safety of bicyclists and motor vehicle users are also likely to be improved, including at intersections within the local areas.

In a system with shared infrastructure, bicyclist safety is strongly influenced by the design and use of motor vehicles. An issue for bicyclist safety in Melbourne is the number of heavier SUV's and high volumes of trucks mixing with bicyclists⁹¹. The high volume of trucks in Inner Melbourne is a consequence of the traffic for nearby busy ports⁹², traffic to and from major projects (see earlier discussion), and redevelopment sites. Trucks in Melbourne have very few restrictions on movement via a comprehensive Heavy Vehicle Network⁹³ that is the most permissive of any capital city in Australia. Two informants pointed to problems with construction trucks serving sites in Inner Melbourne: poor traffic management at some sites, and the time pressure on drivers who are paid per trip – with the incentive to get more loads delivered rather than operate safely.

Trucks in Australia, built to the Australian Design Rules, provide inferior primary safety to that required in the EU and Japan – for example, by continuing to allow trucks with near-field 'blind spots' such that bicycle riders cannot be seen (Pattinson & Thompson, 2014). With proven measures used in the design of trucks in the EU and Japan, the reluctance of the Australian government to mandate visibility and underrun protection on Australian trucks appears to reflect industry opposition (Rechnitzer & Grzebieta, 2014). For passenger vehicles, controls over window tinting to enable communication between bicyclists and drivers have not been established.

Vehicle safety measures in Victoria's *Towards Zero* strategy are implicitly framed as being directed to passenger vehicle occupant safety rather than reducing injuries to people 'outside' the vehicles, that is, neglecting vulnerable and unprotected road users

⁹¹ The interaction between trucks and bicyclists was an initial focus of this research (Pattinson & Thompson, 2014).

⁹² The port activities include 34 commercial berths distributed among river wharves, five docks, Station Pier, and the Gellibrand Pier, and contains two international container terminals (World Port Source, 2019).

⁹³ www.vicroads.vic.gov.au/business-and-industry/heavy-vehicle-industry/heavy-vehicle-map-networks-in-victoria

who may be hit by vehicles⁹⁴. The TAC in their 2016-2020 strategy, and informant M18 looked to future smart technology to minimise crashes, including with bicyclists. The Assistant Commissioner of Police said he believes the experts, that:

Vision Zero is going to be achieved; it is only a matter of time, not through anything else other than advances in technology. Cars, through technology, will not crash into other cars, will not crash into infrastructure, and will rarely crash into vulnerable road users and if they do, the severity of injuries will be reduced.

M18 highlighted the vehicle safety leadership of the Volvo company whose vision for crash avoidance is that by 2020 no one will be killed or seriously injured in or as a pedestrian or bicyclist by a Volvo⁹⁵. That is, the Volvo company is leading on safety while governments are following.

The bicycle as a vehicle is also a neglected area of *Safe System* practice in Melbourne. Police Coordinator M12 said that he could see how safer infrastructure, better rider training and possibly rider licensing, could assist bicyclist safety but did not know of improvements in the bicycle that would assist with safety. Bicycle Cycling Teacher M2 has, however, found that the first problem many women face is buying a suitable bicycle, that is, not a road bike or BMX or mountain bike, one that has brakes that they can operate, can be used to carry shopping, or go out with friends and family. She notes that most bicycle shops in Melbourne are set up and staffed by men for male bicyclists. Yet bicycle shop owners concede that as many as 40% of bicycles are sold to women. Also, unless a customer is prepared to spend \$2000 or more, most staff are not interested in finding a bicycle that is a good fit (in terms of leg and body length) for a customer. M2 described most bicycle shops as being 'a boy's own world' that women find 'really intimidating'.

An increase in the diversity of bicycles in use in Inner Melbourne has been observed, including more E-bikes used for local deliveries and with a safer design that includes

⁹⁴ I raised this issue at the TAC consultation forum in Melbourne in 2015

⁹⁵ The effect of new vehicle technologies can be significant in the short to medium term as they can influence the operation of nearby vehicles and are driven more than older vehicles.

wide tyres – that won't get caught in tram tracks, and a more stable low seating position such that riders can easily put their feet on the road.

Behaviour

At the national level, the *Australian Road Rules* (Australian Transport Council, 1999) that guide traffic regulations, have not been aligned with European best practice.

Municipal Engineer M1 commented that 'have not moved with the times, as there are now more cyclists now than 20 years ago'.

In Victoria, the approach to road safety (to reduce deaths and injuries) has a long history of understanding trauma as a consequence of unsafe behaviour, with heavy fines and enforcement seen as the way to reduce the road toll. For example, Senior Victorian MP M7 said the biggest thing for cyclist safety in Melbourne would be the promotion of safer driver behaviours.

Police Officer M12 said police undertake enforcement to protect vulnerable road users by raising awareness of the risks of some driver behaviours, such as inattention when using mobile phones. Trainer M2 observed that better education of both bicyclists and drivers is needed: 'it goes both ways'. Police Officer M12 said road users need to be alert and very vigilant, as 'even at a speed as low as 40 km/h things can go wrong very quickly'. In the experience of the Police Coordinator M12:

drivers don't understand their obligations to vulnerable road users...car drivers will think about and be considerate of other drivers, for example waving a car through when they are stuck in traffic, but they do not think about the possible effect this could have on a cyclist in the bicycle lane. They will also sneak out at a stop sign without checking for cyclists, a move a cyclist will not expect and have no time to respond to.

Police Officer M2 also said both sides are neglected in education: 'we do not educate our cyclist, and we do not educate our drivers' (about cyclists).

In Police Officer M12's experience, all groups of road users lack an understanding of the needs of other road users. 'You hope that drivers keep learning, that as they see cycling increasing, they will become a bit more aware'. To reduce road trauma, he said:

everybody needs to see that they have a contribution to make, as a motor vehicle driver, as a cyclist or as a pedestrian. Rather than thinking of cyclists, car drivers, truck drivers, or motorcyclists, they need to think of them as people, we really need to bring back the human side of things rather than their mode of transport...driver's attitudes towards cyclists and cyclist's attitudes towards car drivers, both need to change.

However, driver training and licensing, such as the VicRoads Learner Permit test, does not teach drivers to see cyclists as legitimate road users. The on-line test was found to have a maximum of three questions (randomly generated) that include bicyclists, and there was no question as to the legal right of bicyclists to use roadways⁹⁶. Also, in the test scenario diagrams, road vehicles were exclusively shown as motor vehicles. With a pass mark for the test of 78%, it is possible for a learner driver to fail all questions relating to bicyclists and still receive a learner permit and a license.

Police Executive M11 believes we need to develop a holistic outlook, for example, at intersections where much urban road trauma happens; bicyclists need to obey stop signs, drivers need to look out for cyclists, and everyone needs to understand that others are legitimate road users. That is, a co-operative attitude and understanding between road users could immediately improve safety, but attitudinal change is very unlikely to be achieved by the traditional coercive approach.

For riders, knowing how to ride and behave is obviously important. M17, who rides most days to work, has observed that many riders 'do not know how to ride a bicycle in traffic'. The Cycling Trainer M2 also said that adults returning to or beginning cycling are expected by their peers to be able to cycle. It was hard for them to learn about riding in Melbourne as they felt like they were supposed to know how to ride, but if they had learnt to ride a bicycle, for example in Bicycle Ed in primary school, it was as a child in a controlled environment. Most of the women who come to her tended to be in the 35 to

⁹⁶ www.vicroads.vic.gov.au/licences/your-lic/get-your-lic/lpt/lptoffline

55-year-old age group, and many have never cycled, some because of cultural reasons or because their parents believed it was too dangerous for girls to cycle.

Trainer M2 observed that good infrastructure could give untrained cyclists a false sense of safety. She has also found she needs to cover practical things like helmet fitting, tyre pressure, brakes, chain, and gear use, and not using headphones. Also, learner bicyclists often do not have essential skills, like how to start and how to stop safely, which she estimated 90% could not do, which makes negotiating intersections and other stops dangerous for them. For people who have purchased road bikes, clip-in pedals can also be a challenge. M2 was frustrated that a single basic safety lesson that could do so much for safety outcomes is not included with the sale of a new bicycle. Activist M9 said he would like to see the option of an orientation course, roadcraft or buddy system available to adults returning to riding or taking up riding as transport.

Researcher M4 also said that most learner bicyclist participants in her study did not know what to do as riders beyond that they were supposed to wear helmets. They knew the road rules as drivers but not as bicyclists. Trainer M2 made a similar point, saying that covering the road rules for bicyclists is important as most people have not thought through what the road rules mean for a cyclist.

Trainer M2 asserted that most new riders do not know how to keep safe relative to other cyclists, pedestrians, and motor vehicles. Researcher M4 agreed, noting that beginner cyclists did not know if they could do hook turns, ride next to someone, where to position themselves on the road if there was no bicycle-lane, or if they could ride on the footpath when a road seemed too dangerous. It was common for beginner bicyclists to feel that the road was not a safe place for them with their low levels of skill and confidence.

Trainer M2 said that novice riders need help to pick the safest route, avoiding ‘hot spots’ and roundabouts as ‘even a single lane roundabout which can be really dangerous’. They also avoid hills, which she said is advisable as most crashes she knows about happen down-hill when inexperienced riders ‘go too fast and don’t know how to corner, although this tends to be more of a problem for men’. She has observed that quiet streets and T-junctions can also be dangerous as motorists are looking out for

cars, not bicyclists, yet negotiating the dangers of T-junctions was one of the easiest things to teach. In interacting with other traffic, it is essential that cyclists know what they are doing and do not ‘freak out if they have a truck coming from behind them’. ‘If you do not know what you are doing the truck driver cannot know what you are doing’.

Police Officer M12 said that cyclists need to understand the environment, for example, not riding on arterial roads when there are alternative bicycle paths, and not to think that just because they are riding with a lot of cyclists that they will be safe.

The link between infrastructure and behaviour was highlighted by informants. Several people had ridden in other countries where they did not feel as apprehensive as in Melbourne. Trainer M2 rediscovered cycling years ago when she rode around Denmark for several weeks and remembered that she loved riding. When she came back to Melbourne, she took her old bicycle out, but it was not the same: ‘I could not do it’. Some years later she tried again and discovered it was possible to survive on Melbourne's roads. She wishes ‘that we could pick everyone up and take them over to Christiania (the commune district of Christianshavn in Copenhagen), where it is completely different’.

As well as knowledge, bicyclists need the skills to use different types of infrastructure, a point that Trainer M2 said seems to be forgotten by the government. Safety outcomes cannot, however, be achieved by regulation and enforcement alone, hence the need for a system-wide approach.

7.5 Conclusions

This chapter has shown how multiple factors have affected bicycle travel in Melbourne. The city has a travel history where bicycles have only ever been used by a minority, an unsupportive policy context that has privileged motorised transport, a lack of resources for local transport, unbalanced investment in transport infrastructure, and an uneven, inconsistent, and fragmented approach to the three *Safe System* elements. City safety has been pursued with a bias towards the safety needs of motor vehicle occupants. These factors have resulted in Inner Melbourne not being safe enough for many people to make trips by bicycle.

The lead agency for road safety in Victoria, the TAC, together with the Road Safety Partners, have framed road safety as being about reducing death and injury associated with motor vehicle use and have mostly focused on arterial roads where dramatic fatal crashes occur. As the road safety strategies implemented over the last 40 years have been successful in reducing deaths of motor vehicle occupants, there is a degree of hubris amongst decision-makers, and an apparent reluctance to make the paradigm shift to the European concept of *Sustainable Safety*. The ethical challenge of designing the road system for *Sustainable Safety* for all road users remains to be faced. Improving safety – objective and perceived – for potential bicyclists in the Inner Area receives little attention and is yet to see a consistent commitment of funds from the Victorian government. The safety needs of potential bicyclists appear to be neither understood nor supported. Investment in transport infrastructure in Melbourne remains severely unbalanced, with enormous investment in public transport and arterial roads in contrast to negligible investment in measures for the safety of both current and potential bicyclists. The responsibility for safe bicycling thus remains mostly with the people who bicycle, and local municipal councils who, of the three levels of government, have the least resources and are not equipped to deal with vehicle or road user *Safe System* elements.

Some promising work on infrastructure for bicyclists and community education has recently been undertaken by key stakeholders including several municipal councils, and the MMRA. There is, however, significant potential for local communities to be involved in a rethink of how local roads are purposed and managed, and to drive change

for sustainability and liveability in partnership with stakeholders like the RACV, using a co-production approach. There is also potential for stakeholders from a broad constituency to exert pressure on the Victorian and Australian governments to address the neglect, in the *Safe System* approach of bicycle users, the safety by design of vehicles that interact with bicyclists, and the safety of the behaviour of riders and other road users, as I discuss in Chapter 9.

Chapter 8 Discussion of case study findings

In this chapter, I compare findings in the case study cities and discuss why Amsterdam and Copenhagen are safe enough for mainstream travel by bicycling, while Inner Melbourne is not.

The discussion is organised around the three broad themes established in section 2.6, context, process, and content. This chapter concludes with a summary of key learnings for Inner Melbourne, notes the limitations of this analysis, and suggests areas for further work.

8.1 Context

Differences in context across the case study cities and their implications for the safety of bicyclists are discussed under three sub-themes:

- history and travel
- policy adaption to the automobile age
- bicycling and city culture

8.1.1 Different histories, different travel

This section discusses the development of transport in the cities, over three periods: the 19th century, early 20th century and post WW2, to provide a context for understanding why there are the 21st century differences in the comparative popularity and safety of bicycling.

19th century

Amsterdam of the 19th century was an established and compact medieval city with a highly developed system of canals serving the port. Copenhagen, also a compact medieval city with canals was, however, different as, after widespread fire damage in the 18th and early 19th centuries, extensive areas were rebuilt with wider roads. Until the mid-19th century, in both cities, development was largely contained within fortifications, typically moats and walls.

Early Melbourne was unfortified and surrounded by open land; development was limited only by the practical distance that could be walked or reached by horse. Then from the mid-19th century, rapid population growth and suburban expansion were supported by both an extensive tram network and a significant radial suburban train system. The differences in the development of tram and train services are illustrated in Figure 8-1.

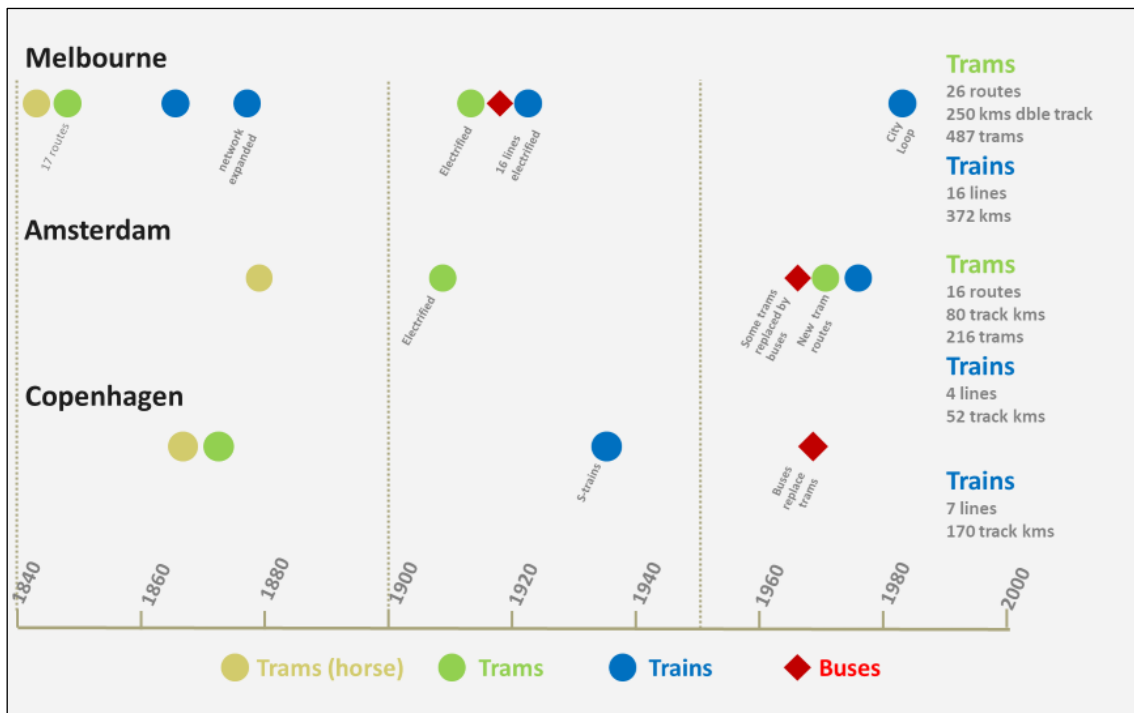


Diagram: By Author

Figure 8-1 Tram and train development compared

Tram services developed in Melbourne from the 1840s; in Copenhagen from the 1860s; and in Amsterdam from 1875. Steam-powered cable trams were introduced to Melbourne in the 1850s, and from the 1860s Melbourne also had five suburban train routes.

By the late 19th century, the three cities were of comparable population size, just over half a million in each (Biguzzi, 2014) and with similar per capita income. When the ‘safety’ bicycle appeared, circa 1885, Melbourne had been shaped by the mixed-use development along the tram lines and around the suburban train stations (Newman, 1992); travel habits were based on homes and businesses being within walking distance of a tram stop and often a railway station. By the end of the 19th century, Melbourne had

more tram routes and more trams operating than Amsterdam and Copenhagen combined. Melbourne was internationally recognised as a model transit city with a public transport system that was exceptional for its extent, cheapness, variety and efficiency (Davison, 1978, 1979 - 2004).

Each of the three cities had a significant seaport in the 19th and 20th centuries, but as ‘land-side’ port traffic in Amsterdam and Copenhagen was mostly carried on barges on the canal systems there was little freight traffic on city streets. As Amsterdam and Copenhagen had remained predominantly walking cities with only modest tram networks, high fares, and no suburban trains⁹⁷ they were a ready market for bicycle transport.

Examination of over 100 historic photos taken in Melbourne’s streets during the late 19th century revealed only 30 images⁹⁸ that featured any bicycles. Newspaper articles from the 1890s indicate that separate paths for bicyclists were contemplated in Melbourne, for example on Sydney Road (Coburg Leader, Saturday 12 May 1900, p.4), and some were built, such as a 10 feet (3 m) wide track from Brighton Beach to Sandringham (Brighton Southern Cross, Saturday 7 November 1896). Other cycle paths were informal tracks, such as in the Dynon Road reserve to the north of the City (Harland, 2016). In Copenhagen, however, separate road space was designated for bicyclists from the 1890s, while in Amsterdam, separate facilities were provided for bicyclists from around 1910.

⁹⁷ In Copenhagen there were no suburban trains until the 1930s and in Amsterdam none till the 1970s.

⁹⁸ See the 19th Century section on my Pinterest Board

<https://www.pinterest.com.au/wazza50/melbourne-street-scenes/>

Early 20th century

In Melbourne, everyone shared the roads; bicyclists with horse-drawn vehicles, motor vehicles and trams on some roads, as shown in the photo of Flinders Street Station, circa 1910, Figure 8-2 below:



Source: State Library of Victoria, Copyright expired.

Figure 8-2 Melbourne c. 1910

The danger to bicyclists from motor vehicles was demonstrated in 1905 when a car collided with and killed a bicyclist (Tranter, 2005). The first (Victorian) Motor Car Act 1909, regulated drivers and vehicles but did not impose speed limits and was described as ‘motorist friendly’ ...under the ‘influence of narratives of ‘progress’ and the desire to legislate for a ‘technological future’ (Tranter, 2005, p. 856). From the early 1900s, many politicians and other men⁹⁹ of influence in Melbourne were captivated by the technological promise of transport based on private motor vehicles (Tranter, 2005).

⁹⁹ Political and infrastructure decisions were made by men, there were no women with overt policy influence until the 1970s.

A 1911 survey located by *cycle-helmets.com* recorded bicycles as 31.8% of road traffic¹⁰⁰, but this overstates the significance of bicycle use as walking and public transport use in travel corridors was not counted. For example, in pre WW1 Melbourne, people made over 250,000 train journeys and 240,000 tram journeys per day (Laughton, 1911). With an intense network and affordable ‘second class’ fares, trams and trains were the most used means of personal travel until the end of WW2 (Moriarty & Mees, 2006). Records suggest that in Melbourne cycling only ever had niche roles: for commuters to get to suburban stations; for suburban factory workers on routes not served by rail; for travel during the great depression of the 1930s; during the WW2 rationing of fuel; and for school children.

A case to provide for bicycling and to learn from the Netherlands was argued in 1937 by the internationally famous cycling champion and experienced transport bicyclist from Melbourne, Hubert Opperman, who called for cycling infrastructure – wide separate cycle tracks at the side of main arterials. However, his calls were ignored (Adelaide Advertiser, Tuesday 5 January 1937).

100 The recorded road traffic mix was: one-horse carts 4,053; two-horse wagons 835; cabs, buggies, etc 2,280; motor cars 762; motorcycles 261; bicycles 3,822) The Reporter, 1911.

In the first half of the 20th century in Amsterdam and Copenhagen the take up of bicycles was enthusiastic, and bicycles came to dominate the city streets, (Buiter, 2013; Jensen, 2009), see Figure 8-3 below:



Source, Jensen 2009, Copyright expired

Figure 8-3 Copenhagen c.1940

From early in the 20th century, national policies influenced the mix of cars and bicycles. In both Copenhagen and Amsterdam national policies suppressed car use, but in Australia, cars were very popular and had political support. Thus, for the first half of the 20th century, in Amsterdam and Copenhagen, bicycling was the main mode of city transport, supplemented by limited tram services, while in Melbourne, the trams and trains were the most used modes, but cars were dominating the roads and political thinking.

Post WW2

In Melbourne, by 1947, motor vehicles comprised 90% of road traffic (Davison, 2004, p. 131; Moriarty & Mees, 2006). By the 1960s motor vehicles visually dominated the main roads in all three cities and most decision-makers saw cars as the future for transport. Different approaches were, however, taken to strategic planning and land use development. In Amsterdam, growth was restricted by the national government and

directed to regional growth centres, which helped to maintain an older and finer-grained urban fabric that remained conducive to bicycling.

Melbourne and Copenhagen developed similar strategies to guide urban development along growth corridors separated by green space (Harris, 2005). In Copenhagen, the ‘finger plan’ was implemented with public transport infrastructure and labour-intensive workplaces located near public transport – which moderated car use. In Melbourne, the ‘green wedges’ were reserved, but proposed public transport improvements in the growth corridors were not implemented, instead development relied on the arterial roads. As public transport was neglected, car use increased and conditions for bicyclists deteriorated.

In Copenhagen in the mid-1960s, a novel approach to managing motor vehicles evolved. The city streets were changed to accommodate more cars more efficiently by replacing trams with buses, with narrow city roads reconfigured for one-way operation, but countervailing measures were also adopted to maintain city amenity. These amenity measures included some pedestrianised CBD streets, traffic metering into the central area, parking removal and parking limitation – not done to improve safety for bicyclists – but which had that unintended consequence.

Also, from the 1960s, vocal sections in the communities of both Copenhagen and Amsterdam, who valued the historic urban fabric, successfully resisted proposals for expensive increases in inner-city road capacity. Around Amsterdam, motorways were built to remove heavy traffic from local areas, which benefitted bicyclists and pedestrians using local streets. In Melbourne, arterial road capacity was increased, which intensified conflict with other road users and reduced amenity.

From the late 1960s, concern over road deaths increased in each city, but the road safety crisis was constructed differently in each jurisdiction and in ways that profoundly influenced the safety of bicycling. In the Netherlands, a dominant concern was the deaths of 500 child bicyclists and pedestrians. The national pressure group *Stop de Kindermoord* – Stop the Child Murder – successfully campaigned for the Netherlands government to re-emphasize building of segregated, safe, and attractive cycle paths and low speed shared zones, *Woonerfs*, in residential areas. In the Netherlands, safety for

bicyclists became a national priority, and it was understood that ‘safety’ needed to be very good. In Copenhagen, little was done for bicyclists, and the main concern was for city liveability, under threat from motor vehicles. In Victoria (and Melbourne), the road safety focus was on car users¹⁰¹ and pedestrians, but not on bicyclists who were less than 4% of those killed (Arnold, 1973). Of the three cities, only in Amsterdam was bicyclists safety prioritised over that of motor vehicle occupants.

In the early 1970s, the OPEC supply of oil to Europe was cut, and emergency measures were introduced to reduce fuel use by motor vehicles, which encouraged travel by bicycle. National policies in the Netherlands limited the growth in car use, including in Amsterdam, by traffic regulations, improvements to public transport, restricted parking, and parking fees in city centres (Directorate-General for Passenger Transport, 1999). In Denmark, motor vehicle purchase and use were restrained by measures that included high taxes – 180% plus 25% VAT.

The OPEC oil embargo was followed by growing environmental concerns over excessive car use and oil dependence. Mass demonstrations in the 1970s by bicyclists in Amsterdam and Copenhagen played a role in building political support for safe bicycle infrastructure. In Amsterdam, there were big ‘sit-in’ demonstrations demanding infrastructure for cyclists. In Copenhagen, a demonstration in 1979 by more than 40,000 cyclists demanding more cycle tracks and drew unexpected support from the broader community. In Melbourne, there were protests, but these were against inner-city freeways (Sandercock, 1990). Also, in Melbourne, deteriorated public transport services from lack of investment and poor reliability from industrial disputes meant that people had come to increasingly depend on private motor vehicles (Davison, 2004, Stone, 2009).

¹⁰¹ Highly effective and internationally recognised road safety measures included compulsory seat belt regulations, drink-driving and speeding penalties.

A further difference was that by the late 20th century, while the people of Amsterdam and Copenhagen could remember times when bicycling was dominant, in Melbourne few people could recall times when bicycling had been significant.

8.1.2 Policy adaption

As described in Chapter 7, development in Melbourne after WW2 was led by road projects. Bicycling was ignored and there were few decision-makers who understood bicycling as travel for adults. Although bicycles had some niche uses, such as for children to ride to school or adults to ride to train stations, road danger and bike theft were deterrents to bicycling.

After WW2 policy decision-makers and planners in most western cities were pre-occupied with automobiles city, including in the case study cities. The policies to adapt to the automobile challenge, however varied in their impact on the safety of bicycle use. Key differences are interpreted in Table 8-1 below.

Table 8-1 Adaption and bicyclist safety from the 1980s

Context factors	Amsterdam	Copenhagen	Inner Melb.
Vision, responding to understood needs, with a clearly articulated role for bicycling	Strong	Strong	Weak
Integrated planning and comprehensive regional plans that included road safety	Strong	Strong	Poor
Management of demand for travel by private motorised vehicles	Strong	Strong	Negligible
Lived experience, understanding that bicycles and cars can co-exist with sharing of space at low (safe) speed on local streets and separation on 'traffic' roads	Strong	Strong	Very low
Pressure from bicyclists	Strong and significant	Strong and significant	Moderate but small numbers
Community support	Strong	Strong	Low

In Amsterdam the safety of bicyclists was supported by a long-term vision and commitment across all levels of government, known from the 1990s as the *Sustainable Safety* approach. Adaptive changes to policy for the automobile age in Amsterdam thus recognised the value of travel by bicycle, decades before Copenhagen and Melbourne –

where the value of bicycling is yet to be recognised. In Copenhagen, safety for bicyclists was unintentionally improved by measures to protect inner-city amenity. In Melbourne, policies that reflected 'path dependence' continued to support private motor vehicle use (Low & Astle, 2009). Redevelopment in the Inner Area of Melbourne rarely if ever considered providing safe infrastructure for bicyclists.

As the reported crash statistics, used as the evidence base for policies and programs, recorded relatively few injuries to bicyclists, trauma to bicyclists was not recognised as a significant issue. That these reported injuries significantly underestimated the injuries to bicyclists was not acknowledged. Also, the focus was on state-wide concerns, such as drink driving and speeding. Consequently, there were very few road safety measures for city bicyclists. Also overlooked was the potential benefit from encouraging low-harm and highly efficient travel by bicycles in cities.

In Amsterdam and Copenhagen most of the population, including planners, engineers, and politicians, understood bicycling. People grew up using bicycles and understood bicycling as a pleasant experience and convenient means of travel. In Amsterdam, and to a lesser extent in Copenhagen, there was the political reality that many people had kept cycling in numbers that could not be ignored. In Melbourne however, there were very few people using bicycles for travel as car use had been enthusiastically embraced and dominated the public discourse.

A final and key factor in the policy context was for the support (or lack of it) for safer bicycling by the 'silent majority' who used motor vehicles in each city. In Copenhagen in the 1970s through to the 1980s, there was majority support for better conditions for bicycling, revealed in response to demonstrations, media surveys and then the Bicycle Account (City of Copenhagen, 2012). In Melbourne, support for safety for vulnerable road users (not only bicyclists) was not evident and may only recently be building as part of broader liveability¹⁰² and sustainability concerns.

102 For example, the trial of 30 km/h speed limits in some inner-city precincts supported by the TAC and City of Yarra, but the lower speed limits are proposed to improve pedestrian safety and amenity (Fildes et al., 2017).

8.1.3 Bicycling and city culture

Perceptions about bicycle use and safety are socially constructed and shape community support. For example, bicyclists may be seen as ‘people like us’ as in Copenhagen, or as outsiders, or as ‘cockroaches on wheels’¹⁰³ in Melbourne. For an understanding of nuances in culture I drew on Hofstede’s extensive analyses of national cultural differences, (2001). Hofstede found that Australians, in contrast to northern Europeans, are inclined to celebrate individualism and competitiveness, avoid uncertainty, and show a reluctance to change. The potential consequences of these cultural differences¹⁰⁴ for city safety for bicyclists are interpreted below in Table 8-2.

¹⁰³ Cyclists – ‘Cockroaches on wheels’, Derryn Hinch, Channel Seven, *Sunday Night*, 18th August 2013

¹⁰⁴ On culture, see also Pojani et al (2017) and Pojani and Stead (2015).

Table 8-2 Cultural influences and consequences

City (Nation)	Amsterdam (Netherlands)	Copenhagen (Denmark)	Melbourne (Australia)
Cultural Influence on:			
Context Policy emphasis	Long term and strategic Social development Welfare of society	Long term and strategic Social development Welfare of society	Short term and project focused Economic growth Individual benefit
Process Decision making*	Working together as equals Accommodating others	Cooperative & engaged Pluralist Compromising	Polarised Adversarial Competitive Uncompromising Low trust in institutions
Content What is provided and how safety is produced	Look out for the vulnerable Compliance is optional High trust	Look out for each other Seek order Fewer regulations but high compliance High trust	Individualistic Look out for yourself Support the strong Blaming & punitive Low trust
Consequences for bicyclist safety	Bicyclists are 'kings of the road' Needs of bicyclists always considered Bicycling is for everyone	Road users are equals, who share and look out for each other Bicycling is part of city transport Bicycling is sensible and for everyone	Cars are 'kings' of the road Safety of bicyclists is subordinated to motorist mobility Bicycling is only for the fit and fearless

*Adapted from Hofstede (2001)

In Amsterdam and Copenhagen, bicyclists are recognised as 'mainstream'. Policies and planning for cycling occur in strategic contexts that locate bicycling as contributing to a reduction of urban problems such as congestion, and that aid social development. The policy context in Melbourne was, however, to focus on benefits to individuals, such as to reduce individual travel times by very large projects to increase capacity and reduce congestion.

In Amsterdam, where bicyclists are 'kings of the road', there is a very good objective safety supported by culture and design. In Copenhagen bicyclists feel safe as they are explicitly supported by government policies and most drivers see them as equals. By contrast, many drivers in Melbourne do not understand that the bicycle is recognised as

a vehicle, with equal rights under legislation, and some wrongly believe that riders should not be on the roads.

How bicyclists are identified, as mainstream or marginal, is indicated by clothing. Two of my informants observed, as did I, that most people riding bicycles in Amsterdam and Copenhagen were dressed for their destinations, not for the ride, like the 'lycra' clad commuter cyclists in Melbourne. In Amsterdam and Copenhagen, the mode of travel does not define a person's identity.

To summarise, Amsterdam and Copenhagen appear to be 'safe-enough' cities for bicycling in part because of the community support and associated political necessity to provide for bicycling, compared to the political power associated with the car culture in Melbourne. In Melbourne, the potential for bicycling is routinely ignored in a combative and highly politicised environment where strategic options that could include encouraging more bicycling, do not receive serious attention. The consequence for bicyclists is that their safety is habitually subordinated to the mobility of people in motor vehicles.

8.2 Process

In this section I explore the influence on safety outcomes of process dynamics and decision-making arrangements, actor support, and co-production.

8.2.1 Process dynamics

Key characteristics of local processes are how policy is developed, political leadership, and funding; these characteristics are compared in Table 8-3. The assessments, Strong, Moderate or Weak, are interpretations made from the interviews, documents, and observations.

Table 8-3 Process factors compared

Process factors	Amsterdam	Copenhagen	Inner Melbourne
Policy developed and supported through a broad public discourse; change may be led by stakeholders	Strong	Strong	Weak
Political leadership that articulates and responds to challenges, with the will and capacity to implement change	Strong	Strong	Weak
Adequacy of funding, including the possibility of hypothecation, with ongoing revenue supporting research, implementation, and monitoring	Strong	Moderate	Weak

In both Amsterdam and Copenhagen, the policy process is sensitised by the history of demonstrations by bicyclists, which led to policy responses from elected political municipal representatives at local and national levels. In Amsterdam, the decision-making processes reflect accommodation of multiple viewpoints, characterised by consensus and compromise, consistent with the Dutch ‘Polder model’¹⁰⁵. In Copenhagen public engagement is required under national planning legislation.

Decision-making processes in Amsterdam and Copenhagen are also undertaken to be inclusive, working with major stakeholders, and balancing the desire for ‘green’ growth with economic growth, and a balanced transport system for riders, drivers, and public transport users. There are, however, some tensions over the balance between provisions for cars and bicycles in both cities. For example, in both cities there is some frustration among professional planners who believed that the best technical solutions are often not achieved in the interest of accommodating multiple stakeholders, such as the (national) Police, who are keen to keep motor traffic moving. There is also annoyance amongst bicycle planners with the police power of veto over any measures that could require increased police enforcement or are perceived as possibly reducing safety.

For Inner Melbourne, the Australian Government, the level of government with most resources, has in recent decades provided no funding for implementation of bicycle

¹⁰⁵ The Polder is the low land protected by the dykes - which everyone has an interest in maintaining. The Polder is an early example of co-production. The Polder model is about coordination, cooperation and sharing for mutual benefit (Price, 2013).

measures. By contrast, in the Netherlands, the national government previously provided grants for some 40% of the investment in bicycling infrastructure¹⁰⁶ and continues to support research on issues that are likely to impact on bicyclist safety, such as autonomous vehicles, that are beyond the capacity of municipal and state governments (Threlfall, 2019).

In Melbourne, short term, year-to-year Victorian Government budgets have provided minimal and declining funding for bicycle programs. From 2012, the number of planned infrastructure projects for bicycling was cut from 22 to four (Cooper, 2012). In 2017 the Australian Bicycle Council noted that investment in bicycle infrastructure in Victoria had declined dramatically to only \$3 per capita, with very little spent on projects in the inner area where most bicycling occurs and where most injuries are reported. For Amsterdam and Copenhagen, comparative per capita expenditure is not readily determined, but estimates by Reid (2018) suggest that they each invest about 15 times what is invested in Melbourne.

In both Amsterdam and Copenhagen there is also a willingness to try new things and if necessary, to learn from mistakes (Torslov & Tiemens, 2013). An early example of a trial that worked in Copenhagen was the gradual removal of car parking from city squares that started in the 1960s, initiated by the then City Engineer – also an example of professional rather than political leadership. The experimental approach is today backed and made acceptable by quick feedback from road users, through ‘web’ surveys, that are transparently reported through the Copenhagen Bicycle Account. The municipality does not wait for crashes to occur at a location; designs are subject to road safety audits, and if riders feel unsafe, the municipality makes changes to improve safety.

In Melbourne, there is great political caution over projects for bicyclists. Also, for major projects, such as Melbourne Metro Rail and the North East Link toll road, planning processes have typically been reduced to discussion of minor details on committed

¹⁰⁶ It is to be noted that the Dutch government infrastructure expenditure in the late 2010s was however directed to improve bicycle parking and inter urban snelfietsroutes, freeways for bicyclists (Reid, 2018).

projects, which have by-passed community and municipal government engagement on strategic issues.

Main roads in Melbourne are controlled by the Victorian government through VicRoads, and apart from shared paths within arterial road reserves, there has been great reluctance to provide for bicyclists. As noted above, see Section 0, progress on a Melbourne's Principal Bicycle Network has been very slow and insignificant in comparison to what has been achieved in Copenhagen over a shorter period, see Section 6.4 above.

For the few and relatively minor projects that have provided for bicyclists, these have mostly been provided by municipal councils and restricted to local roads. Melbourne's municipalities are relatively small and have very limited resources for implementation. Also, in developing the detail for *Safe System* measures that are sensitive to local demands, such as on-street parking, municipalities do not necessarily have the capacity to devise best practice solution, the will to implement changes in the face of vocal if minority opposition, or influence over supportive *Safe System* components such as vehicle standards or road user behaviour.

Compared to the cities of Amsterdam and Copenhagen, for Melbourne's municipalities funding is a major barrier if they wish to improve infrastructure for bicyclists. In Melbourne, the capacity of municipalities to raise revenue is limited by the Victorian Government's 'rate capping' legislation, and they are denied sources of continued funding, as could be provided by hypothecation of charges such as parking space levies¹⁰⁷.

¹⁰⁷ A central-area parking levy, introduced in 2005, to 'reduce traffic congestion in central Melbourne by encouraging more motorists to regularly use public transport' has been a price (demand) mechanism (Hamer et al., 2011; State Revenue Office Victoria, 2018). Internationally, other jurisdictions have leveraged the benefits of increased funds to 'supply' alternatives to car use, providing commuters with travel options including through improvements to the safety of travel by bicycle (Goodwin, 2008).

Actor influencers

The levels of support for safe city bicycling from key actors are compared in Table 8.4, rated as strong, moderate, or weak. Melbourne rates as low on all measures, except for the support from the motoring association (RACV).

Table 8-4 Actors

Factor	Amsterdam	Copenhagen	Melbourne
Support from National Government	Moderate Previously strong	Moderate	Weak
Regional Government	Strong support for bicycling from <i>Stadsregio</i>	Moderate	Weak IMAP has a limited role
Municipal capacity and powers	Strong 17,000 employees. Municipality influences roads and city public transport decisions	Strong 45,000 employees. Shared power over most roads and city public transport	Weak Five small municipalities with a total of 4,000 employees. No power over major roads or public transport
Bicyclist groups and regard by governments	<i>Fietsberaad</i> – Strong, - well regarded	<i>Danish Cyclist Federation</i> – Strong, - well regarded	<i>Bicycle Network</i> moderate influence
Motorist group	Strong, (<i>AMWB</i>) Long term and active support	Weak, (<i>FDM</i>) Little interest	Moderate, (<i>RACV</i>) Increasing interest and support

For decades, bicycling in Amsterdam has been supported by successive Dutch governments. The regional government has also consistently promoted sustainable transport, recognising the key role of bicycling. Copenhagen has acted more independently, with tacit support from the Danish government. On some issues, however, the Danish government favours motorist mobility over bicycle safety, such as with the default urban speed limit of 50 km/h, as does the Australian government. However, with vehicle design rules, by being part of the EU, Amsterdam and Copenhagen have rules that enable safer interaction between large vehicles and riders (Pattinson & Thompson, 2014).

Municipalities have a key role in providing for safe bicycling, but there are major differences in capacity. Melbourne's small municipalities have limited powers and resources compared to Amsterdam and Copenhagen who each have significant in-house capacity with many more technical staff. Amsterdam and Copenhagen, as large municipalities with broad responsibilities, are actively involved in road and public transport investment. For example, the City of Copenhagen is a significant shareholder in the Copenhagen Metro Company and ensured that Metro carriages were designed for bicyclists – which reduces bicyclists exposure to road traffic on long trips. Amsterdam is also able to draw on technical support from national institutions such as SWOV, CROW and TNO, while Copenhagen can draw on ideas from cities in the Netherlands and Sweden.

Another difference is the degree of support from national motoring organisations. In the Netherlands, the ANWB, has for over a century, strongly supported improvements in bicycling safety. In Denmark however, the FDM has little interest in bicycling. In Melbourne, the RACV, important because of its large member base, has become a strong advocate for infrastructure to enable safe travel by bicycle in the inner area.

8.2.2 Co-production of safety

As recognised in the *Safe System* approach, safety cannot be achieved by governments alone. System safety needs the support of the three interdependent pillars: the road environment provided by governments; the vehicles provided by manufacturers; and the behaviour of road users. Co-production, as described by Alford (2014), is beneficial where there is interdependency between governments and citizen clients, as with road safety; or where action is more effectively undertaken by citizens, as is the case of voluntary compliance rather than intense and expensive enforcement.

With co-production:

- governments provide a framework for co-operation, suggest the desired behaviour, and articulate the motivation – the value to be achieved by citizens through co-operation
- provide system support
- equip citizens with the operational capacity to contribute to safe outcomes

Co-production already occurs to varying degrees in each city, as assessed in Table 8-5.

Table 8-5 Safety co-production rating

	Amsterdam	Copenhagen	Melbourne
Framework for co-production	Strong	Strong	Weak
System support	Strong	Strong	Weak
Population capacity	Moderate	Strong	Weak

In Amsterdam, the comprehensive *Sustainable Safety* approach, that operates across all levels of government, is a framework for co-production. In Copenhagen the framework is provided by the municipality who have motivated the community to work together, for example, by the way riders obey the simple ‘keep to the right’ road rule and the ‘messaging’ for drivers to look for riders before making small (right) turns.

In Melbourne, however, production of safety relies heavily on regulation, high penalties, and enforcement. The TAC has however sought to raise awareness of road safety as an issue for everyone, through recent (2016-17) *Vision Zero* campaigns. For example, the 2018 campaign directed at drivers to give riders ‘a metre’ when passing, has some aspects of co-production.

In Inner Melbourne, however, it is also not feasible to co-produce safety on inadequate and often poorly designed shared infrastructure – such as ‘bike’ paths where bicyclists are required to give way to pedestrians, or at intersections where bicyclists are left unprotected, or on roads where drivers who are ignorant of the rights of riders. Amsterdam and Copenhagen demonstrate that when road users who understand bicyclists are provided with separate and clearly delineated space, then safe operation can be co-produced. Copenhagen stands out in terms of co-production with low-cost

system support, with features like the protected network of lanes and the Copenhagen Bicycle Account, that provides a platform for the exchange of information.

In terms of population capacity, both Amsterdam and Copenhagen have an advantage over Melbourne in that their citizens have an excellent understanding of bicycling such that both riders and drivers can contribute to safe operation. In Amsterdam, riders contribute to the co-production of safety by, for example, riding at modest speeds and at night by ensuring that their bicycles are fitted with lights. In other ways, however, some riders in Amsterdam seem to take safety for granted and can be observed smoking and talking on their phones while riding or carrying children on their shoulders (see Figure 5-4). Also, in Amsterdam, the 'green plate' moped riders who were permitted to use bike paths and lanes, often exceeded the 25 km/h maximum speed and disproportionately contributed to crashes (City of Amsterdam, 2017). These considerations suggest only a moderate rating for co-production in Amsterdam.

Copenhagen is an exemplar city for co-production of safety. The bicyclists are possibly the most disciplined in Europe and can be observed keeping to the right and making box turns at intersections. A further example is the response in the early 2010s to collisions caused by right-turning (small turn) motor traffic not looking for or giving way to through bicyclists; as the regulatory solution sought through changes to national road rules was denied, a co-production solution was successfully implemented by the municipality through a publicity campaign for drivers to check for riders.

In Melbourne, with most people ignorant on bicycle safety matters, there is currently a low level of capacity for co-production, but this may be improving as private providers, bicyclists groups and municipalities endeavour to improve rider skills and driver understanding.

8.3 Content for safety

In this section I compare the *Safe System* 'content' elements: Infrastructure, Vehicles, and Behaviour, and explore how these can work together to contribute to good-enough safety. The exemplar approach for *Safe System* content is the Netherland's *Sustainable Safety*, as recognised by Victoria's Transport Accident Commission (Cockfield, 2011).

The principles of *Sustainable Safety* are given on pages 40-43 above, the key principles for content are summarised below:

- For infrastructure:
 - a simple, legible, road classification system, based on three traffic functions: access, distribution, and through travel
 - each class of road differentiated by detailed design and management, for operational homogeneity of mass, speed, and direction – to reduce the potential for and consequences of any conflict
 - user safety is given priority over ‘level of service’, with safety for every road user type prioritised by vulnerability in all anticipated situations, even if the expected numbers are small
 - design for operational simplicity, presenting users with only one decision at a time and with predictable movements of users in designated space
 - maintenance standards that recognise the specific needs of different user types, including that bicyclist’s need better maintained surfaces than motor vehicle operators.
- For vehicles:
 - design for safe interactions between users
 - allow for and forgive human errors
- For behaviour of road users:
 - manage for safety (over mobility) in a positive rather than punitive way and on the basis that users have awareness
 - capabilities and responsibilities instilled through traffic safety education

Source: Author, adapted from Wegman and Aarts, 2006

Content in Amsterdam is focused on objective safety, informed by the national *Sustainable Safety* thinking, with technical support from research organisations like CROW, SWOV and NTO, funding of demonstration projects, and research and advocacy by ASNWB – the national motoring association. Content in Copenhagen is interpreted as being shaped by ‘people-centred design’, drawing on technical support from Danish universities and NGOs like the Cycling Embassy of Denmark, and Copenhagen based internationally recognised consulting firms like Gehl Architects and the Copenhagenize Design Company.

The approach in Copenhagen is different to that in Amsterdam as although they design for very good objective safety, they also aim for and check that infrastructure is perceived as being safe. The overt emphasis is on improving perceived safety, which supports positive messages on the convenience of switching from car to bicycle; hence,

they avoid raising concerns about safety among potential riders. Also, with most bicyclists in Copenhagen competent and law-abiding, if safety issues arise, the municipality first looks to change the infrastructure or driver behaviour and tends not to lecture riders about behaviour. In Melbourne, the approach to content is biased by a state-wide preoccupation to reduce deaths and injuries from motor vehicle crashes.

Infrastructure.

Infrastructure development in Amsterdam and Copenhagen, but not in Inner Melbourne, occurs in a context where the important role of bicycling in urban transport infrastructure is recognised as supporting environmental, economic, and social goals. Below, in Table 8.6., differences in infrastructure across the case study cities are compared.

Table 8-6 Road infrastructure characteristics

	Amsterdam	Copenhagen	Melbourne
Road classifications	Access Distribution Through traffic	Local General distributor Through traffic	Local Collector/Distributors Arterial or Main roads
Design goal	Operational homogeneity	Managed sharing or exclusion	Mobility service to motor vehicles, and mixed-use
Consistency of design within road class	High	Reasonable, because of 'Copenhagen' lanes	Inconsistent, some local roads and arterials look very similar
Operational design	Simple, one decision at a time	Predictable location of users	Complex
Compliance 'by design' (rather than enforcement)	High	Moderate	Low
Design standards for bicyclists needs	Very high	Recognise both motor vehicles and bicyclists	Variable but often low
Priorities	Bicycles over motor vehicles	Motor vehicles and bicycles share	Motor vehicles (movement and parking), trams, and pedestrians over bicyclists
Bicycling in road design	Well integrated	Somewhat conflicted, some designs favour motor vehicles	Considered optional
Awareness of bicyclists needs	Very good	Good	Inconsistent

The approaches to road classification in each city are superficially similar in that they each have three basic classifications based on functions. The approach in Amsterdam is the simplest, while the 'Smart Roads' approach in Melbourne is more complex with the arterial roads managed to serve user needs, varying by location and time. Operation in Melbourne is further complicated, for bicyclists and drivers, as within the 'reserve' of an arterial road, bicyclists may potentially and legally use four different areas: through traffic lanes (with motor traffic operating at speeds of 60 to 80 km/h); service roads with traffic operating at 40 or 50 km/h; any designated bike path – often shared with pedestrians; or, if an adult is riding with a child under 12 years – the footpath. The infrastructure in Melbourne thus has significant risks as bicyclists may be exposed to high-speed traffic and motorists are faced with the difficulty of anticipating where bicyclists may be located.

In Amsterdam, and to a lesser extent in Copenhagen, the infrastructure acts as artefacts that communicate function and speed limits to users by the details of design, such as where the bicycle lanes are, the type of surface materials, and the parking arrangements. Road users can also ‘read’ from the design, what other road user types to expect and the allowed speed. For example, in Amsterdam, the local streets are distinctively paved – often with red bricks, bicyclists are likely to use the middle of the street, and the speed limit for drivers is 30 km/h (or less).

Safety features of the roads available to bicyclists are compared in Table 8.7 below:

Table 8-7 Features of roads for bicyclists

	Amsterdam	Copenhagen	Inner Melbourne
Density of exclusive paths or lanes	2.3 km per km ² (equiv. 800m grid*)	5.5 km per km ² (equiv. 400m grid*)	Inconsistent
Speed zones for unprotected sharing	15, 30 or 40 km/h	30 or 40 but up to 50 km/h	30 to 80 km/h
Bicyclists excluded from traffic lanes	Speed zones 50 km/h and above	Speed zones 60 km/h and above	Speed zones 100 km/h and above
Designated space (when provided)	Mostly kerb protected lanes	Mostly lanes between the kerb and (protected by) car parking lanes	Mostly by marked lanes, often on the traffic side of parked cars
Continuity of routes	Good	Good	Inconsistent with many gaps
Main road intersections, traffic light controlled	Separate crossing paths, clearly designated 30 km/h operation	Separate crossing paths, clearly designated	Operated for the efficiency and safety of motor vehicles and trams when present
Local intersections	30 km/h limit and bicyclist priority	Mostly “T” junctions, 40 (or 50) km/h traffic speeds may be permitted	Operated for efficiency and safety of motor vehicles, traffic speeds from 30 to 60 km/h

*the bicycle lane and path network densities are not formal grids but are expressed above as grids to indicate what could be needed in Inner Melbourne.

Amsterdam has some 513 km of exclusive routes for bicyclists and Copenhagen some 426 km. Amsterdam, however, occupies almost three times the area of Copenhagen. To compare the accessibility of the bike route networks, notional bike route density was calculated and related to a typical Inner Melbourne ‘block’, that is an area 1.6 km by 1.6

km, bounded by arterial roads. The Amsterdam bicycle network density is equivalent to four exclusive bike routes per block – a grid spacing of 800 m. The Copenhagen bicycle network density is equivalent to eight bike routes per block– a grid spacing of 400 m. The lower density of bike routes in Amsterdam works because on almost every street bicyclists are explicitly catered for. In Copenhagen a higher density of protected bike routes is probably needed because some local distributor roads have high (50 of km/h) default speed limits and are unsuitable for bicyclists. The comprehensive networks of bicycle arterials benefit motorists in Amsterdam and Copenhagen because many commuters use the bike network instead of driving, leaving more roadway capacity for those who drive. Also, the dense network of bicycle routes makes safe driving easier, as motorists know bicyclists will not be on main roads¹⁰⁸.

Infrastructure is an artefact that communicates expectations about behaviour to road users. For example, in Copenhagen, the bicycle infrastructure communicates that rider comfort and safety are priorities. Most roads and streets in Melbourne, however, communicate that motor vehicles movement and parking has priority. Also, in Inner Melbourne the cross-sections of main roads are often very similar to that of local streets, hence as ‘artefacts’ they communicate on both roads and streets that motorists have priority.

Bicycle infrastructure in Inner Melbourne is also discontinuous, often built to inconsistent and low design standards, including narrow on-road lanes and narrow shared – pedestrian priority – paths. Safety problems, objective risk, have been created by token bicycle infrastructure that appears to prioritise the safety of bicyclists, such as narrow marked bike lanes next to parked cars. Risk has also been increased for bicyclists by inconsistent traffic calming on local roads, by the use of ‘sharrows¹⁰⁹’, and by minimum deflection roundabout designs that allow motor vehicles to maintain high speeds.

¹⁰⁸ Through traffic roads that operate at speeds above 50 km/h.

¹⁰⁹ A sharrow is an American invented shared traffic lane with marking consisting of a bike logo and two arrows (chevrons) to suggest that the lane is for bicycles and motor vehicles.

In Amsterdam and Copenhagen where bicycle routes, tracks or paths cross a through road, traffic lights and designated space are provided. Part of the solution in Amsterdam was to design the bike routes so as to minimise the number of road crossings. In Copenhagen, safety is improved by the continuation of the bike path or lane through the intersection, providing clearly designated priority space for bicyclists.

In Inner Melbourne until the mid-2010s, most bicycle lanes were truncated at intersections. At some inner-city intersections, marked ‘bicycle boxes’ were installed, but without supporting ‘head start’ traffic light timing, potentially placing any waiting bicyclists in the near field ‘blind spot’ and path of any long-bonneted trucks. Many major intersections were also explicitly optimised for the mobility and safety needs of car users (Fitts, 2013). At major – traffic light controlled – intersections in Amsterdam and Copenhagen, however, bicyclists are provided with designated space and favourable signal operational timing to minimise the need for riders to stop¹¹⁰ and if they have had to stop, an early ‘green’ head start is provided. In both Amsterdam and Copenhagen, a wide range of different treatments¹¹¹ are used at and through major intersections, such as blister kerbs to protect cyclists from motor vehicles making small (left) turns. In Copenhagen, bicyclists are doubly protected by the designated space of an outer ‘box’ and the requirement for bicyclists to keep right and to move through intersections using the ‘outer box’.

In Copenhagen, for the local street network, ‘cross’ intersections are avoided by design, roundabouts are not installed, and most uncontrolled intersections are T junctions. In Inner Melbourne, most ‘uncontrolled’ intersections are cross intersections, roundabouts are common, and bicyclists put themselves at risk if they may mistakenly believe that

¹¹⁰ At low speed (below say 10 km/h), riders have reduced stability and are at greater risk of falling, with high risk of injury to senior bicyclists.

¹¹¹ A variety of proven treatments are given in the Dutch Design Manual for Bicycle Traffic (2007) and the Copenhagen influenced NACTO Urban Bikeway Design Guide (CROW, 2007; National Association of City Transportation Officials (NACTO), 2012).

drivers will acknowledge them as legitimate road users and will pause when facing a Stop or Give Way sign.

For the infrastructure in the three case study areas there are differences in objective risk and perceived danger at several sites. In Amsterdam, the approach was to improve objective safety for the already large numbers of people bicycling. In Copenhagen the emphasis was on improving perceived safety – reducing danger – to encourage more people, particularly commuters, to ride instead of drive. In Melbourne the approach can at best be described as confused and at worst, encouraging bicycling on objectively unsafe infrastructure such as narrow, unprotected bike lanes beside parked cars and through complex intersections.

As very few riders know a sites objective risk – crash history and exposure – most riders respond to the safety communicated by infrastructure, as discussed in section 2.1. In Amsterdam and Copenhagen congruency was generally observed between the danger communicated by infrastructure and the objective risk. That is, there were very few situations where perceptions of danger and objective safety were incongruent, except for some short lengths of unprotected bike lanes¹¹². Examples of incongruencies between risk and danger are provided below in Figure 8 4.

¹¹² These were, however, identified as a priority for improvement.

B Looks bad, is safe

Less cycling and few injuries



Copenhagen

C Looks bad, is bad

Little cycling and few injuries



Inner Melbourne

A Looks safe, is safe

More bicycling and fewer injuries



Copenhagen

D Looks safe, is not

More bicycling and more injuries



Inner Melbourne

Photos by Author

Figure 8-4 Risk and danger nexus - examples

An example of low risk and low danger – ‘green quadrant’ (Example A) – is the well-designed, well maintained separate bicycle path in Copenhagen. An example of high danger and obvious risk is the Melbourne intersection shown in the ‘pink quadrant’ (Example C). A situation with high danger (to a rider from Melbourne) but low risk, is ‘grey quadrant’ (Example B) from Copenhagen (but which is not as risky as it appears due to a low 30 km/h speed environment and disciplined road users).

Of most concern are measures, both infrastructure and regulations, that create a false sense of safety – low perceived danger – but are objectively high risk, the red quadrant, as in example ‘D’ above in Figure 8.4. Other type D examples in Inner Melbourne include:

- marked bicycle lanes at intersection approaches which encourage bicyclists to ‘filter’ beside slow-moving large vehicles, placing them where they cannot be seen by truck drivers and may not be recognised by other drivers, exposing riders to the danger of being struck or run over by left and right turning motor vehicles
- ‘bicycle boxes’ at controlled arterial road intersections which are used by trucks. Such designs direct riders to stop and wait in front of motor traffic. They are then left exposed, with no bicyclists ‘head start’ signal phase – in the forward blind-spot zone, as any waiting truck moves off
- unprotected bike lanes adjacent to parked cars that increase the risk of dooring
- expecting bicyclists to behave like motor vehicles in roundabouts and at uncontrolled intersections, where many motorists fail to give priority as required under the road rules

A lesson from both Amsterdam and Copenhagen is that to serve a broad demographic, decision-makers must aim for the ‘best’ safety quality of infrastructure for bicyclists. Copenhagen also shows that very good safety can be achieved over a short period, even in a society that also wants to use motor vehicles. Safe infrastructure also needs to be supported by safe vehicle design, as discussed below.

Safer vehicles

Vehicle factors that influence the safety of bicycling are of two broad types: the designs of bicycles and the design features of the motor vehicles bicyclists may encounter, as summarised in Table 8.8 below.

Table 8-8 Safety influence of vehicles

Feature	Amsterdam	Copenhagen	Melbourne
Bicycles - style	Most are of the upright, single gear, classic utility Dutch style	A greater mix of utility, hybrid, and sport styles	Most are of the sport or hybrid style
Personal mobility variants	Mopeds and an increasing number of e-bikes.	Very few mopeds but a mix of bicycles including cargo bikes	Very few mopeds but many variants including skate-boards and scooters
Private MV's	Lower MV ownership Smaller vehicles	Lower (but increasing) MV ownership Smaller vehicles	Higher MV ownership and use. Many more SUV's and 'utility' vehicles Tinted windows
Trucks	Smaller trucks Good visibility and protection under EU standards	Smaller trucks Good visibility and protection to EU standards	Larger trucks (e.g. B-doubles ¹¹³) No special design requirements for city use.

Most of the bicycles seen in Amsterdam are designed for safety and utility, with an upright riding position and features like front and rear taillights that turn on automatically. In Copenhagen there is a wider variety mix of bicycles, including Dutch-style bikes, cargo bikes, and hybrids. In Melbourne there appear to be more 'road' bikes designed for on-road sport cycling, hybrids for commuting, and some examples of the bikes seen in Europe.

As noted by Jacobsen et al., (2009) the number, type, and operating characteristics (particularly speed) of private motor vehicles that bicyclists experience strongly influence bicyclist safety (Jacobsen et al., 2009). In Amsterdam, with a highly developed motorway system, there are comparatively fewer motor vehicles on city streets (Schepers, J. P. et al., 2014). Also, in both Amsterdam and Copenhagen, under EU rules the trucks encountered must be designed so that drivers can see bicyclists (Pattinson &

¹¹³ B-double: a truck combination consisting of a prime mover and two semi-trailers.

Thompson, 2014). For operation in Inner Melbourne there are no similar design requirements for near-field truck driver vision and trucks can use most roads with few restrictions (Pattinson & Thompson, 2014). Bicyclist safety in Amsterdam and Copenhagen has thus benefitted from EU vehicle safety design standards, particularly for trucks and buses. In Melbourne, vehicle design standards (the responsibility of the Australian government) have privileged occupant protection, and in the case of trucks and buses, operational efficiency; with minimal attention given to making motor vehicles safer in their interactions with bicyclists in cities.

Safer behaviour

As was noted by several informants, good infrastructure improves rider (and driver) behaviour while poor infrastructure may lead to risk taking by bicyclists. Differences in the behaviour of road users that influenced the safety of bicyclists were observed across the case study cities, as discussed below in Table 8.9, under the headings of: road user competence; compliance with road rules; behaviour – care vs asserting priority – at intersections; and safety achieved through co-production.

Table 8-9 Behavioural differences

Feature	Amsterdam	Copenhagen	Melbourne
Road user competence	Most understand bicycling, and riders expect priority over drivers	Most understand bicycling, and riders are treated as legitimate road users	Most have minimal understanding of bicycling Drivers expect bicyclists to keep out of their way
Regulatory compliance	Riders observe few rules	Minimal regulation but good compliance	Emphasis on penalties and enforcement, and what works for drivers
At Intersections (care for others versus asserting priority)	Riders keep to designated space when provided, otherwise go where they please Drivers approach at reduced speed.	Well-disciplined riders who keep right and behave predictably Drivers lookout for bicyclists but some resistance by drivers to safe speed	Drivers expect and take priority without reducing speed Bicyclists movements are unpredictable
Co-production of safety	Responsibility rests on drivers	Responsibility shared by riders, drivers, and pedestrians	Riders are responsible for their own safety.

Both riders and drivers in Copenhagen and Amsterdam have experienced bicycle riding throughout their primary and secondary school years. In Melbourne, however, riders are at increased risk because of their limited skills, the low awareness of drivers and infrastructure challenges. Most riders have not completed any rider training (Biegler et al., 2012); and drivers can pass the Victorian license test ignorant of the rights of bicyclists. For riders, there are also practical limits to the production of safety by their behaviour alone. For example, several Melbourne informants who were highly skilled and experienced riders reported serious injuries due to poor infrastructure design and maintenance. Some infrastructure hazards, such as unexpected slippery surfaces and road debris, cannot be overcome by rider skill.

At intersections in Melbourne, driver behaviour can be characterised as asserting priority; most drivers only look for dangers to themselves (from other motor vehicles) and rarely consider the danger they present to vulnerable road users. At ‘uncontrolled’ urban intersections, traffic operates under priorities established by Stop or Give Way signs or the default ‘give-way to vehicles on the right’ rule. Drivers with priority typically approach and proceed through intersections, without caution and at the zoned speed of the approach road. That bicycles are vehicles with equal rights is rarely acknowledged, placing the responsibility to avoid injury on the bicyclists.

At intersections in Amsterdam used by bicyclists, motor vehicles must slow to 30 km/h and where designated and protected space is provided for bicyclists, good compliance can be observed. In Copenhagen, bicyclists are very disciplined, most keep to their expected path on the right, and are predictable in their movements at and through intersections. In Copenhagen, operational safety can be understood as being co-produced by road users, for example, by riders keeping to the right, and by community campaigns to establish norms among drivers to look out for cyclists and travel at or below 40 km/h on local roads and when approaching intersections look for and give way to through bicyclists when turning, which works because riders are well behaved and predictable in their movements.

Influences on successful content are summarised below in Table 8-10.

Table 8-10 Content influencing factors

Content factors	Amsterdam	Copenhagen	Inner Melb.
Measures based on design codes that are congruent with strategic policies	Strong	Strong	Weak
Packaging of 'push' and 'pull' measures, like restrictions on car use linked to making bicycling safer and more attractive	Strong	Strong	Weak
Recognition that city-to-city diversity (e.g. urban form, topography, economic activities, and constraints), requires implementation of principles not prescriptions.	Medium	Strong	Weak

That is, on the above criteria, Inner Melbourne does not compare well. It should, however, be noted that in the adaption of content ideas there have been both good examples, such as the mostly good Melbourne version of the Copenhagen bike lanes, and bad examples, such as the use of 'bike boxes' potentially placing bicyclists in the forward blind spot of trucks.

8.4 Lessons for a safer Inner Melbourne

As a 'follower' city on bicycle safety, Inner Melbourne has the advantage of being able to learn from the experience of successful bicycle cities like Amsterdam and Copenhagen. Also, socio-technical systems theory stresses that the successful transfer of learnings requires explicit consideration of historic, social, and technical differences (Persia et al., 2010; Valderrama & Jorgensen, 2008; Wegman et al., 2012). Stead et al., advise that successful policy transfers require development of locally appropriate solutions and implementation mechanisms; working with strong local change agents, and seizing opportunities in times of crisis or when there is a community appetite for change (2010). With these cautions, key ideas follow, grouped under the themes of context, process that could be adapted to make Inner Melbourne safe enough for more travel by bicycle.

Contextual fit

Amsterdam and Copenhagen show that change is possible, that neglect can be reversed, but bicycling must fit with the local context and culture. In Amsterdam (and the

Netherlands), where bicycling has long been part of cultural identity, a gradual change to sustain bicycling occurred. Copenhagen, however, demonstrates that bicycling can be re-invigorated when it is seen as a key part of a broader policy, such as sustainability, and a key part of the response to this new challenge. In Copenhagen, support for bicycling is embedded in the relatively new city liveability and ‘green’ agenda, broadly supported by the community as they have experienced progress and improvement under this agenda.

For bicycling to work, to be supported in the policy context for Melbourne, decades of policy and program neglect by the Victorian and Federal governments needs to be challenged and reversed. Better safety for bicycling can be connected to the existing context with community support for liveability, sustainability, and congestion reduction, including:

- policies for a 20-minute city, but that seriously engages with the potential for bicycling to deliver
- liveability improvements that recognise the diversity of people’s needs, some of which can best be met by bicycling
- the urgent need for feasible action on congestion, climate change and protection of amenity, framed in an appealing cost-effective narrative

Process engagement

Both Amsterdam and Copenhagen demonstrate the advantages of developing substantial institutional capacity and inclusive processes aimed at doing the best for the safety of bicyclists, while accommodating the needs of other road users. In both cities, the community and key stakeholders are engaged, and their viewpoints influence outcomes. The processes are open, undertaken with flexibility and an appetite for innovation, with a willingness to experiment and learn. Amsterdam demonstrates the advantages of broad engagement across all levels of government. Both cities have benefitted from highly effective and relatively low cost invested in improvements for bicycling: Amsterdam from sources across all levels of government; Copenhagen from the city’s own sources.

Copenhagen demonstrates what can be achieved by a committed municipality in less than two decades, with little financial support from ‘higher’ levels of government.

Copenhagen has also used low-cost ways to provide timely leadership and community engagement through social media, including reporting of problems, getting suggestions and feedback on proposals, and the perceived safety of implemented projects. An optimistic and appealing improved liveability ‘storyline’ has been developed with and embraced by the community.

As noted above, a weakness of the road safety approach in Melbourne, is that the main actors (the TAC and the other Road Safety Partnership members) have focused on reducing deaths and serious injuries from crashes involving motor vehicles, with a bias towards measures that have worked to reduce fatalities on highways. Road safety leaders are yet to fully engage with the distinct road safety needs in urban areas where there is potential synergy between improving perceived safety of bicycling, (leading to more travel by bicycle –a low harm to others mode), and improved safety in aggregate for all road users, as demonstrated in Amsterdam and Copenhagen (see section 4.2).

In comparison to Amsterdam and Copenhagen, the institutional arrangements for Inner Melbourne are diluted by state-wide institutions with weak local connections. For communities to be engaged in co-producing safety, they need a sense of connection, an effective voice, and the experience of being heard and having an influence on local outcomes. Explicit institutional recognition of geographic communities-of-interest in urban centres (and rural areas), would facilitate community engagement.

In Amsterdam and Copenhagen, the municipalities take a broad view and have a significant role in road and public transport provision. In Melbourne, decision making and expenditure decisions are dominated by the Victorian government. The municipalities in the Inner Area also receive very little financial support for bicycling from the Victorian and Federal governments, with neglect of possible actions on road user behaviour and vehicle design. With no formal arrangement for municipalities to be included in decision making on transport infrastructure there is a severe power imbalance between the state and local interests which diminishes the voice of local communities.

The experience of Inner Melbourne municipalities from working with local interests and the use of social media could be developed to build co-production capacity across

potential allies. In the Netherlands a key actor was the motoring association, the ANWB. In Melbourne there are several local actors who are not explicitly about cycling or road safety, but who have the capacity to independently lead change, and have the credibility and political influence to press the Victorian government for change to further high level goals like improved liveability, that could also improve the safety of the city for bicycling. These actors include the RACV; the Committee for Melbourne; professional associations such as ITEANZ, Institution for Engineers Australia, PIA; and municipal groupings including IMAP, MTF, VLGA and MAV. Bicycling groups like the Bicycle Network and the Amy Gillette Foundation would need to be included, but they should not control a new agenda because of their bias towards the interests of existing cyclists.

The learnings on process include the importance of:

- openness to build community trust in government
- an appetite for learning, an antidote to local hubris, to spur innovation and experimentation
- strong and co-operative institutions with horizontal and vertical permeability
- broad engagement between governments and community in the co-production of content
- emotional engagement with the community through social media, including reporting of problems, receiving suggestions and feedback on proposals, and implemented measures (including perceived safety)
- working with key stakeholders to build co-production capacity
- demonstration projects and trials to develop community and stakeholder understanding of possibilities
- support for decision-makers who need to face down minority opposition
- clarity in decision making and responsibilities
- adequate financial resources – preferably with dedicated revenue sources to fund research, implementation, and monitoring of measures so that any problems are detected and quickly corrected

Conclusions

The three study areas have similarities in urban morphology and land use arrangements such that many activities are accessible by short trips. Amsterdam and Copenhagen, however, have different histories of travel choices, strategic planning, and implementation. Also, a century ago, decision-makers in Amsterdam and Copenhagen learnt that for safety on busy roads bicyclists needed physical separation. The importance of a strategic protected and continuous bicycle network, designed to a high standard, is now unquestioned in these cities. Bicycles are seen as a significant part of the transport mix for city access and mobility, and in neither city is there an anti-car bias.

In the 1960s Amsterdam learnt that on local streets, physical measures such as bollards were needed to control motor vehicles for urban amenity and safe use by bicyclists. On many streets and roads, design measures were used to differentiate the space for bicyclists from that for pedestrians and motor vehicles, including at controlled intersections. By design, most streets and roads explicitly consider bicyclists, with priority on low-speed local streets, designate separate space on intermediate roads, and exclusion from high-speed roads. At intersections, where bicyclists (or pedestrians) may be present, national regulations require motor vehicles to slow to 30 km/h. Over recent decades Amsterdam has also demonstrated that high-quality infrastructure can be provided for all modes, including motorways for motor vehicles, to protect city amenity and liveability.

In the 1960s, Copenhagen followed a unique path, to provide better conditions for pedestrians, and managed traffic by reducing parking and limiting the numbers of motor vehicles entering the city. They also controlled traffic speed on shared streets by installing speed humps, that slowed did not restrict motor vehicle access. These measures, although not for bicyclists, inadvertently provided a basis for the later transition to a safer and sustainable city for bicyclists. In recent years Copenhagen has focused on establishing strategic separate protected routes that are perceived as safe enough for commuters to switch from cars to bicycles.

Different thinking, however, underlies the safety measures and design approaches in each city. In Amsterdam, with high levels of bicycling, content measures aim to improve objective safety to reduce the number of serious injuries to current bicyclists. By contrast, in Copenhagen, the imperative was to reduce peak-hours motor vehicle congestion by increasing the numbers bicycling – which required improving perceived safety to make the city seem safe enough for drivers to become riders. A connected and comprehensive network for commuter bicyclists was developed, separated from motor traffic, that was perceived as providing convenience and safety. Copenhagen demonstrated how attractive, convenient, and safe infrastructure can be provided at a modest cost and without alienating drivers.

In Amsterdam and Copenhagen, most adults come to the road system with behaviour shaped by extensive experience of bicycle riding throughout their school years, compared to Melbourne where less than one-third have undertaken the short ‘bike-ed’ program in late primary school. Decision-makers in Amsterdam and Copenhagen generally understand cycling, which is not the case in Melbourne, and they appear predisposed to seeking balance and compromise in providing for all road users.

Safety in Amsterdam and Copenhagen has been co-produced by populations with extensive road user education who understand and have experienced bicycling; this leads to empathy towards bicyclists, unlike the antipathy towards riders by many drivers in Melbourne. Governments have accepted their role in ensuring that citizens learn the operational skills to construct their own safety, including the moment to moment tactical decisions about manoeuvres and speed. The model city for co-production of safety is considered to be Copenhagen, where the municipality provides a framework for co-operation between drivers and riders, involving infrastructure and behavioural management.

While the detail of specific measures may rarely be effectively copied, the seriousness of intent to provide very good safety for bicyclists can be copied. The ‘big picture’ lessons on safety are that the approach needs to be comprehensive and respond to both the shared and special needs of all in the city, including for:

- improved amenity and liveability

- enhanced safety for all road users, for example, by separation of bicyclists using main bicycle routes from both pedestrians and drivers
- high-quality designs, including meeting the needs of inexperienced riders or riders with special needs such as impaired hearing

As the potential importance of bicycling is not well understood or broadly valued in Inner Melbourne, it will be a challenge to co-produce safety for people who could bicycle. Also, in contrast to riders in Amsterdam and Copenhagen, Melbourne riders will need significant roadcraft skills and local information on the limited areas and routes where it may be possible to create safe travel.

8.5 Limitations

Data limitations

The crash data from each jurisdiction on which comparisons are based has limitations due to differences in definitions, the diligence of reporting, and the absence of data on trip purpose. Police statistics on bicyclists injuries in all three jurisdictions are biased towards crashes involving motor vehicles, neglecting many bicycle-only crashes; that is, that did not involve collisions with motor vehicles.

As mass crash statistics do not record trip purpose when a rider is injured, it is not possible to discriminate between transport, recreational or sport riding. Therefore, safety for possible (additional) adult travel by bicycle may not be properly understood by extrapolating from aggregated injury statistics. This lack of discrimination by purpose is possibly more of a problem in Inner Melbourne where there may be a higher percentage of recreational and sport riders injured than in Amsterdam or Copenhagen. Use of aggregated (by trip purpose) injury numbers overstates the reported injuries to transport bicyclists, but this may in part compensate for the under-reporting of injuries.

Regarding exposure, while the 'R' factor developed in this thesis is proposed as an improvement on per capita rates, any single and aggregated travel measure averages-out multiple factors that influence risk, including: rider experience, riding solo or in groups, gender of riders, routes used, the time of day trips are made, rider behaviour (speed and risk-taking) and possible rider impairment. These factors are likely to vary across cities

and point to the value of in-depth studies where such factors can be explored (Biegler et al., 2012; Johnson et al., 2010; Stevenson et al., 2014).

The findings from this research relate to the time period 2013-2018. Interviews were conducted between December 2013 and July 2014. The documents examined were mostly published between 2013 and 2018.

From documents and social media monitored over the course of this research, several significant changes are apparent in the safety scene for bicycling across the here cities. This research was restricted to conventional bicycles used by adult riders, but the diversity of vehicles using bicycle infrastructure has increased, with more e-bikes, scooters, and other variants that may be hired or owned. Sharing space with such a diversity of vehicles is more challenging for both riders and drivers. The motor vehicle mix that may interact with bicyclists is also changing, with (quieter) electric vehicles and the development of autonomous motor vehicles that are having some difficulty in recognising bicyclists, pointing to the importance of separation (Threlfall, 2019). Also, there is the challenge of minimising injuries to the increasing number of people over 60 years who are much more vulnerable to serious injury from minor falls due to reduced muscle mass and weaker bones.

Some aspects of organisations, policy and regulatory practices have also changed. For example, in Melbourne and Victoria there have been several organisational changes, including that the Victorian Planning Authority restructured in 2018 to give more attention to the inner area, and the announcement that in 2019 the Department of Transport is to absorb VicRoads and Public Transport Victoria, with explicit recognition of the previously neglected Transport Integration Act (2010).

The TAC has also taken an increased interest in local area traffic calming measures that are likely to improve safety for bicyclists, through control of motor traffic speed on local streets and improvement in road user behaviour. The RACV, a key stakeholder, now strongly supports new bike-only 'superhighways' to provide safe access by commuter bicyclists to the inner city.

Changes in Amsterdam and Copenhagen have also no doubt occurred but are not as readily tracked. However, the dangers to bicyclists from mopeds on bike paths in Amsterdam has been resolved by requiring moped riders in the central area to use the roads and wear helmets. Also, in Copenhagen the lowering of the default urban area speed limit from 50 km/h (to 40 or 30 km/h) may soon be achieved.

The number of drivers and pedestrians distracted by personal devices has apparently increased, increasing the risk to themselves and riders. Problems with impaired driving – by drug use – may also have worsened. Also, penalties like loss of licence or impounding of vehicles appear to be of limited effectiveness with repeat offenders, for example, re-offending unlicensed and in stolen vehicles.

8.6 Further work

The comparatively low level of bicycle use for transport in much of Inner Melbourne, suggests a low level of community support for bicycling. Research could explore the likely level of community support for policy to improve liveability and sustainability, as distinct from bicycle user safety. However, measures that could be aimed at: improving amenity, safety for all road users, reducing the complexity of road use, and increasing the efficiency of access to activities, could be designed to have the secondary effect of improving the safety of the city for bicyclists.

New challenges, for the safety of people who could ride, appear to be emerging with climate change effects and associated extreme weather events including heavier rain, stronger winds, and higher temperatures; these effects need to be monitored and investigated.

Municipalities are central to improving safety for bicyclists. Municipalities in Inner Melbourne face unique challenges compared to Amsterdam or Copenhagen, and more work is needed to understand the challenges of scale and capacity and the possibilities for municipalities to lead co-production, working with key stakeholders, like the TAC, RACV, the freight industry and local schools.

Research could also be undertaken on co-production of safety, including:

- trials of non-punitive measures (e.g. rewards)¹¹⁴ to encourage compliance with road rules
- ‘buddy’ systems for new riders
- support for rider safety training by bicycle retailers
- development of platforms involving increased use of social media for injury reporting, hazard reporting¹¹⁵ and sharing of perceptions on safe routes

Infrastructure

The concept of the Melbourne PBN needs to be reviewed and a strategic connected network developed that could be implemented in less than 10 years, with a guaranteed source of funding for implementation, monitoring and research. The Copenhagen network of high standard connected protected paths and lanes, that impacts less than 5% of the road network, was achieved in half the time that the Melbourne PBN has been under consideration.

To develop safe and effective main bicycle routes with protection on sections and at intersections and crossings, locally appropriate design prototypes are needed.

Melbourne has unique design challenges from the local context that include heritage valued cobbled bluestone kerb and gutter, trees planted in road pavements and omnipresent on-street parking. For example, parking could be relocated to the centre of the road, as in some traditional local streets.

The work by TAC and some municipalities on traffic calming in local streets need to continue and be extended, informed by the ‘self-explaining’ design approach from the Netherlands, with documented ‘before and after’ studies. Research is needed on individual response variations – including by age, gender, and ability – across the

¹¹⁴ For example, the Victorian Government from early 2018, rewards probationary drivers who do not lose any demerit points with a free full licence.

¹¹⁵ A very effective system of hazard reporting and remediation was in place when I broke my arm because of a road hazard in 2014.

population, that could influence the perception of infrastructure safety for bicycling, including perception of speed reduction approaches, parking management options, and designs for physical separation.

As the micro-climate for bicyclists in Melbourne on hot sunny days can be very oppressive, with pavement surface temperatures above 50 °C that add to the risk of fatigue and heat stroke, measures such as shade are needed to moderate the excessive temperatures experienced by bicyclists. Local solutions have previously been proposed (Department of Justice & Department of Sustainability and Environment, 2005). Copenhagen and Amsterdam are experimenting with heated pavements to reduce the risk from ‘black ice’, perhaps Melbourne needs to experiment with means of cooling pavements.

Vehicle design

The future characteristics of the motor vehicle fleet will be influenced by many factors, including market signals and vehicle design regulations, such changes could hold both challenges and opportunities for bicyclist safety. As noted by Baker, there has been an increase in numbers of heavy SUV’s and pickup trucks, which are more likely to kill people they hit; however manufactures like Volvo, offer the promise of cars equipped with technology to avoid detect and avoid pedestrians and bicyclists (Baker, 2019). Further policy work is needed in Australia to increase safety for vulnerable road as part of the autonomous vehicles agenda.

Detailed work also appears to be urgently needed to attend to safety for unprotected road users, such as checking the transferability of road rules into programmed autonomous decisions, from a ‘drive on the left’ to a ‘drive on the right’ context. For example, in both Europe and Australia there is a default, give way to the right, but the vehicles are operating on different sides of the road. There may also be issues, in Melbourne (and Australia), with recognition of different vulnerable road users on shared paths, and main road infrastructure – where, in Europe, bicyclists are not allowed and not expected.

There is thus a strong case, in view of the change and disruption from autonomous vehicles, for Australian research to be undertaken from the viewpoint of vulnerable road

users, on changes to local road regulations, vehicle design standards and road design standards. Early changes to align with international best practice, such as for the degree of separation and operating speeds, may have both short term and long term benefits for vulnerable road users.

A problem with behaviour

A possible gap between regulations and on-road behaviour, as may arise between autonomous vehicles and driver controlled vehicles, could warrant study. There are also likely to be implications for riders in Australia of autonomous vehicles programmed in Europe and America. For example, in northern Europe, drivers give right-of-way to pedestrians and bicyclists waiting at crossings and uncontrolled intersections, behaviour that is rare in Australia.

The emerging problem of distracted driving appears to be getting worse and should be monitored for the implications for riders sharing road space with the distracted drivers. (National Safety Council, 2012).

Chapter 9 Prospects for a safe enough Inner Melbourne

This chapter looks to the future after reflecting on the nature and pace of change in Amsterdam and Copenhagen and the unique features of Inner Melbourne. An outline is then given of the adaptive challenge to progress to a sustainable Inner Melbourne, using the Context, Process and Content framework, as in previous chapters.

9.1 Introduction

From their mode choices, the people of Inner Melbourne are saying they understand that it is safer to walk, use motor vehicles and public transport, rather than ride. A *Sustainable Safety* vision needs to speak to both the people who do not make trips by bicycle, because of concerns about their safety; and to the decision-makers in the Municipal, Victorian and Federal governments, who may be reluctant to promote travel by bicycling for fear of increasing road trauma. The safety fears of both groups have limited thinking on the possible contribution of bicycle riding for transport to solving broader liveability, sustainability, health, and social equity problems (Aldred, 2014; Heesch et al., 2014). It is also understandable that the policymakers, politicians, and their technical advisors, have focused on investment and measures for the main-stream modes (car and public transport), that are politically popular and seem to involve lower risk.

Models from two cities, to improve safety for bicyclists, have been explored above. Amsterdam's support for bicyclist safety developed from the 1970s as the undesirable consequences of growth in automobile use and dependence on imported oil came to be appreciated. The National government supported bicycling and institutions developed significant technical know-how on safe bicycling. Copenhagen's pursuit of bicycle safety was more recent and different, as it aimed to encourage commuters to ride instead of drive. Copenhagen demonstrates what can be achieved by a city municipality in the 21st century, acting virtually alone, but with community support, to 'co-produce' a city safe enough for extensive bicycle use.

In Amsterdam and Copenhagen, there are, however, some common elements, including:

- a history of bicycling
- supportive cultural and policy contexts
- inclusive processes for broad engagement with the community and other stakeholders
- commitment to quality content that meets bicyclists needs, through an integrated policy package and comprehensive *Safe System* measures

In Melbourne, over the period of this research, the 'journey of improvement' has progressed, including:

- RACV (motoring organisation) advocating for dedicated bike lanes into the city (Sakkal, 2019)
- Lord Mayor of Melbourne giving strong support to bicycling (City of Melbourne, 2018)
- TAC continuing with steady support (within the limitations of its legislated brief) for lower speed limits
- Victorian Government establishing a new Department of Transport to follow through on the intentions of the Transport Integration Act (2010) (Government of Victoria, 2019)

For Inner Melbourne to adapt and transition to a sustainable city that is safe enough for travel by bicycle, a paradigm shift will be required, as was recognised by several of the informants for this research. A suggested approach is *adaptive leadership* (Heifetz, 2003), with change led by stakeholders, and with implementation by *co-production* (Alford, 2009). The key insight from Heifetz's research is that the power to initiate adaptive change lies outside current institutions and their ways of operating. Adaptive change requires innovation, learning, and an interpretation mind-shift to understand that problems like road congestion will not be solved by more road capacity. Adaption may, therefore, need to be led by stakeholders, not governments – at least not the Victorian or Australian Governments.

9.2 Context opportunities

For adaptive change to occur a shared understanding is needed about the reason for the change. The need for change can be understood to avert a crisis – such as impending gridlocked or unaffordable and destructive new roads – or the appeal of potential benefits, such as convenient travel and improved city amenity (Goldfinch & t'Hart, 2003; t'Hart, 2014). As noted by Heifetz, a strategic vision for change needs to connect with individual desires and experiences, reflecting an understanding and accommodation of some of the concerns of opponents of change, such as those who may want to continue to use cars – compromises of the sort practised in Amsterdam and Copenhagen.

For people to connect with the idea of change, some concrete experience of difference is valuable. As noted by informant A1, in the 1980s many Dutch people could recall the experience of growing up on low-speed streets (Woonerfs), not dominated by cars. The Victorian TAC also understands the importance of experiencing different environments and has funded European study tours for leaders and technical experts as part of implementing *Vision Zero* for road safety (Corben et al., 2009; Healy et al., 2012).

Several people consulted in this research, who now live in Melbourne but had previously been in the Netherlands or Copenhagen, said how much they valued and enjoyed the experience of safe bicycling in these European cities. Hence the importance of local demonstration projects as part of the process of change, so that more people can experience a different *Safe System* road environment. Local examples are provided by several 'traffic-calmed' neighbourhoods in the Cities of Yarra, Melbourne, and Port Phillip, and the trials of 30 km/h speed zones supported by the TAC.

A barrier in Melbourne is, however, community antagonism to 'cyclists'. Change may, therefore, need to focus on broadly supported goals, such as sustainability and liveability – as occurred in Copenhagen – rather than on safety for cyclists – as in Amsterdam. The pursuit of sustainability and liveability goals by reducing motor traffic volumes and speeds for urban amenity were identified by Jacobsen as the key changes to increase bicycling (Jacobsen et al., 2009).

Over the next decade, Inner Melbourne faces significant traffic disruption from major projects including the Metro Tunnel, the Westgate Tunnel, and the proposed Melbourne Airport Rail Link. Amsterdam and Copenhagen have decades of experience of major project disruption, which they used to change travel behaviour to support city sustainability. Already the Melbourne Metro Rail Authority is working with stakeholders to apply the *Safe System* approach to protect vulnerable road users when interacting with heavy construction traffic. A logical next step is for travel behaviour change to support greater use of bicycles. Such a 'demand management' step had been suggested but was resisted by the Victorian Government (Lucas, 2017, 2018); but could be pursued by stakeholders.

An opportunity is also developing with the need to change the taxation of road use, because of the trend for motor vehicles to use less fuel, requiring governments to look to ways to replace receipts from fuel taxes through some form of road use pricing ¹¹⁶ (Hensher & Bliemer, 2014; Stanley et al., 2011). An interesting possibility would be to include in the road use charge the cost of previously avoided 'externalities', like injuries to other road users, negative effects on health, and amenity reduction associated with motor vehicle use. Alternatively, or additionally, there could be negative taxes, with drivers paid to change to bicycles as in the Netherlands.

A better understanding is needed of the policy context. For example, the major beneficiaries from fewer drivers and more riders in the city – following improved safety for riders – will not be the new riders, but the people who continue to drive and who would experience less road congestion. Also, part of the long-term value proposition for policies of adaptive change and co-production of a sustainable transport future, would be avoiding the disruption and cost of future major projects.

¹¹⁶ For example, a road use charge could, like a taxi tariff be based on distance travelled and time the roads are used, or the charge could vary with when and where the road use occurs.

A context for change is thus envisaged that:

- responds to local contemporary challenges including congestion and increasing injuries to vulnerable road users
- is framed as a positive 'sustainable travel' vision that is not anti-car but offers wide-ranging community benefits and that responds to concerns including climate change
- is based on an understanding of the diversity of travel needs, that includes those who do not want to or cannot make some trips by bicycle, but who will benefit from less congestion

9.3 Process lessons and opportunities

Good enough safety for new bicyclists will need to be at a very high level to provide conditions safe enough for drivers to become riders. Inner Melbourne needs its own transformation to adapt to the challenges and opportunities presented by the early 21st century, involving local institutions and stakeholders, and learning from, but not copying, what has been achieved in Amsterdam and Copenhagen.

The need for change has come about because of the failure by governments to adapt to changed circumstances. Recent Victorian Governments have avoided discussion of high-level normative values, such as sustainability, and have instead shaped the public agenda as being about major project delivery with discussion limited to minor details of projects. The process of adaptive change will, therefore, need to be led by stakeholders. Heifetz suggests that the process of adaptive change starts with the clarification of 'orienting' normative values, like sustainability and liveability (2003).

A key insight from this research is that the lead stakeholders for adaptive change need to have a broad constituency, that is, beyond cycling activists. The IMAP group is one possibility, but they have very limited resources. The RACV could, like the ANWB in the Netherlands, have a key leadership role. The RACV has the advantage of being a large, independent, and broadly-based organisation with over 1 million members who own bicycles and who could switch from cars to bicycles for some short trips. The RACV, with some 2.1 million members, is also a significant political force compared to Bicycle Network – the bike rider's organisation – which has only 50,000 members. In

Inner Melbourne there is also the opportunity to build on the stakeholder relationships developed by Rail Projects Victoria and others in the CLOCS¹¹⁷ initiative to protect vulnerable road users from construction traffic¹¹⁸ which involves stakeholders (National Road Safety Partnership Program, 2019).

The adaptive change suggested in this thesis could involve some of the CLOCS stakeholders, but the intent would be broader, that is for systemic change, to reduce the risk and perceived danger of riding by people who are not existing riders.

The process lessons from Amsterdam and Copenhagen that can be taken forward in Inner Melbourne include:

- making 'people' and their needs the focus of change, not infrastructure or technology
- articulation of systemic change as an effective response to contemporary challenges, such as increasing injuries to vulnerable road users and concerns over liveability and climate change
- refinement of and compromise on proposals in dialogue with sections in the community, as can now be broadly fostered through social media
- providing lived experience of the benefits of change through trials and demonstration projects
- building community understanding of what change could mean, including the benefits of integrated design approaches that communicate road function and intended road user behaviour without reliance on regulatory signs and enforcement
- developing trust that decision-makers will seek and respond to community concerns and aspirations

Key local stakeholders in Inner Melbourne would need to include the TAC, whose staff understand *Sustainable Safety*, and the other members of the Victorian Road Safety

117 CLOCS brings organisations together from across the construction and related industries, including operators, contractors, developers, vehicle manufacturers and regulators, who share a commitment to road safety and aim to co-operatively and systematically manage risk for existing riders.

118 Melbourne's Metro Tunnel project, the Westgate Tunnel project and the Melbourne Airport Rail link are expected to generate well over a 1 million additional truck movements in the Inner Area over the next five years, thus increasing risk to vulnerable road users (VRUs). CLOCS is an excellent example of co-production but does not aim for the systemic change envisaged by 'adaptive change'.

Partnership who are the champions of *Vision Zero*. The formal brief of the TAC and the partnership would, however, need to be broadened to improve road safety more generally, by encouraging low harm modes – bicycling, walking and public transport, and land use planning to reduce exposure by shorter trips to activities. A reconstituted TAC, to a Transport Safety Commission, with a broader remit for prevention and treatment of all transport injuries, could be a key step towards adaptive change.

Opportunities have also been created by the incorporation of VicRoads into the Department of Transport. Changes could follow to advance safety over mobility through road user education, arterial road management, funding for municipalities in managing local collector roads, vehicle registration, driver licensing and road safety, including much greater support for vulnerable road users and transport integration, as was intended under the Transport Integration Act. The narrow and closed decision-making processes at VicRoads, noted by Health Academic M17, could now be opened to oversight by community members. Oversight of policy and program areas that have direct impacts on communities needs to go beyond the 'advisory' arrangements previously favoured by VicRoads, such as with the Victorian Bicycle Advisory Council.

Support for sustainable change appears to be building among engineering and planning professionals in Melbourne, as occurred in Amsterdam and Copenhagen. For example, forums related to bicycling such as those organised by the local Melbourne chapters of the AITPM and the Institution of Transportation Engineers (ITEANZ) show strong local interest in improving knowledge and expertise in bicycle planning.

9.4 Content (actions)

One motivation for this research was concern over the ethics of encouraging bicycling as sustainable travel in Inner Melbourne, which did not appear to be safe enough. As stated by Tingvall and Howarth two decades ago, providing a *Safe System* is an ethical obligation for governments (1999). The findings above show that Amsterdam and Copenhagen are well on the path of responding to ethical concerns by close and comprehensive attention to safety for bicyclists. They are now low-risk cities for interactions with motor vehicles, with use of safe bicycles, with safe operating behaviour acquired by riders and drivers during school years, and are working on improving safety for travel by bicycle on safer infrastructure.

A framework for understanding what contributes to making a city safe enough for bicycling is provided in Figure 9-1; which builds on theories outlined in Chapter 2, and the findings in Chapters 4 to 8. The framework recognises individual contexts, such as history, geography, and culture, that influence habits, choices, and perceptions.

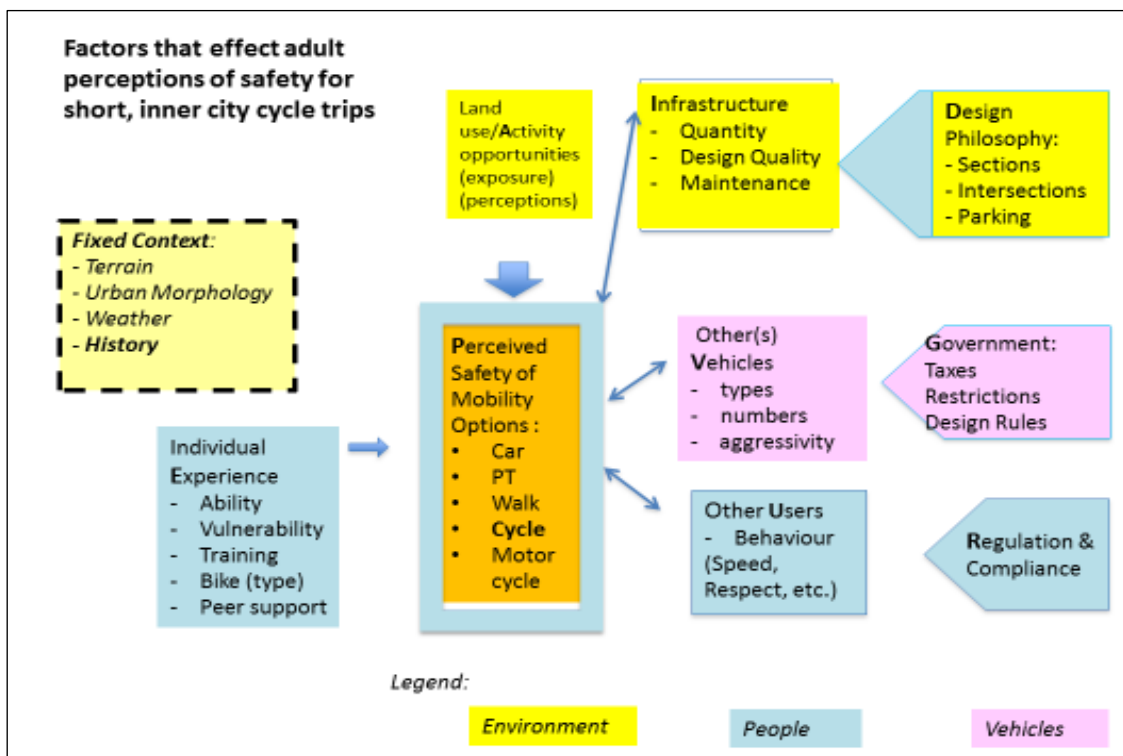


Figure 9-1 Production of safety

Perceptions about safety are a threshold issue for travel choice and are complex individual constructs, influenced by many factors including how safe the three *Safe System* pillars seem, how the system is experienced, and the match between system challenges and each rider's abilities. Future ideas for each of the factors: infrastructure environment, vehicles, and behaviour are outlined below.

9.4.1 Infrastructure

Infrastructure reflects the priorities for mobility and safety assigned by road managers between road user groups. Infrastructure also communicates to each user group, their relative status, and the level of care they can expect. Infrastructure could be worked with as an artefact to shape behaviour, rather than reactively developed to meet demand.

Good enough safety would be understood as very good objective safety for interactions with both motor vehicles, and a system that minimises by design, falls and all types of crashes, not just those with motor vehicles.

Safe infrastructure for bicycling can be considered as two complementary parts. First, local streets, where bicycles and motor vehicles can safely mix at low speed, including at local intersections, where motor vehicles would give way to bicyclists and pedestrians – as occurs in Amsterdam. Second, a separate strategic bicycle network, of off-road paths and protected lanes utilising a small percentage of existing traffic lanes – as in Copenhagen; and where at intersections and crossings, a defined path, time, and with rules for sharing that minimise conflicts. A lesson from Amsterdam is that for shared streets and any crossings and intersections where conflicts could occur, the safe operating speed should not exceed 30 km/h – for both motor vehicles and bicyclists. Low-speed sharing gives road users time to co-produce safe interactions and to minimise injuries should any conflicts occur.

Adaptive changes to infrastructure need to include detailed design which provides visual cues to behaviour for co-production of operational safety – as with the Dutch self-explaining road – but developed for the local Inner Melbourne context. For example, Inner Melbourne has unique challenges including its trams, extensive kerbside parking on arterial roads, and many wide local streets with bluestone cobbled kerb and gutter, often with trees planted in the pavement.

The infrastructure ideas that follow would explicitly give road artefacts a role in improving safety for all road users by providing cues to safe road user behaviour, as distinct from meeting the demand for a level of service for motor vehicle users. That is, infrastructure could provide a framework for co-production of safe operations and to support amenity and liveability. The suggestions that follow recognise *sustainable safety* principles, they draw inspiration from Amsterdam or Copenhagen, include some existing innovations from Inner Melbourne, and could be adapted and refined to suit Inner Melbourne conditions. A key future refinement would be to reduce several of the 40 km/h speed limits to 30 km/h.

1) Road section design detail and operation to communicate speed limits

- road markings to indicate speed limits:
 - a marked centre line only, 50 km/h
 - no centre line and marked but unprotected bike lanes, 40 km/h
 - no centre line or traffic lanes marked, 30 km/h
 - where parallel parking bays are marked in the centre of the road or street, 30 km/h
 - a traffic lane adjacent to marked angle parking, 20 km/h
 - road cross-section:
 - for narrow streets and lanes <4 m paved, 15 km/h
 - on local streets wider than 4 m but without footpaths, 30 km/h
 - local streets when pedestrians or bicyclists are present on the road, 20 km/h
 - streets, up to 7 m kerb to kerb with parking, 30 km/h
 - wide streets, that is greater than 9 m kerb to kerb, with centre of the road parking, 30 km/h
- traffic operation, stationary vehicles to indicate:
 - on any road when a stationary tram or bus is occupying a traffic lane, 40 km/h
 - on main/arterial roads, for lanes adjacent to parking lanes and where bicycle lanes are marked, 40 km/h
- abutting land use with both direct access and high pedestrian activity
 - when pedestrians are present at schools and shopping strips, (excluding roads with service roads), 40 km/h
- type and location of street vegetation providing a code for speed limits:
 - if trees are growing in the pavement – that is, on the traffic side of the kerb, 30 km/h
 - if trees are within one metre of the back of the kerb, 40 km/h
- street lighting style
 - on streets with motion sensitive lights that activate when moving vehicles or people are detected, 40 km/h
 - streetlights colour coded to indicate speed limits.

2) Speed limits through intersections

- at intersections with traffic signals where all turning movements are controlled by signals, the speed limit of the adjoining road would continue to apply
- at intersections with traffic signals but where turns are not separately controlled, 40 km/h
- through roundabouts, 40 km/h¹¹⁹
- at intersection approaches facing extended and elevated footpaths, 20 km/h

9.4.2 Vehicles

Greater attention is needed to the safety by design (and selection) of bicycles. Retailers of bicycles could be required to sell bicycles that are suitable for an individual rider's age, size, gender, ability, and trip purposes.

Through the Australian Design Rules there are opportunities to improve bicycle safety by:

- standards for bicycle stability
- stability warning devices for bicycles – as is being pursued by TNO
- conspicuity standards for flashing daytime lights

A key change for motor vehicles to enable co-production would be stricter controls on window tinting so that visual contact can be made between drivers and people outside motor vehicles.

For trucks¹²⁰, design standards equivalent to EU Directive 2003/97 for improved mirrors, and EU Directive 2007/38 for the retrofitting of indirect vision installation, and Class IV mirrors, could be required to improve driver spatial awareness. Australian businesses and governments who purchase vehicles and logistics services could also have a role by specifying the use of urban trucks that can operate safely in cities, as with CLOCS (noted above). Companies who make sizable trucks and bus fleet acquisitions could be supported with model specifications, requiring designs that provide drivers

119 In the interim, until redesigned as suggested by Wilkie et al. to deflect and slow down through traffic (Wilkie et al., 2014)

120 For over a decade European (and Japanese) truck regulators and manufactures have shown outstanding leadership in designing and supplying safer trucks, but the Australian market has not always demanded such features.

with adequate near-field visibility so they can see bicycle riders, that is, to eliminate ‘blind spots’.

Managing the interaction between system elements is likely to be of increasing importance with autonomous vehicles. For example, to avoid potentially fatal impacts, operating speed in shared space situations for all vehicles may need to be limited to 20 km/h, or lower. It would also be advisable to establish consistent safe limits in International forums as soon as possible.

9.4.3 Behaviour

Behaviour of the different groups of road users is influenced by several factors, including the quality of infrastructure, education, licensing, and the way regulations are formulated and enforced. Traffic regulations and management could be re-thought to prioritise safety. Where this re-think is most needed is at unsignalized intersections and roundabouts where the objective should be to instil caution and respect for others, instead of establishing priority rights for through vehicles. An option that could be explored would be to remove the Stop and Give Way signs, regulate maximum approach speeds to 30 km/h, and require vehicles approaching unsigned intersections to ‘give way’ to anyone in the intersection or waiting to cross. That is, establishing an environment for self-management – co-production of safety.

Also, as suggested in 9.4.1 above, the detailed design of infrastructure could be re-thought to provide a framework for co-production of safety by communicating expected behaviour. Riders would however need to be equipped with the agency and ability to contribute to their safety – as envisaged for children by Winnicott (1954).

New transport riders in Melbourne will need high level skill and knowledge: skill for operational competence; and knowledge about when and where it is, or is not, safe to ride. It is suggested that developing rider competence be based on three types of adult riders: novice, transitional, and operational, see Table 9-1 below.

Table 9-1 Developing individual competence

Rider stage	Environment needs	Behavioural needs	Vehicle needs
Novice	<i>Safe and supportive:</i> anticipates and is designed to anticipate rider failures (e.g. loss of control) with forgiving infrastructure (e.g. soft surfaces, frangible objects). Low speed (30 km/h max.) shared traffic, or physically separated from fast motor vehicles and other users (eg pedestrians and fast bicyclists).	<i>Foundation building:</i> empathic support by a skilled coach to help the novice learn the basics in a very safe, traffic-free environment. Then, to help them to develop skills to assess what environments would be safe enough for them, including when and where to not ride.	<i>Basic:</i> a simple bicycle (not an e-bike or cargo bike), with an upright riding position, that is a good 'fit', e.g. feet can be placed on the ground and brakes can be activated, and that is easily maintained in good order.
Transitional	<i>Considerate:</i> understands that the rider lacks skills but can create a comfortable level of safety. Failures in adaption not to have serious injury consequences.	<i>Development:</i> area-specific adaptive strategies (e.g. route selection), and tactics (e.g. speed control) by advice and observing a person modelling adaptive behaviour with an emphasis on primary safety - crash avoidance and no satisficing.	<i>Functional:</i> a bicycle designed for the rider's purpose, e.g. shopping, or commuter hybrid, but not a road bike with clip-in pedals.
Operational	<i>Forgiving:</i> understands rider desire for both safety and mobility, e.g. rider errors forgiven rather than punished by severe injury. Separation from high speed and heavy vehicles.	<i>Independence:</i> understands how and where to ride, including adaptations in complex environments and the risks of satisficing for mobility over safety.	<i>Specialised:</i> possibly the same bicycle as for a <i>Transitional rider</i> , but also bicycles designed for specific transport like intense commuting or 'cargo' carrying (shopping, children, etc.).

Novice riders will need very safe environments, initial personal support and help to select a bicycle that is easy to control and the right fit. Novice cyclists will need objectively safe conditions, like a park or quiet cul-de-sac, that is free of dangers where

they can feel comfortable as they develop basic skills and the capacity to make future operating adaptations to create their safety. Novice riders could be matched to a support person, coach, or buddy, who can ensure they have a bicycle that suits them, and that they gain experience in a physically safe environment, separated from motor traffic and other hazards. The riding environment would need to be as objectively safe as when walking. Basic skills such as stopping, starting, turning, positioning, and knowledge of road rules and wisdom about other road users would be learnt so they can start to successfully make adaptations in ‘good enough’ environments that can be made very safe. Their coach or buddy would need to know the high-risk environments that cannot be made safe and need to be avoided.

Transitional riders will need to be supported to graduate to more challenging but objectively safe environments. As suggested by Winnicott, a person’s adaptive success depends on reasonable continuity of ‘considerate care’, with the individual encouraged by and understanding the caring intent (Winnicott, 1954, p. 202). The environments common in Amsterdam and Copenhagen represent considerate care¹²¹ for bicyclists. The potential environments for riders in Inner Melbourne, on even a short trip, could include ‘alive neglect’ – with a high risk of serious injury. Transitional riders would thus need information on route safety and the capacity to add safety by riding tactics such as line and intended speed, to avoid situations of unacceptable risk.

A different approach would be needed for riders who are operationally competent, such as experienced sports riders, but who do not ride for transport. Operationally competent riders face distinct challenges from their ‘satisficing’¹²² behaviour, such as on time-sensitive trips, when they make moment to moment trade-offs between speed and safety, relying on their skill and experience.

121 A model for ‘considerate care’, that shows an understanding of cyclists needs, is provided by the CROW Guidelines which encompass infrastructure quality and control of motor traffic speed (CROW, 2007)

122 The satisficing decisions for drivers, as explained by Summala, include the moment to moment trade-offs between faster mobility and perceived safety (Summala, 2007).

A co-production approach could be taken to different degrees in each of the three *Safe System* areas. For example, some councils have undertaken rider education, including in conjunction with bicycle user groups (BUGs). Riding skills can also be improved by independent providers like trainer M2, or by 'buddies' as with the ANMWB program. There are also further opportunities for actions on behaviour that could be advanced with stakeholders such as the RACV and bicycling groups.

New adult riders in Inner Melbourne will lack the skills of riders in Amsterdam and Copenhagen and will face a far greater challenge to create safety for themselves in traffic environments that, unlike the environments in Amsterdam and Copenhagen, may be hostile. They will, therefore, need to be able to make judgements about risk and will need information to make informed judgements about the possibility of making a safe trip.

Riders will, therefore, need for trip specific safety information and the capacity to make judgements on riding or not riding. Riders will need information about route discontinuities, hazardous intersections with high-speed motor traffic, and infrastructure with low and inconsistent design standards or that may be poorly maintained. Information on infrastructure, traffic conditions and hazards for bicyclists could be co-produced; collected and accessed through social media, on a digital platform, as has been developed as part of the *Smart Cities* approach:

After a decade of experimentation, smart cities are entering a new phase. Although they are only one part of the full tool kit for making a city great, digital solutions are the most powerful and cost-effective additions to that tool kit in many years. ... Smart cities add digital intelligence to existing urban systems, making it possible to do more with less. Connected applications put real-time, transparent information into the hands of users to help them make better choices.

(Woetzel et al., 2018, p. 8)

A digital, riding conditions platform could be area-based and regularly updated by users – as is done with surf reports – to inform individual decisions about riding. Bicycle route conditions could be given a simple rating, as is done for ski trails in Australia and North America, rated from Easiest to Intermediate to Advanced, and updated as required.

9.5 Summary

Ideas identified and inspired by this research that could be developed to respond to the unique opportunities in Inner Melbourne include:

- the street and road environment re-thought to, by design, provide a framework for co-production of safety, communicating the behaviour expected of each road user
- over the next ten years, developing a connected network of bicycle-only ‘arterial’ infrastructure (protected lanes and paths) of adequate capacity to avoid congestion by new bicyclists
- excluding bicycles from arterial roads as practical alternative strategic links are provided in corridors – established recreational routes could be excluded
- requiring bicyclists to keep left at all times and at all intersections, including requiring right-turning (large radius turns) bicyclists to make ‘box turns’ at all¹²³ intersections – as in Copenhagen
- re-thinking regulations for the management of uncontrolled intersections to promote safe sharing instead of pre-determined priority for motor vehicles
- development of roadcraft among new transport riders, appropriate to their skill level
- providing a digital information platform to provide subjective safety rating information on streets and routes

123 At several intersections with trams in Melbourne all right turning traffic is required to make ‘box’ turns.

Chapter 10 Conclusions

In this chapter I provide my responses to the research questions used to explore why Inner Melbourne is not currently safe enough for many adults to travel by bicycle, why Amsterdam and Copenhagen appear safe enough, and what could be learnt from these cities.

Different safety outcomes across the three case study sites have been interpreted as the result of differences in:

- historic, cultural and policy contexts
- processes governing safety including institutional arrangements, decision-making processes, and cooperation of actors in the production of safety
- content of measures and actions implemented to support travel, including infrastructure, vehicles, and management of the behaviour of road users

10.1 What is 'good enough' safety in a city for adults to travel by bicycle and how safe are Inner Melbourne, Amsterdam, and Copenhagen?

Safety is relative, that is, for adults to ride instead of drive, the safety of making a trip by bicycle needs to be perceived as safe enough compared to car use, or walking, or public transport. Safety also has an objective dimension – the measurable risk of injury – the number of injuries related to exposure and governments have an ethical responsibility to ensure bicycle travel is objectively safe enough compared to other travel options provided by governments.

Travel surveys reveal the complex choices, including considerations of safety, that people make about travel options. In Amsterdam and Copenhagen, over 30% of people chose to make trips by bicycle, while in Inner Melbourne slightly more than 5% of people did. As many city trips are short and more efficiently made by bicycle in each city, fear of injury was a likely deterrent in Inner Melbourne.

Using the risk index developed in this thesis to consider the number of reported serious injury crashes related to the number of trips, the differences in risk are stark. Bicycle riders in Inner Melbourne faced, per trip, risk of serious injury six times greater than for

trips in motor vehicles or as pedestrians. In comparison with riders in Amsterdam, the risk was eighteen times higher and with riders in Copenhagen, fifteen times higher. That is, in Inner Melbourne, safety was not good enough for existing riders, and potential riders were wise not to ride.

10.2 Why is it that safety is good enough for many adults to travel by bicycle in Amsterdam or Copenhagen but not in Inner Melbourne?

The present-day safety outcomes for bicyclists in each city are understood as developing from differences in the demand for and supply of various means of city transport. From the late 19th century through to the 1950s, in Inner Melbourne, closely spaced and competitively priced suburban train and tram services were well patronised and served the city and suburban development. In the late 19th century in Amsterdam and Copenhagen, where only expensive trams had been available, the ‘safety’ bicycle was embraced as the mode for intracity trips. Bicycling met a clear need and safety needs of bicyclists were understood by decision-makers with early attention given to the provision of separate bicycle infrastructure.

From the middle of the 20th century, providing for automobiles came to dominate transport thinking in each city. Bicycling was neglected to varying degrees and from different levels of use, with bicycles were used by a significant minority in Amsterdam and Copenhagen but by very few people in Melbourne.

Amsterdam, in the 1970s, in response to community outrage over deaths to bicyclists and as part of a national response to reduce dependence on imported oil, gave renewed attention to objective safety by separate arterial infrastructure and low-speed local streets. Differences also occurred in how motor vehicles and urban growth were managed. Amsterdam was sheltered from growth in demand while Copenhagen sought to protect city amenity while providing for efficient automobile movements. Later, in Copenhagen, the approach of the municipal government was to improve the perceived safety of bicycling to encourage commuting by bicycle as a central part of the city’s ‘green’ agenda.

In both cities, safe bicycling continues to be supported by bicycling education throughout the school years and by local cultures that see bicycling as unexceptional,

something that nearly everyone does. In both cities the community participates in the co-production of safety for bicycling, appreciating the benefits of bicycling. Both municipalities have significant institutional capacity and financial resources, although the funding devoted to bicycling appears to be significantly less than what could be apportioned based on mode choice or the incidence of injuries.

In Inner Melbourne, the responsibility for primary bicycle safety – crash avoidance – has mostly been left to the small local governments, and individual bicyclists, and it is beyond both to create a comprehensive *Safe System*. The approach to safety in Melbourne has relied on coercion of riders, such as by heavy fines for failure to wear helmets (secondary safety); and has been characterised by failure to provide infrastructure or support development of safe operational competencies. Also, unlike in Copenhagen, over recent decades, policy for transport cycling has not been connected to community goals for sustainability, amenity, and liveability. Key barriers to improving bicyclist safety in Melbourne have been the institutional separation – policy silos; and a narrow road safety focus on reducing reported injury crashes involving motor vehicles, as distinct from more broadly seeking a sustainable and liveable city.

In both Amsterdam and Copenhagen, bicycling continues to be valued as contributing to convenience, liveability, and the economy of these cities. *Sustainable Safety* is part of an integrated policy approach that considers: land-use arrangements to minimize the need for long-distance intra-city travel; a balanced mix of travel options – walking, bicycling, public transport and private motor vehicle use; and revenue raised in ways that encourage behaviour with minimal externalities, such as encouraging bicycle use over car use, with less road trauma, less pollution and better population health.

The *Safe System and Sustainable Safety* approaches have included:

- recognition of cycling as a legitimate form of transport with government investment in safety improvements
- cultures of accommodation and compromise that support the legitimacy of bicycle riders as road users
- political awareness, technical capacity, and wide-ranging responsibilities of the city municipalities, including to take the lead in creating safety

- professional competence of planners and engineers resulting in the implementation of transport and land use policies and people-centred design outcomes
- two-part infrastructure: local streets with mixed-use at low speed, and arterial bicycle routes with separation from motor traffic and time or space separation at intersections

The *Sustainable Safety* approach in Amsterdam (and the Netherlands) and the Green Capital, eco-city approach in Copenhagen, both aim for long term improvement in people's lives.

10.3 What can be learnt for Inner Melbourne from Amsterdam or Copenhagen?

The main lessons from the comparative research of city safety for bicycling in Amsterdam, Copenhagen and Inner Melbourne are listed below:

- For Inner Melbourne to evolve into a city safe enough for travel by bicycle, detailed 'homegrown' solutions will be needed that are sensitive to Melbourne's context and recognise its key institutional actors, with their mandates and resources, including municipal councils, the TAC and the RACV.
- Community support is essential. This research shows what can be achieved by a municipality like Copenhagen with community support in the face of indifference from higher levels of government.
- Where there is low visible demand for safe bicycling, as in Inner Melbourne, improvements need to be pursued as a sub-set of broader liveability and sustainability agenda, as was initially done in Copenhagen.
- Copenhagen has also demonstrated the feasibility of providing for bicyclists at modest cost and over the medium term.
- Road safety needs could be framed as safety for all road users, not just those in or interacting with motor vehicles. Political and technical decision-making needs to be connected to community values and goals, including the safety of people – not just those using particular modes.
- A people-centred approach to policy and programs can lead to a re-purposing of roads for people, be they walking, on bicycles, using public transport or cars. Inner Melbourne will, however, need to develop its own approach to re-thinking streets and roads that is sensitive to the unique features and community needs of Inner Melbourne. These unique features, which include wide local streets, cobbled

roadside kerbs and channels, street trees and a dense on-road tram network, could be reimagined to provide a legible and consistent framework for co-production of safety in ‘self-explaining’ environments. Road environments could communicate speed limits, and regulations could re-think traffic operation at local street intersections, supported by behavioural programs for road users.

- Stakeholders could have a key role to educate about and mobilise support for the evolution of a local *Safe System* approach and to overcome entrenched technical and political interests focused on motor vehicle mobility.
- Developments in autonomous vehicles and power sources are likely to have major implications for bicyclists and need urgent attention; otherwise Australia will be left to accept the design rules developed elsewhere, that may not be a good fit with local conditions. Separation of riders from higher speed motor vehicles could become a top priority.
- New riders in Inner Melbourne face a traffic system that is much more challenging than in Amsterdam or Copenhagen, yet they have comparatively low road craft skills. Inner Melbourne’s sparse, disconnected, and inconsistent infrastructure means new riders will need information on areas where it is safe to ride and when. Two actions are essential:
 - training and support for new riders
 - a digital platform that provides subjective¹²⁴ safety information about route and riding conditions related to rider ability
- To guide the development of policy and programs for equitable safety, better injury data is also needed that includes bicyclist only injuries.

10.4 Contribution

This research furthers the understanding of why transport riders are a minority in Inner Melbourne, and what could be done to improve safety so that a broad demographic of adults, including more women, could consider riding for transport. City safety for bicyclists was conceptualised by drawing on several disciplines in addition to urban planning and engineering.

¹²⁴ That is, real time, rider produced information (rather than historic data on where reported injuries occurred) as with BikeSpot being developed by <http://crowdspot.com.au/> in 2020.

The CPC model developed in this thesis encompasses the complex influences on safety outcomes including context – historic, cultural and policy, local processes of governance and decision-making, the content of measures/actions – adapted to include the ‘*Safe System*’ pillars, local actors, and artefacts. The CPC model provided a robust organising framework that enabled consideration of opportunities for broader, systemic change. The analysis revealed that the barriers faced by could-be bicyclists in Inner Melbourne are far more challenging than for riders in Amsterdam or Copenhagen.

For the comparative case study, three inner-city areas of Melbourne, Amsterdam, and Copenhagen were identified to be sufficiently similar on a range of measures so as to potentially reveal obscured differences. The Inner Melbourne study area, an aggregation of five municipalities, was of similar size and population to Amsterdam and Copenhagen. Other case studies have usually compared Amsterdam or Copenhagen to either the small City of Melbourne or the much larger Metropolitan Melbourne area.

The embedded quantitative analysis included the development of a measure of exposure based on trip numbers, the R index, to reveal differences in objective safety between modes and between cities. Safety for bicycling for could-be adult riders was considered relative to the safety of modes available in each city – walking, car, and bike use – and between cities. This research thus addressed a gap in much previous road safety research that did not account for exposure related to trips.

Objective and subjective dimensions of safety were defined, and a framework provided to consider the interactions between objective safety (risk) – of ethical importance to policy and decision-makers; and perceived safety (comfort or low danger) – of importance to individual travellers.

Application of the interpretive research approach to the urban planning problem of city safety for bicyclists, allowed the use of a mix of quantitative and qualitative methods, including document analysis, interviews, and observation to provide insights from multiple social and technical perspectives. Fundamental differences were identified that have influenced safety outcomes for bicyclists in the three case study cities.

Socio-technical systems theory provided a robust framework to consider the nature of safety and the factors that contribute to the safety of bicycling in different cities. The theories on adaptive change and co-production from the public policy area provided practical ways to approach the implementation of change.

The psychoanalytic perspective of 'good enough' parenting, developed by the British psychotherapist Donald Winnicott, enabled the role of Governments and decision-makers to be reconceptualised for the co-production of city safety. That is, Governments can acknowledge that they alone cannot create safety that is good enough for bicycling. However, they can act with the best of intentions, provide safe enough traffic conditions, safe enough vehicles, and equip riders with the operating skills necessary to co-produce high levels of safety for bicycle transport.

Opportunities for implementation are explored by drawing on ideas from public policy. It is suggested that the use of existing infrastructure could be re-thought and re-engineered to provide a framework for governments and road users to work together on the co-production of sustainability, amenity, and safety. That is, having regard to Inner Melbourne's unique attributes and the culture of the population, a vision for a safe enough city for bicycling is advanced as part of a change to a sustainable city, founded on the shared value of liveability.

An implication of this research is that it could be possible to advance safety for bicyclists in Inner Melbourne at modest cost by re-thinking system management and implementing change, with broad community and stakeholder support, through a co-production approach. The research also provides a foundation for further research on design improvements to existing streets and community engagement via a digital platform to provide real-time safety information for new riders.

References

- Adams, J. (1995). *Risk: the policy implications of risk compensation and plural rationality*. Taylor and Francis e-Library: London.
- Agudo, S. J. S. (2014). *The Dutch and Their Bikes*. XPat Scriptum: Nieuwe Haven.
- Aldred, R. (2014). Benefits of investing in cycling. British Cycling: Manchester.
- Aldred, R. (2017). The culture behind the infrastructure - Understanding why people don't cycle. Paper presented at the Allgemeiner Deutscher Fahrrad-Club Symposium, Fahrradland, Germany.
- Aldred, R., et al. (2017). Cycling provision separated from motor traffic: a systematic review exploring whether stated preferences vary by gender and age. *Transport Reviews*, 37(1), 29-55.
- Alford, J. (2009). *Engaging Public Sector Clients : From service-delivery to co-production*. Palgrave Macmillan: Basingstoke, Hampshire.
- Anderson, T., et al. (2012). *Collection of Cycling Concepts 2012*. Cycling Embassy of Denmark: Copenhagen.
- Appelt, V., et al. (2011). Report on Transferability Audit (Draft). European Commission: Rome.
- Arnold, V. H. (1973). Victorian Year Book 1973, Centenary Edition. Melbourne.
- Australian Department of Infrastructure and Transport. (2012). *Overcoming Barriers to Walking and Cycling*. Commonwealth of Australia: Canberra.
- Australian Transport Council. (1999). *Australian Road Rules*. National Road Transport Commission: Melbourne.
- Austroroads. (2013). Improving the Performance of Safe System Infrastructure: Stage 1 Interim Report. Austroroads: Sydney.
- Avenoso, A., & Beckmann, J. (2005). The safety of vulnerable road users in the southern, eastern and central European countries. European Transport Safety Council: Brussels.
- Baker, P. C. (2019). Collision course: why are cars killing more and more pedestrians. *The Guardian* 3/10/2019.
- Bamberg, S., et al. (2011). Behaviour theory and soft transport policy measures. *Transport Policy*, 18(1), 228-235.
- Banister, D. (2008). The sustainable mobility paradigm. *Transport Policy*, 15(2), 73-80. doi: <https://doi.org/10.1016/j.tranpol.2007.10.005>

- Bauman, A. E., et al. (2008). Cycling: Getting Australia Moving: Barriers, Facilitators and Interventions to Get More Australian Physically Active Through Cycling. Paper presented at the 31st Australasian Transport Research Forum 2008.
- Beck, B., et al. (2016). Bicycling crash characteristics: An in-depth crash investigation study. *Accident Analysis & Prevention*, 96, 219-227.
- Beckmann, J. (2004). Mobility and safety. *Theory, Culture & Society*, Vol. 21(4/5), 81-100. doi: 10.1177/026327640404046062
- Bell, E., & Thorpe, R. (2013). *A Very Short Fairly Interesting Book about Management Research*. Sage: London.
- Benington, J., & Moore, M. H. (2011). Public value in complex and changing times *Public Value: Theory and Practice* (pp. 1-30). Palgrave Macmillan: Basingstoke, Hampshire.
- Bicycle Dutch. (2012). Sustainable Safety. 7. Retrieved from: <http://bicycledutch.wordpress.com/2012/01/02/sustainable-safety/>
- Bicycle Dutch. (2014). Amsterdam can send mopeds to the carriageway. Retrieved from <https://bicycledutch.wordpress.com/2014/06/05/amsterdam-can-send-mopeds-to-the-carriageway/>
- Bicycle Network. (2017). Bicycle Network Crash Report 2012-2016. Melbourne.
- Bicycle Victoria. (2008). Priority bike route network for IMAP. Melbourne.
- Biegler, P., et al. (2012). Monash Alfred Cyclist Crash Study (MACCS). MUARC: Clayton.
- Biguzzi, A. (2014). Database of City Populations from around the World over time. *World City Populations*. Retrieved 13/05/2015 from http://worldcitypop.com/1_data.asp
- Blainey, G. (2013). *A History of Victoria*. Cambridge University Press: Melbourne.
- Boonghee, Y., et al. (2011). Measuring Hofstede's Five Dimensions of Cultural Values at the Individual Level: Development and validation of CVSCALE. *Journal of International Consumer Marketing*, 23(3/4), 193-210. doi: 10.1080/08961530.2011.578059
- Boufous, S., et al. (2010). Factors in Cyclist Casualty Crashes in Victoria. George Institute: Sydney.
- Brett, J. (2017). *The Enigmatic Mr Deakin*. Text Publishing: Melbourne.
- Brown-May, A., et al. (2005). *The Encyclopedia of Melbourne*. Melbourne: Cambridge University Press: Melbourne.
- Bryman, A. (2012). *Social Research Methods* (4th ed.). Oxford University Press: New York.

- Buehler, R., & Pucher, J. (2012a). Big city cycling in Europe, North America, and Australia. In J. Pucher & R. Buehler (Eds.), *City Cycling* (pp. 287-318). The MIT Press: Cambridge, MA.
- Buehler, R., & Pucher, J. (2012b). International overview: Cycling trends in Western Europe, North America, and Australia. In J. Pucher & R. Buehler (Eds.), *City Cycling* (pp. 9-29). MIT Press: Cambridge, MA.
- Buiter, H. (2013). Why the Netherlands became a country of cyclists. Paper presented at the Federation Internationale De L'Automobile (FIA) Mobility Conference 2013, The Hague.
- Cameron, M. H., et al. (1994). Mandatory bicycle helmet use following a decade of helmet promotion in Victoria, Australia—an evaluation. *Accident Analysis & Prevention*, 26(3), 325-337.
- Cannon, M. (1967). *The Land Boomers* (2nd ed.). MUP: Melbourne.
- Carey, A. (2016). Melbourne's cycling-friendly reputation on the line as bike budgets go flat. *The Age*, 29/06/2016.
- Cavill, N. (2012). *Highlighting the Costs and Benefits of Cycling*. Cavill Associates: Oxford.
- City of Amsterdam. (2007). *Leidraad Centrale Verkeers Commissie*. City of Amsterdam: Amsterdam.
- City of Amsterdam. (2012a). *Cycling in Amsterdam*. City of Amsterdam: Amsterdam.
- City of Amsterdam. (2012b). *Road Safety 2012-2015*. City of Amsterdam: Amsterdam.
- City of Amsterdam. (2012c). *Summary Long-term Bicycle Plan 2012 – 2016*. City of Amsterdam: Amsterdam.
- City of Amsterdam. (2014). *Plan Amsterdam, Cycling Policy and Design*. City of Amsterdam: Amsterdam, retrieved from <http://www.amsterdam.nl/gemeente/organisatie-diensten/dienst-ruimtelijke/making-amsterdam/planamsterdam-magazi/2014/4-2014-cycling/>.
- City of Amsterdam. (2017). *New rules for mopeds and scooters in Amsterdam*. City of Amsterdam: Amsterdam.
- City of Copenhagen. (2007b). *Eco-Metropolis - Our Vision for Copenhagen*. City of Copenhagen: Copenhagen, retrieved from http://kk.sites.itera.dk/apps/kk_pub2/pdf/674_CfbnhMePZr.pdf.
- City of Copenhagen. (2011). *Good, Better, Best The City of Copenhagen's Bicycle Strategy 2011-2025*. City of Copenhagen: Copenhagen.

- City of Copenhagen. (2012). Copenhagen City of Cyclists, Bicycle Account 2012. City of Copenhagen: Copenhagen.
- City of Copenhagen. (2013a). Copenhagen 2013-2020, Traffic Safety Plan. City of Copenhagen: Copenhagen.
- City of Copenhagen. (2013b). *Focus on Cycling*. City of Copenhagen: from http://kk.sites.itera.dk/apps/kk_pub2/pdf/1133_mLNsMM8tU6.pdf.
- City of Copenhagen. (2014a). Copenhagen City of Cyclists. City of Copenhagen: Copenhagen, from <http://www.cycling-embassy.dk/wp-content/uploads/2015/05/Copenhagens-Bicycle-Account-2014.pdf>.
- City of Copenhagen. (2014b). Copenhagen European Green Capital 2014; A review. City of Copenhagen: Copenhagen.
- City of Copenhagen. (2014c). *Københavns Kommunes administrationsgrundlag for trafikledelse 2014-2018*. City of Copenhagen: Copenhagen, from <http://subsite.kk.dk/~media/AD08EEC67019448A880E4E5C11AC9233.a.shx>.
- City of Copenhagen. (2015). Copenhagen City of Cyclists, The Bicycle Account 2014. City of Copenhagen: Copenhagen.
- City of Maribyrnong. (2014). Maribyrnong Bicycle Strategy 2014. City of Maribyrnong: Maribyrnong.
- City of Melbourne. (2016). Bicycle Plan 2016-2020. City of Melbourne: Melbourne.
- City of Melbourne. (2018). Cycling key to unlocking congestion [Press release, 31/05/2018]
- City of Port Phillip. (2011). Bike Plan 2012-2020. City of Port Phillip: St Kilda.
- City of Port Phillip. (2018). Local area speed limit changes [Press release]
- City of Yarra. (2010). The City of Yarra Bicycle Strategy 2010-2015. City of Yarra: Richmond.
- Cockfield, S. (2011). Road safety-the experience of the Transport Accident Commission in Victoria, Australia, Discussion Papers, No. 2011/24. Paper presented at the International Transport Forum, Paris.
- Cockfield, S. (2014). *Victoria's new Safe System Road Infrastructure Program*. Paper presented at the National Road Safety Forum, Canberra. https://infrastructure.gov.au/roads/safety/nrsf/2014/files/Session_2_Samantha_Cockfield.pdf
- Colville-Anderson, M. (2018). *Copenhagenize The Definitive Guide to Global Bicycle Urbanism*. Island Press: Washington, DC.
- Cooper, A. (2012). Baillieu put under the pump on cycling budget. *The Age*, 23/07/2012, p. 1.

- Copenhagen Portal. (2018). Brief History about Copenhagen. from <http://www.copenhagenedk.dk/CPH-History.htm>
- Copenhagenize Design Company. (2015). The 2015 Copenhagenize Index, Bicycle friendly Cities. Retrieved 18/6/2015, from Copenhagenize Design Company <http://copenhagenize.eu/index/index.html>
- Corben, B., & Oxley, J. (2006). The Next Steps, Emerging road safety philosophies and their significance for safe walking. Paper presented at the Walk 21, The 7th International Conference on Walking and Liveable Communities,, Melbourne. www.walk21.com
- Corben, B., et al. (2009). Safe Road Infrastructure Program (SRIP3) Study Tour to High-Performance European Countries, October 2008. MUARC/TAC: Melbourne.
- Corben, B. F., et al. (2010). Strengthening road safety strategy development 'Towards Zero' 2008-2020 - Western Australia's experience scientific research on road safety management SWOV workshop 16 and 17 November 2009. *Safety Science*, 48(9), 1085-1097. doi: 10.1016/j.ssci.2009.10.005
- Creswell, J. W., & Clark, V. L. P. (2011). *Designing and conducting mixed methods research* (2nd ed.). Sage: California.
- CROW. (2007). *25: Design Manual for Bicycle Traffic* (CROW Ed.). CROW: Ede, The Netherlands.
- Cumming, B. (2011). Roundabouts: Why they are dangerous for cyclists and what can be done about it. *Transport Engineering in Australia*, 13(1), 27-40.
- Curtis, C., et al. (2010). Melbourne: Policy Position, Working Paper Number 2. Melbourne.
- D'elia, A., & Newstead, S. (2015). Pedestrian injury outcome as a function of vehicle market group in Victoria, Australia. *Traffic Injury Prevention*, 16(7), 709-714.
- Danish Cycling Embassy. (2017). Danish Cycling Know-How. Denmark.
- Danish Cyclists' Federation. (2018): Your entry to Danish cycling. From <https://www.cyklistforbundet.dk/englis>
- Danish Road Directorate. (2011). *Road Safety Principles*. Danish Road Directorate: Copenhagen. From <http://english-vejregler.lovportaler.dk/ShowDoc.aspx?t=%2fv1%2fNavigation%2fVejreglerEnglish%2fConstruction+and+planning%2f&docId=vde-2014-0002-full>.
- Danish Road Directorate. (2012). *Manual of Traffic Planning in Cities*. Danish Road Directorate: Copenhagen. From <http://vejregler.lovportaler.dk/ShowDoc.aspx?t=%2fv1%2fNaviga>.

- Danish Road Directorate. (2017). Welcome to Denmark. From http://www.nvfnorden.org/library/Files/Sanne%20Attermann_Welcome%20to%20Denmark%20the%20Danish%20Road%20Directorate.pdf
- Davison, G. (1978). Public Utilities and the expansion of Melbourne in the 1880's. In J. W. McCarty & C. B. Schedvin (Eds.), *Australian Capital Cities* (pp. 82-101). Sydney University Press: Sydney.
- Davison, G. (1979 - 2004). *The rise and fall of marvellous Melbourne* (2nd ed.). Melbourne University Press: Carlton.
- Davison, G. (2004). *Car Wars*. Allen and Unwin: Crows Nest.
- Department of Economic Development Jobs Transport and Resources. (2015). *Travel in metropolitan Melbourne VISTA Survey 2013*. Government of Victoria: Melbourne. From <http://economicdevelopment.vic.gov.au/vista>.
- Department of Environment Land Water and Planning. (2017). Plan Melbourne 2017-2050. from <http://www.planmelbourne.vic.gov.au/>
- Department of Justice, & Department of Sustainability and Environment. (2005). *Safer Design Guidelines for Victoria*. Government of Victoria: Melbourne.
- Department of Transport Victoria. (2009). *Victorian Integrated Survey of Travel and Activity 2007 (VISTA 07)*. Government of Victoria: Melbourne.
- Directorate-General for Passenger Transport. (1999). *The Dutch Bicycle Master Plan, description and evaluation in a historical context*. Directorate-General for Passenger Transport: The Hague.
- Drew, J., & Grant, B. (2017). Introduction to Australian Local Government Economics and Finance *Local Government in Australia* (pp. 265-291). Springer: Singapore.
- Dwyer, C. (2011). Socio-technical systems theory and environmental sustainability. *Sprouts : working papers on information systems*, 11(3).
- European Commission. (2010). *Towards a European road safety area: policy orientations on road safety 2011-2020* (COM 389). European Commission: Brussels. From https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/pdf/road_safety_citizen/road_safety_citizen_100924_en.pdf.
- European Cyclist Federation. (2011). *Lorry/Cyclist Blind Spot Accidents*. European Cyclist Federation: Brussels.
- European Transport Safety Council. (2013). *Risks on the roads - a male problem?* ETSC: Brussels.
- Fietsberaad. (2009). *Cycling Cities*. Fietsberaad: Amsterdam.

- Fietsberaad. (2010). The bicycle capitals of the world: Amsterdam and Copenhagen (Vol. 7A). Velo-city conference Copenhagen. Fietsberaad: Amsterdam.
- Fildes, B., et al. (2017). City of Yarra – 30 km/h speed limit: pre-trial final report. MUARC: Clayton.
- Fishman, E., & Schepers, P. (2014). Global bikeshare: what the data tells us about safety. Paper presented at the 3rd International Cycling Safety Conference, Gothenburg.
- Fishman, E., et al. (2012). Understanding the fear of bicycle riding in Australia. *Journal of the Australasian College of Road Safety*, 23(3).
- Fitts, T. (2013). Improving access for cyclists at signalised intersections. Paper presented at the Bike Futures 2013, Melbourne.
- Forester, J. (1994). *Bicycle transportation: a handbook for cycling transportation engineers* (2nd ed.). MIT Press: Cambridge, Mass.
- Freeman, C., & Tranter, P. (2011). *Children and their urban environment: changing worlds*. Earthscan: London
- Furth, P. G. (2012). Bicycle infrastructure for mass cycling: a transatlantic comparison. In J. Pucher & R. Buehler (Eds.), *City Cycling* (pp. 103 – 139). Massachusetts Institute of Technology: Cambridge, Massachusetts.
- Furth, P. G. (2017). Systematic Safety: the principles behind Vision Zero [Video]: BicycleDutch.
- Garrard, J. (2011). Bikes as transport: getting Australian women along for the ride. Retrieved from: <http://theconversation.com/bikes-as-transport-getting-australian-women-along-for-the-ride-2157>
- Garrard, J., et al. (2010). Cycling injuries in Australia: Road safety's blind spot? *Journal of the Australasian College of Road Safety*, 21(3).
- Garrard, J., et al. (2008). Promoting transportation cycling for women: the role of bicycle infrastructure. *Preventive Medicine*, 46(1), 55-59.
- Garratt, M., et al. (2015). Road crashes involving bike riders in Victoria, 2002-2012. TAC: Melbourne.
- Geels, F. W. (2004). From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. *Research policy*, 33(6), 897-920.
- Gehl, J., et al. (2011). Cities for people. *Planning News*, 37(4).
- Gemeente Amsterdam. (2012). Facts and figures: Road Safety 2012 – 2015. City of Amsterdam: Amsterdam.

- Giles-Corti, B., & Whitzman, C. (2012). Active living research: Partnerships that count. *Health & Place, 18*, 118-120.
- Godefrooij, T. (2014). Road Safety. In S. Agudo (Ed.), *The Dutch & Their Bikes*. XPat Scriptum: Nieuwe Haven.
- Goldfinch, S., & t'Hart, P. (2003). Leadership and institutional reform: Engineering macroeconomic policy change in Australia. *Governance, 16*(2), 235-270. doi: 10.1111/1468-0491.00215
- Goodwin, P. (2008). Policy incentives to change behaviour in passenger transport. Paper presented at the OECD International Transport Forum on Transport and Energy: The challenge of climate change. Leipzig.
- Gössling, S. (2013). Urban transport transitions: Copenhagen, City of Cyclists. *Journal of Transport Geography, 33*, 196-206.
- Government of Victoria. (2012). *Cycling into the Future 2013–23 Victoria's Cycling Strategy*. Victorian Government: Melbourne.
- Government of Victoria. (2014). *Plan Melbourne*. Government of Victoria: Melbourne. From https://www.planning.vic.gov.au/_data/assets/pdf_file/0016/104182/Plan-Melbourne-2014-WEB-PT1.pdf.
- Government of Victoria. (2019). About the Department of Transport. Retrieved from <https://transport.vic.gov.au/about>
- Greater Copenhagen Committee. (2018). About Greater Copenhagen. From <http://www.greatercph.com/about>
- Green, D. M., & Swets, J. A. (1966). *Signal detection theory and psychophysics*. John Wiley: Oxford.
- Greig, R. (2010). Limitations on the use of the term 'Cyclist' to describe people who ride bicycles. Paper presented at the Australian Cycling Conference, Adelaide.
- Grous, A. (2011). *The British Cycling Economy - Gross Cycling Product Report*. London School of Economics: London.
- Haddon Jr, W. (1972). A logical framework for categorizing highway safety phenomena and activity. *The Journal of Trauma and Acute Care Surgery, 12*(3), 193-207.
- Hall and Partners. (2010). *Cyclist Segmentation Research - Final Report*. Open Mind: Melbourne.
- Hamer, P., et al. (2011). Parking Price Policies–A review of the Melbourne congestion levy. Paper presented at the 34th Australasian Transport Research Forum, Adelaide.

- Harland, J. C. (2016). Email to the author. 7/04/2016. Subject: Bikepaths.
- Harman, B. (2007). *Bicycle Law Enforcement*.
<https://arsrpe.acrs.org.au/index.cfm?action=main.paper&id=818>
- Harris, G. (2005). Melbourne's green belt and wedges: A short history of open places and spaces in the city and their strategic context. RMIT: Melbourne.
- Healy, D., et al. (2012). Safe Road Infrastructure Programme (SRIP) study tour to high performing European countries, May/June 2012. TAC, MUARC.
- Heesch, K. C., et al. (2014). Cycling for transport and recreation: associations with socio-economic position, environmental perceptions, and psychological disposition. *Preventive Medicine*, 63, 29-35.
- Heesch, K. C., et al. (2012). Gender differences in recreational and transport cycling: a cross-sectional mixed-methods comparison of cycling patterns, motivators, and constraints. *International Journal of Behavioral Nutrition and Physical Activity*, 9(1), 106.
- Heifetz, R. A. (2003). Adaptive work. *DEMOS COLLECTION*(19), 68-78.
- Heinen, E., et al. (2010). Commuting by bicycle: an overview of the literature. *Transport Reviews*, 30(1), 59-96.
- Hembrow, D. (2014). The best roundabout design for cyclists. From www.aviewfromthecyclepath.com/2014/05/the-best-roundabout-design-for-cyclists.html?m=0
- Hensher, D. A., & Bliemer, M. C. (2014). What type of road pricing scheme might appeal to politicians? Viewpoints on the challenge in gaining the citizen and public servant vote by staging reform. *Transportation Research Part A: Policy and Practice*, 61, 227-237.
- Hofstede, G. (2001). *Culture's consequences: Comparing values, behaviors, institutions and organizations across nations*. Sage Publications:Thousand Oaks, California.
- Horton, D. (2007). Fear of cycling. In D. Horton, P. Rosen, & P. Cox (Eds.), *Cycling and Society* (pp. 133-152). Ashgate: Aldershot, Hampshire.
- Hydén, C., et al. (1999). WALCYNG How to enhance WALking and CYcliNG instead of shorter car trips and to make these modes safer *Deliverable D6*. University of Lund: Sweden.
- Illich, I. D. (1974). *Energy and Equity*. Calder & Boyars Ltd: Great Britain.
- Inner Melbourne Action Plan. (2013). About IMAP. From <http://imap.vic.gov.au/index.php?page=about-imap>

- Inner Melbourne Action Plan. (2016). Inner Melbourne Action Plan 2016-2026.
From
http://imap.vic.gov.au/uploads/Strategy%20Documents/Inner%20Melbourne%20Action%20Plan%20FINAL_Website%20version.pdf
- Institute for Road Safety Research (SWOV). (2016). Index of Road Safety Measures. Retrieved 31/03/2018, from <https://www.swov.nl/en/tools/asures>
- International Traffic Safety Data and Analysis Group (IRTAD). (2013). Road Safety Annual Report 2013 (I. T. F. International Traffic Safety Data and Analysis Group, OECD, Trans.). OECD: Paris.
- Jacobsen, P. L. (2003). Safety in numbers: More walkers and bicyclists, safer walking and bicycling. *Injury Prevention*, 9(3), 205-209.
- Jacobsen, P. L., et al. (2009). Who owns the roads? How motorised traffic discourages walking and bicycling. *Injury Prevention*, 15(6), 369-373.
- Jacobsen, P. L., et al. (2015). Safety in numbers for walkers and bicyclists: Exploring the mechanisms. *Injury Prevention*, 21(4), 217-220.
- Jacobsen, P. L., & Rutter, H. (2012). Cycling Safety. In J. Pucher & R. Buehler (Eds.), *City Cycling* (pp. 141-156). MIT Press: MA.
- Jensen, N. (2009). How Copenhagen became a cycling city. City of Copenhagen: USA.
- Jensen, N. (2013). Planning a Cycling Infrastructure - Copenhagen - city of cyclists. In J. Dextre, M. Hughes, & L. Bech (Eds.), *Cyclists & Cycling Around the World, Creating Liveable & Bikeable Cities* (pp. 127 - 138). Lima, Peru: Fondo Editorial de la Pontificia Universidad Catolica del Peru.
- Johnson, M. (2011). *Cyclist safety: an investigation of how cyclists and drivers interact on the roads*. (PhD Thesis), Monash University. Retrieved from <http://arrow.monash.edu.au/hdl/1959.1/530304>
- Johnson, M., et al. (2010). Naturalistic cycling study: Identifying risk factors for on-road commuter cyclists. *Annals of Advances in Automotive Medicine*, 54, 275-283.
- Jordan, P. (2013). *In the city of bikes: The story of the Amsterdam cyclist*. Harper Collins: New York.
- Jurewicz, C., et al. (2014). Improving roadside safety: Summary report. Austroads: Sydney.
- Kambanas, A. (2012). What I loved and hated about cycling in Copenhagen. *London Cyclist*. <https://www.londoncyclist.co.uk/what-i-loved-and-hated-about-cycling-in-copenhagen/> Retrieved 5/12/2012

- Katz, B., & Noring, L. (2016). Why Copenhagen works. *Project on 21st Century City Governance*. Brookings Institute: Washington, D.C.
- Katz, R., et al. (2012). Making bike safety research count. Paper presented at the Road Safety Conference 2012, Sydney.
- Kayser, A. (2017, March 2017). Copenhagen: the Cycling City. From <http://nws.euocities.eu/MediaShell/media/CREATETechnicalMeeting.pdf>
- Kharis, R., & Friel, S. (2014). A conceptual framework for researching the processes of integrating public health and environmental goals in food policy. Paper presented at the Public Policy Network Annual Graduate Conference, Canberra. http://www.ppnc.com.au/uploads/1/9/6/2/19623627/ruth_kharis_and_s_haron_friel.pdf
- KiM Netherlands Institute for Transport Policy Analysis. (2014). Mobility Picture 2014. KiM: The Hague.
- KiM Netherlands Institute for Transport Policy Analysis. (2016). Mobility Report 2016. KiM: The Hague.
- Knowles, R. D. (2012). Transit oriented development in Copenhagen, Denmark: from the finger plan to Ørestad. *Journal of Transport Geography*, 22, 251-261.
- KO, D. (2011). Cycling in Copenhagen. Retrieved from underlying <http://innercitymobility.blogspot.com/2011/10/cycling-in-copenhagen.html>
- Koornstra, M. J. (1992). Research and road safety in Europe. Paper presented at the Road Safety in Europe, Conference, 1992, Berlin, Germany.
- Krizek, K. J., & Marten, K. (2015). Land use changes, transport poverty and potential mobility solutions; An exploration of a possible future. KiM: Nijmegen.
- Latour, B. (2005). *Reassembling the social: an introduction to Actor-Network-Theory*. Oxford University Press: Oxford.
- Laughton, A. M. (1911). Victorian Year-Book, 1910-11 (Vol. 31). Melbourne.
- Lee, I. M., et al. (2012). Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *The Lancet*, 380(9838), 219-229.
- Lindsay, V. (2013). Injured cyclist profile - An in-depth study of a sample of cyclists injured in road crashes in South Australia. Centre for Automotive Safety Research, The University of Adelaide: Adelaide.

- Low, N. (2007). Towards a bicycle infrastructure plan for Metropolitan Melbourne. Australasian Centre for the Governance and Management of Urban Transport (GAMUT): Melbourne.
- Low, N., & Astle, R. (2009). Path dependence in urban transport: an institutional analysis of urban passenger transport in Melbourne, Australia, 1956–2006. *Transport Policy*, 16(2), 47-58.
- Lowe, M., et al. (2015). Improving integrated planning in Melbourne: Exploring barriers and enablers of health-promoting policy integration. Paper presented at the State of Australian Cities Conference 2015, Gold Coast, Queensland.
http://researchbank.acu.edu.au/cgi/viewcontent.cgi?article=9298&context=fhs_pub
- Lucas, C. (2017). Premier Daniel Andrews intervenes on safer bicycle lanes plan for St Kilda Road. *The Age*. 14/04/2017.
- Lucas, C. (2018). Temporary road closures for big projects should be permanent. *The Age*. 1/03/2018.
- Major Cities Unit. (2012). State of Australian Cities 2012. Australian Government: Canberra.
- Marshall, W. E., & Garrick, N. W. (2011). Evidence on why bike-friendly cities are safer for all road users. *Environmental Practice*, 13(1), 16-27.
- Maslow, A. H. (1943). A theory of human motivation. *Psychological review*, 50(4).
- McDonald, L. (2014, Feb 3, 2014). Amsterdam Government. Retrieved 13/08/2014, from <https://prezi.com/mz-hhkofp1mi/amsterdam-government/>
- McLean, A. J., et al. (1994). Vehicle travel speeds and the incidence of fatal pedestrian collisions. NHMRC Road Accident Research Unit, University of Adelaide. Federal Office of Road Safety: Canberra, ACT.
- Meadows, D. H., et al. (1972). *The limits to growth*. Earth Island Limited: London.
- Meggs, J., et al. (2012). Best Practices in Cycling. European Union Regional Development Fund: University of Bologna.
- The Planning Act in Denmark, Consolidated Act No 813 61, Ministry of the Environment, Denmark 2007.
- Ministry of Transport. (2018). The Ministry of Transport, A brief organisational overview, from <https://www.trm.dk/media/3775/organisational-overview-netversion.pdf>

- Mooren, L., et al. (2011). Safe System-Comparisons of this Approach in Australia. Paper presented at A Safe System: Making it Happen! Conference, Melbourne.
- Morgan, A. S., et al. (2010). Deaths of cyclists in London: trends from 1992 to 2006. *BMC Public Health*, 10(699).
- Moriarty, P., & Mees, P. (2006). The Journey to Work in Melbourne. Paper presented at the 29th Australasian Transport Research Forum, Surfers Paradise.
- Muir, C., et al. (2018). Evolution of a holistic systems approach to planning and managing road safety: the Victorian case study, 1970–2015. *Injury Prevention*, 0:1-6. injuryprev-2017-042358.
- Munro, C. (2015). National Cycling Participation Survey 2015: Victoria. Australian Bicycle Council: Sydney.
- National Association of City Transportation Officials (NACTO). (2012). *Urban Bikeway Design Guide* (2nd ed.). National Association of City Transportation Officials: New York.
- National Road Safety Partnership Program. (2019). NRSPP Secures NHVR Safety Funding for Adapting Transport for London's Construction Logistics and Community Safety Initiative in Australia [Press release]. from <https://s3-ap-southeast-2.amazonaws.com/cdn-nrspp/wp-content/uploads/sites/4/2017/07/21114133/Understanding-Construction-Logistics-And-Cyclist-Safety-CLOCS-A-Practical-Guide.pdf>
- National Safety Council. (2012). Understanding the distracted brain, why driving while using hands-free cell phones is risky behaviour *White Paper*. National Safety Council: Itasca, Illinois.
- Newman, P. (1992). The compact city: An Australian perspective. *Built Environment (1978-)*, 18(4), 285-300.
- Nieuwesteeg, M. (2013). TACKling the risk - setting the scene. Paper presented at the Bike Futures, Melbourne.
- Noland, R. B. (1995). Perceived risk and modal choice: risk compensation in transportation systems. *Accident Analysis & Prevention*, 27(4), 503-521.
- OECD. (2009). Metropolitan Governance in Copenhagen Territorial Reviews (pp. 207-239). OECD Publishing: Paris. From www.oecd-ilibrary.org/urban-rural-and-regional-development/oecd-territorial-reviews-copenhagen-denmark-2009/metropolitan-governance-in-copenhagen_9789264060036-4-en.

- OECD. (2013). Environment at a glance 2013: OECD Indicators. OECD Publishing: Retrieved December 2013, from <http://dx.doi.org/10.1787/9789264185715-en>
- Oke, C., & Robinson, G. (2013). Building a Cycling City. Paper presented at the Bike Futures 2013, Melbourne.
- Transport Integration Act 2010 Melbourne, 6 of 2010 Stat. Victorian Government Printer.
- Patterson, F. (2010). Cycling and roundabouts: An Australian perspective. *Road & Transport Research*, 19(2), 51 – 68.
- Pattinson, W. (2015). Why do cyclists feel safer in inner Amsterdam and Copenhagen than Melbourne? A contextual framework. Paper presented at the State of Australian Cities National Conference, 2015, Gold Coast, Queensland.
- Pattinson, W., & Thompson, R. G. (2014). Trucks and bikes: Sharing the roads. *Procedia - Social and Behavioral Sciences*, 125, 251-261. doi: <http://dx.doi.org/10.1016/j.sbspro.2014.01.1471>
- Pattinson, W., & Whitzman, C. (2013). City cycling at the crossroads. Can Australia learn from Northern Europe? Paper presented at the State of Australian Cities 2013, Sydney. <http://www.soacconference.com.au/wp-content/uploads/2013/12/Pattinson-Movement.pdf>
- Pattinson, W. H. (1977). Bicycle Facilities for Australian Capital Cities. Paper presented at the 3rd Australasian Transport Research Forum, Melbourne.
- Pattinson, W. H. (1982). Review of the Hierarchy of Roads Study. Paper presented at the 11th AARB Conference, University of Melbourne.
- Pattinson, W. H. (2017) Imagining an inner Melbourne safe enough for travel by bike. Presentation at the Eco City Conference, Melbourne.
- Peden, M., et al. (2004). World report on road traffic injury prevention. World Health Organization: Geneva.
- Persia, L., et al. (2010). *Transferability of European Methodologies and Tools for Vulnerable Road User Safety to Emerging Economies*. Paper presented at the Conference on Safety and Mobility of Vulnerable Road Users: Pedestrians, Motorcyclists and Bicyclists, Jerusalem.
- Pojani, D., et al. (2017). Do Northwestern and Southeastern Europe Share a Common “Cycling Mindset”? Comparative Analysis of Beliefs toward Cycling in the Netherlands and the Balkans. *European Journal of Transport and Infrastructure Research*, 17(1). doi: 10.18757/ejtir.2017.17.1.3178

- Pojani, D., et al. (2018). Cycling and walking are short-changed when it comes to transport funding in Australia. *The Conversation*, 20/03/2018.
- Prato, C. G. (2014). Personal e-mail 11/11/2014.
- Price, G. (2013). Netherlands Diary 7 - Polder Models and Logistics. From <http://pricetags.wordpress.com/2013/06/10/netherlands-diary-7-polder-models-and-logistics/>
- Pucher, J., & Buehler, R. (2008). Making cycling irresistible: Lessons from The Netherlands, Denmark and Germany. *Transport Reviews*, 28(4), 495-528. doi: 10.1080/01441640701806612
- Pucher, J., & Buehler, R. (2012). *City Cycling*. MIT Press: Cambridge, MA.
- Pucher, J., & Buehler, R. (2013). How to increase walking and cycling: Lessons from across the Globe: YouTube, SEAGreenways.
- Pucher, J., & Buehler, R. (2016). Safer cycling through improved infrastructure. *AJPH*, 106(12), 2089-2091.
- Pucher, J., & Dijkstra, L. (2000). Making walking and cycling safer: lessons from Europe. *Transportation Quarterly*, 54(3), 25-50.
- Pucher, J., et al. (2010). Infrastructure, programs, and policies to increase bicycling: An international review. *Preventive Medicine*, 50, Supplement, 106-125. doi: 10.1016/j.ypmed.2009.07.028
- Pucher, J., et al. (2011). Cycling down under: A comparative analysis of bicycling trends and policies in Sydney and Melbourne. *Journal of Transport Geography*, 19(2), 332-345.
- Rask, S., & Skov-Peterson, H. (2013). Bikeability. *Newsletter 11*, 7. Retrieved from: www.cycling-embassy.dk/2013/06/05/fahrradartikeln-aus-danemark-juni-2013/
- Rechnitzer, G., & Grzebieta, R. (2014). So you want to increase cycling on roads: Then we need side underrun barriers on all trucks. Paper presented at the Australasian Road Safety Research, Policing & Education Conference, Melbourne.
- Reid, C. (2018). Netherlands invests extra Euro 552m to get even more people on bicycles. *Forbes*. November.
- Rigitano, E. (2016). Copenhagen is first in the Copenhagenize Index. Retrieved 21/01/2018, <https://www.lifegate.com/people/lifestyle/copenhagen-copenhagenize-index-bike-friendly-cities>
- Rose, G. (2012). E-Bikes and urban transportation: Emerging issues and unresolved questions. *Transportation*, 39(1), 81-96. doi: <http://www.springerlink.com/link.asp?id=103007>

- Rose, G., & Johnson, M. (2013). Exploring ownership and use of electric bikes in Australia. Paper presented at the Bike Futures 2013 Conference, Melbourne.
- Ruby, L. (2014). How Denmark became a cycling nation. Retrieved from Denmark website: <http://denmark.dk/en/green-living/bicycle-culture/how-denmark-become-a-cycling-nation/>
- Sakkal, P. (2019). Top motoring body urges investment in bike 'superhighways'. *The Age* 12/02/2019.
- Sandercock, L. (1990). *Property, politics, and urban planning: a history of Australian city planning, 1890-1990* (2nd ed.). Transaction Publishers: New Brunswick, USA.
- Schepers, J., et al. (2014). The safety of electrically assisted bicycles compared to classic bicycles. *Accident Analysis & Prevention*, 73, 174-180.
- Schepers, J. P. (2013). A safer road environment for cyclists. (PhD Dissertation), Delft TU. Available from Delft TU (ISBN: 978-90-73946-12-5)
- Schepers, J. P., & Heinen, E. (2013). How does a modal shift from short car trips to cycling affect road safety? *Accident Analysis & Prevention*, 50, 1118-1127. doi: <http://dx.doi.org/10.1016/j.aap.2012.09.004>
- Schepers, J. P., et al. (2014). The Dutch road to a high level of cycling safety. Paper presented at the International Cycling Safety Conference 2014, Göteborg, Sweden.
- Schepers, P., et al. (2014). An international review of the frequency of single-bicycle crashes (SBCs) and their relation to bicycle modal share. *Injury Prevention*. January 9, 2014, doi:10.1136/injuryprev-2013-040964
- Schepers, P., & den Brinker, B. (2011). What do cyclists need to see to avoid single-bicycle crashes? *Ergonomics*, 54(4), 315-327.
- Schonberg, M. (2009). Danmarks Cyklister kræver, Cyklestier langs Vejene. 22/02/2012 translation <http://asp.vejtid.dk/Artikler/2009/09%5C5568.pdf>
- Schwartz-Shea, P., & Yanow, D. (2012). *Interpretive Research Design: Concepts and processes*. Routledge: New York and Milton Park.
- Scott, M. J. C., et al. (1978). The Geelong Bike Plan: Practical planning for cyclist's real needs. Paper presented at the 4th Australian Transport Research Forum, Perth.
- Seidman, I. (2013). *Interviewing as qualitative research: A guide for researchers in education and the social sciences* (4th ed.). Teachers College Press: New York and London.

- Sikic, M., et al. (2009). Bicycling injuries and mortality in Victoria, 2001–2006. *MJA*, 190(7), 353-356.
- Sinclair, A., & Haines, F. (1993). Deaths in the workplace and the dynamics of response. *Journal of Contingencies & Crisis Management*, 1(3), 125-137.
- Slovic, P., et al. (2004). Risk as analysis and risk as feelings: Some thoughts about affect, reason, risk, and rationality. *Risk Analysis*, 24(2), 311-322.
- Stadsregio Amsterdam. (2014). Stadsregio Amsterdam, English Information. Retrieved 15/08/14, from <http://www.stadsregioamsterdam.nl/algemene-onderdelen/english-information/>
- Stanley, J. K., et al. (2011). Road transport and climate change: Stepping off the greenhouse gas. *Transportation Research Part A: Policy and Practice*, 45(10), 1020-1030.
- State Government of Victoria. (2015). *Towards Zero*. Melbourne: State Government Victoria. Retrieved from <http://www.roadsafety.vic.gov.au/images/TOWARDSZEROPUBLICATIONWEB.pdf>.
- State Government of Victoria. (2016). *Towards Zero*. Retrieved 6/4/2016, from <https://www.towardszero.vic.gov.au/>
- State Revenue Office Victoria. (2018). Car Parks. From <https://www.sro.vic.gov.au/car-parks>
- Stead, D., et al. (2010). West-east policy transfer: the case of urban transport policy. In P. Healey & R. Upton (Eds.), *Crossing Borders: International exchange and planning practices*. Routledge: London.
- Stern, E., & Richardson, H. W. (2005). Behavioural modelling of road users: current research and future needs. *Transport Reviews*, 25(2), 21.
- Stevenson, M., et al. (2014). Study protocol: Safer cycling in the urban road environment: Study approach and protocols guiding an Australian study. *Injury Prevention* (2014-041287).
- Stigson, H., et al. (2008). Use of fatal real-life crashes to analyze a safe road transport system model, Including the Road User, the Vehicle, and the Road. *Traffic Injury Prevention*, 9(5), 463-471. doi: 10.1080/15389580802335240
- Stipdonk, H. L., & Bos, N. M. (2014). Road safety analysis Municipality of Amsterdam: Relevant focal groups, developments and points of interest. SWOV: The Hague
- Stipdonk, H. L., & Forest, N. M. (2014). Traffic Analysis City of Amsterdam. SWOV: The Hague.

- Stone, J. (2008). Political factors in the rebuilding of mass transit: An investigation of failure in Melbourne since 1970. PhD thesis. Swinburne University of Technology: Hawthorn.
- Sullivan, J. (2012). A fighter pilot's guide to surviving on the roads: Whats wrong with you are you blind! Retrieved from <https://www.londoncyclist.co.uk/raf-pilot-teach-cyclists/>
- Summala, H. (2007). Towards understanding motivational and emotional factors in driver behaviour: Comfort through satisficing. In C. Cacciabue (Ed.), *Modelling driver behaviour in automotive environments* (pp. 189-207). Springer-Verlag: London.
- Sweeney, E. Y. (2018, 26 September 2018). Transport Strategy Refresh, Participate Melbourne Community Engagement Analysis. from <https://s3.amazonaws.com/hdp.au.prod.app.com-participate.files/7015/4330/2824/Transport Strategy refresh EYSweeney Participate Melbourne Community Analysis.pdf>
- Sweezy, P. M. (2000). Cars and cities. *Monthly Review*, 51, 19-34.
- SWOV. (2013). Cyclists. Fact Sheet. SWOV: Leidschendam.
- t'Hart, P. (2014). *Understanding Public Leadership*. Palgrave Macmillan: London.
- The Capital Region of Denmark. (2017). Cycling Report for the Capital Region 2016. Capital Region Council: Kongens Vænge 2.
- The Danish Ecological Council. (2016). Fact Sheet: The Danish motor vehicle taxes. The Ecological Council: Copenhagen.
- Threlfall, R. (2019). 2019 Autonomous vehicles readiness index. KPMG: Amstelveen, Netherlands.
- Tingvall, C., & Haworth, N. (1999). Vision Zero: An ethical approach to safety and mobility. Paper presented at the 6th ITE International Conference Road Safety & Traffic Enforcement: Beyond 2000, Melbourne.
- Tomlinson, R. (2017). An argument for metropolitan government in Australia. *Cities*, 63, 149-153.
- TomTom. (2016). Measuring Congestion Worldwide, Copenhagen. from https://www.tomtom.com/en_gb/trafficindex/city/copenhagen
- Torslov, N., & Tiemens, H. (2013). Trouble in Paradise. *Sound of Cycling*, 12-13. from: <https://www.youtube.com/watch?v=GCXAcxj bxl>
- Transport Accident Commission (TAC). (2010). A Decade of Reducing Road Trauma. TAC: Geelong.
- Transport Accident Commission (TAC). (2018). 2017/18 Annual Report. TAC: Geelong.

- Transport Accident Commission (TAC). (2016). Towards Zero 2016-2020. Victoria's Road Safety Strategy and Action Plan. TAC: Geelong, Victoria.
- Transport for Victoria. (2017). *Victorian Cycling Strategy 2018-28, Increasing cycling for transport*. Transport for Victoria, Department of Economic Development, Jobs, Transport and Resources: Melbourne, Victoria.
- Tranter, K. (2005). History of the Haste-Wagons: The Motor Car Act 1909 (VIC), Emergent Technology and the Call for Law. *Melbourne University Law Review*, 29, 843-879.
- Tranter, P. (2012). Effective Speed: Cycling because it's faster. In J. Pucher & R. Buehler (Eds.), *City Cycling*. MIT Press: Cambridge MA.
- Tranter, P. (2018). Taming traffic to encourage children's active transportation. In R. Larouche (Ed.), *Children's Active Transportation*. Elsevier: Amsterdam.
- Trist, E. L. (1980). *The evolution of socio-technical systems*. Paper presented at the Organizational Design and Performance, University of Pennsylvania.
- Turner, B., et al. (2012). Effectiveness of Road Safety Engineering Treatments. Austroads: Sydney.
- Twisk, D., et al. (2013). From bicycle crashes to measures: Brief overview of what we know and do not know (yet). SWOV Institute for Road Safety Research: Leidschendam, the Netherlands.
- UITP (Union Internationale des Transport Publics). (2015). Mobility in Cities Database. from <http://www.uitp.org/MCD>
- Valderrama, A., & Jorgensen, U. (2008). Urban Transport Systems in Bogot and Copenhagen: An approach from STS. *Built Environment*, 34(2), 200-2017.
- van der Horst, A. R. A., et al. (2014). Traffic conflicts on bicycle paths: A systematic observation of behaviour from video. *Accident Analysis & Prevention*, 62, 358-368. doi: <http://dx.doi.org/10.1016/j.aap.2013.04.005>
- van Ommeren, K., et al. (2012). Social costs and benefits of investments in cycling - Summary. DECISIO: Amsterdam.
- Vandenbergh, M. P., & Steinemann, A. C. (2007). The Carbon-Neutral Individual. *New York University Law Review*, 82, 16734-11745.
- VicRoads. (2012a). 2011-2012 Victorian Speed Limit Review. VicRoads: Kew.
- VicRoads. (2012b). CrashStats. from VicRoads <http://crashstat1.roads.vic.gov.au/crashstats/crashr.htm>
- VicRoads. (2013) Submission to Parliamentary Road Safety Committee Inquiry into Serious Injury, http://www.parliament.vic.gov.au/images/stories/committees/rsc/serious_injury/submissions/31_VicRoads_WEB.pdf

- VicRoads. (2015). CrashStats Summary, IMAP LGA's, 2009 - 2012. Retrieved 16/08/2015.
- Victorian Government. (2019). Suburban Transport Blitz. From <https://bigbuild.vic.gov.au/budget>
- Victorian State Bicycle Committee. (1986). Melbourne for Bikes: The Final Report of the Melbourne Bikeplan. The SBC: Melbourne
- Victorian Auditor-General. (2011). Developing Cycling as a Safe and Appealing Mode of Transport, Victoria Auditor General: Melbourne.
- Victorian Planning Authority. (2018). *Business Plan 2018/19*. Victoria State Government: Melbourne.
- Wagenbuur, M. (2013). Cycling in Brisbane. From <http://wp.me/p2faP1-1yk>
- Wagenbuur, M. (2018a). Houten: Cycling City of the Netherlands 2018. From <https://wp.me/p2faP1-3pW>
- Wagenbuur, M. (2018b). More cycling fatalities than deaths in cars. From <https://bicycledutch.wordpress.com/2018/04/25/more-cycling-fatalities-than-deaths-in-cars/>
- Walt, G., & Gilson, L. (1994). Reforming the health sector in developing countries: the central role of policy analysis. *Health policy and planning*, 9(4), 353-370.
- Walt, G., et al. (2008). 'Doing' health policy analysis: methodological and conceptual reflections and challenges. *Health policy and planning*, 23(5), 308-317.
- Wann, D. (1995). *Deep design: pathways to a livable future*. Island Press: Washington D.C.
- Wegman, F. (2012). Driving down the road toll by building a Safe System. Government of South Australia: Adelaide.
- Wegman, F., et al. (2012). How to make more cycling good for road safety? *Accident analysis and prevention*, 44(1), 19-29.
- Weijermars, W. A. M., et al. (2013). Duurzaam Veilig, ook voor ernstig verkeersgewonden (Sustainable Safety: also for serious road injuries). SWOV: Leidschendam.
- Welleman, T. (1995). The autumn of the Bicycle Master Plan: After the plans, the products. Paper presented at Velo-City, Basel, Switzerland.
- White, M. (2006). Sorry, Mate, I didn't see you: A plausible scientific explanation. Paper presented at the Australasian Road Safety Research, Policing and Education Conference, Melbourne. <https://acrs.org.au/files/arsrpe/RS060062.pdf>
- WHO. (2013). Global status report on road safety 2013. WHO: Geneva.

- Wilkie, A., et al. (2014). Assessment of the effectiveness of on-road bicycle lanes at roundabouts in Australia and New Zealand. Austroads: Sydney.
- Winnicott, D. W. (1954). Mind and its Relation to the Psyche-soma. *British Journal of Medical Psychology*, 27(4), 201-209.
- Winters, M., et al. (2011). Motivators and Deterrents of Bicycling: Comparing Influences on Decisions to Ride. *Transportation*, 38(1), 153-168. doi: <http://www.springerlink.com/link.asp?id=103007>
- Woetzel, J., et al. (2018). Smart Cities: Digital solutions for a more liveable future. McKinsey Global Institute: San Francisco.
- Woolley, J. (2012). Traffic Management and Infrastructure – Lessons from in-depth crash investigation. Austroads: Sydney.
- Woolley, J., et al. (2018). Inquiry into the National Road Safety Strategy 2011-2020. Canberra. from <https://www.roadsafety.gov.au/nrss/inquiry>
- World Port Source. (2019). Port of Melbourne. from [http://www.worldportsource.com/ports/commerce/AUS Port of Melbourne 494.php](http://www.worldportsource.com/ports/commerce/AUS%20Port%20of%20Melbourne%20494.php)
- Wundersitz, L., & Baldock, M. (2011). The relative contribution of system failures and extreme behaviour in South Australian crashes. The University of Adelaide: Adelaide, South Australia.
- Yarra City Council. (2019). *Agenda and Minutes of Ordinary Council Meeting 17 December 2019*. Yarra City Council, from <https://www.yarracity.vic.gov.au/about-us/council-information/past-council-and-committee-meetings/2019-council-meetings>
<https://www.yarracity.vic.gov.au/about-us/council-information/past-council-and-committee-meetings/2019-council-meetings>.
- Yin, R. K. (1981). The Case Study Crisis: Some Answers. *Administrative Science Quarterly*, 26(1), 58-65. doi: 10.2307/2392599
- Yin, R. K. (2008). *Case study research: Design and methods* (4th ed. Vol. 5). SAGE Publications, Thousand Oaks CA.

Appendices

Appendix 1 Approved documents for interviews

Appendix 2 Documents reviewed by study area

Appendix 3..Melbourne, developed for profit not to a plan

Appendix 1 Approved documents for interviews

As noted in sections 3.6 and 3.7 of my thesis this appendix provides the two documents approved by the Ethics committee in 2014 prior to commencement of the interviews.

Document 1. Plain Language Statement

University of Melbourne
Faculty of Architecture, Building and Planning

PLAIN LANGUAGE STATEMENT

Warwick Pattinson, PhD Student Research Project:
Overcoming barriers to support a safe system for cycling
in Inner Melbourne

Invitation/request for an interview



THE UNIVERSITY OF
MELBOURNE

You are invited to participate in research on providing a safer system for cycling in inner Melbourne. Your participation would involve a 30 to 60-minute interview. With your permission the interview will be recorded to ensure an accurate record is made of what you say. If you wish some discussion to be made 'off the record' you can request this during the interview. Your name and contact details will be kept separate from any information that you supply during the study. If you request anonymity, we will remove any references in findings and publications that might allow someone to guess your identity. The findings from this research activity will be combined with findings from other research. The confidentiality of the information will be safeguarded subject to any legal requirements. The University of Melbourne will securely store the recordings and notes from these research activities for at least 5 years from the date of publication of findings, after which they will be destroyed.

The research is being conducted by Warwick Pattinson, a PhD candidate in the Faculty of Architecture, Building and Planning at The University of Melbourne. Warwick is an experienced transport planner who has been involved in bike planning and policy for over 40 years. This research is part of his doctoral thesis that is being supervised by Professor Carolyn Whitzman and Dr. John Stone.

Your participation in this research is completely voluntary. You can withdraw your consent at any time during the interview or ask that recording be suspended. If you have any concerns following the interview or would like more information about the research please contact the researcher: w.pattinson@student.unimelb.edu.au; phone: + 61 (0)401712222 or the responsible supervisor: Prof. Carolyn Whitzman: whitzman@unimelb.edu.au; phone: +61 3 8344 8723.

This project has been cleared by the Architecture, Building and Planning Human Ethics Group. Should you have any concerns about the conduct of this research you are welcome to contact the Executive Officer, Human Ethics Office, The University of Melbourne, (phone 8344 2073; fax 9347 6739).

Thank you

Warwick Pattinson

(Alternative email: warwick.pattinson@gmail.com)

Document 2 Project Description

PhD Research Project by Warwick Pattinson, Faculty of Architecture, Building & Planning, University of Melbourne

My research is exploring the local (Melbourne, Australia) institutional barriers and enablers to ‘safe system’ measures for transport (every-day utility) cycling. Systematic measures to support cycling have been implemented in several European cities that have significantly increased levels of cycling, reduced road trauma and provided other benefits including improved health, social, environmental, and economic outcomes. Measure include innovations in traffic engineering designs, modifications to trucks, education of drivers, cyclists and road managers, and enforcement aimed at behavioural change.

While the technical aspects of the measures used to support city cycling are well researched, there is a gap in knowledge regarding the institutional and other factors that may limit adoption in Melbourne. My research involves a comparative case study: inner Melbourne compared with inner Amsterdam and inner Copenhagen. The three inner city areas have several comparable features, including historic pre-car urban development, relatively flat terrain, and similar socio-economic characteristics, thus suggesting the potential to explore cultural and institutional differences that may have a bearing on the ‘how’ and ‘why’ of different outcomes.

My key research question is:

What are the barriers to, and enablers of, safer ‘transport’ cycling in inner Melbourne?

Sub questions are:

What are the technical, cultural and institutional barriers and enablers to a ‘safe systems’ approach in Melbourne compared to Amsterdam and to Copenhagen?

What are the differences in actions and outcomes, how have they come about and why have they occurred?

How could (and can) institutional barriers be overcome and enablers supported for safer cycling in Melbourne?

Methods

The main research task is to explore the institutional differences that may influence the ‘what’, ‘how’ and ‘why’ actions for each of the three safe system elements (infrastructure, people, and vehicles). Policies, reports, crash statistics, regulations, plans and subsequent actions will also be examined to provide background and context for comparisons. Key informant interviews will seek reflections on the reasons for the local outcomes, guided by differences in approaches identified in the document analysis.

I am particularly interested in the institutional, community and stakeholder support (or opposition) for ‘safe system’ (sustainable safety) measures for cyclists in the contested space of city intersections. My research is exploring:

- 1) **Activating** event(s) and their context
- 2) **Actors** (others) involved
- 3) **Alignment** of stakeholder interests (supporters or blockers)
- 4) **Authorization** for action including processes and funding
- 5) **Action** taken: policy content and implementation.

Appendix 2 Documents reviewed

2.1 Amsterdam

Bicycle Dutch. (2014). Amsterdam can send mopeds to the carriageway.

<https://bicycledutch.wordpress.com/2014/06/05/amsterdam-can-send-mopeds-to-the-carriageway/>

City of Amsterdam. (2007). Leidraad Centrale Verkeers Commissie.

City of Amsterdam. (2012a). Road Safety 2012-2015. Amsterdam.

City of Amsterdam. (2012b). Summary Long-term Bicycle Plan 2012 – 2016. Amsterdam.

City of Amsterdam. (2014). Plan Amsterdam, Cycling Policy and Design. Retrieved from

<http://www.amsterdam.nl/gemeente/organisatie-diensten/dienst-ruimtelijke/making-amsterdam/planamsterdam-magazi/2014/4-2014-cycling/>.

CROW. (2007). 25: Design Manual for Bicycle Traffic. The Netherlands.

Directorate-General for Passenger Transport. (1999). The Dutch Bicycle Master Plan, description and evaluation in a historical context. The Hague.

Fietsberaad. (2010). The bicycle capitals of the world: Amsterdam and Copenhagen (Vol. 7A). Velo-city conference Copenhagen.

Furth, P. G. (2017). Systematic Safety: the principles behind Vision Zero [Video]: BicycleDutch.

Gemeente Amsterdam. (2012). Facts and figures: Road Safety 2012 – 2015.

Hembrow, D. (2014, 23 May 2014). The best roundabout design for cyclists.

www.aviewfromthecyclepath.com/2014/05/the-best-roundabout-design-for-cyclists.html?m=0+

Institute for Road Safety Research (SWOV). (2016). Index of Road Safety Measures. Retrieved 31/03/2018, from <https://www.swov.nl/en/tools/measures>

Krizek, K. J., & Marten, K. (2015). Land use changes, transport poverty and potential mobility solutions; An exploration of a possible future. Nijmegen.

McDonald, L. (2014, Feb 3, 2014). Amsterdam Government. Retrieved 13/08/2014, from

<https://prezi.com/mz-hhkofp1mi/amsterdam-government/>

Price, G. (2013). Netherlands Diary 7 - Polder Models and Logistics. Retrieved 10/09/2014, 2014, from

<http://pricetags.wordpress.com/2013/06/10/netherlands-diary-7-polder-models-and-logistics/>

Stadsregio Amsterdam. (2014). Stadsregio Amsterdam, English Information. Retrieved 15/08/14, 2014, from

<http://www.stadsregioamsterdam.nl/algemene-onderdelen/english-information/>

Wagenbuur, M. (2018, April 2018). More cycling fatalities than deaths in cars.

<https://bicycledutch.wordpress.com/2018/04/25/more-cycling-fatalities-than-deaths-in-cars/>

2.2 Copenhagen

Andersen, T., Bredal, F., Weinreich, M., Jensen, N., Riisgaard–Dam, M., & Nielsen, M. K. (2012). Collection of Cycling Concepts 2012: Cycling Embassy of Denmark.

City of Copenhagen. (2007a). Eco-Metropolis - Our Vision for Copenhagen. Retrieved from http://kk.sites.itera.dk/apps/kk_pub2/pdf/674_CFbnhMePZr.pdf.

City of Copenhagen. (2007b). Eco-Metropolis - Our Vision for Copenhagen.

City of Copenhagen. (2011). Good, Better, Best - The City of Copenhagen's Bicycle Strategy 2011-2025. City of Copenhagen.

City of Copenhagen. (2013a). Copenhagen 2013-2020, Traffic Safety Plan.

City of Copenhagen. (2013b). Focus on Cycling. Retrieved from http://kk.sites.itera.dk/apps/kk_pub2/pdf/1133_mLNhMM8tU6.pdf.

City of Copenhagen. (2014a). Copenhagen European Green Capital 2014 A Review.

City of Copenhagen. (2014b). Københavns Kommunes administrationsgrundlag for trafikledelse 2014-2018. Retrieved from <http://subsite.kk.dk/~media/AD08EEC67019448A880E4E5C11AC9233.ashx>.

City of Copenhagen. (2015). Copenhagen City of Cyclists, The Bicycle Account 2014. Copenhagen.

Copenhagen Portal. (2018). Brief History about Copenhagen. from <http://www.copenhagenet.dk/CPH-History.htm>

Danish Cycling Embassy. (2017). Danish Cycling Know-How.

Danish Cyclists' Federation. (2018). Your entry to Danish cycling. from <https://www.cyklistforbundet.dk/englis>

Danish Road Directorate. (2011). Road Safety Principles. Retrieved from <http://english-vejregler.lovportaler.dk/ShowDoc.aspx?t=%2fV1%2fNavigation%2fVejreglerEnglish%2fConstruction+and+planning%2f&docId=vde-2014-0002-full>.

Danish Road Directorate. (2012). Manual of Traffic Planning in Cities. Retrieved from <http://vejregler.lovportaler.dk/ShowDoc.aspx?t=%2fV1%2fNaviga>.

Danish Road Directorate. (2017). Welcome to Denmark. from http://www.nvfnorden.org/library/Files/Sanne%20Attermann_Welcome%20to%20Denmark%20_the%20Danish%20Road%20Directorate.pdf

Directorate-General for Passenger Transport. (1999). The Dutch Bicycle Master Plan, description and evaluation in a historical context. The Hague.

European Commission. (2010). Towards a European road safety area: policy orientations on road safety 2011-2020 Retrieved from https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/pdf/road_safety_citizen/road_safety_citizen_1_00924_en.pdf.

Greater Copenhagen Committee. (2018). About Greater Copenhagen. From <http://www.greatercph.com/about>

Jensen, N. (2009). How Copenhagen became a cycling city. USA: City of Copenhagen.

Katz, B., & Noring, L. (2016). Why Copenhagen works. Washington, D.C.

Kayser, A. (2017, March 2017). Copenhagen: The Cycling City. from <http://nws.euocities.eu/MediaShell/media/CREATEETechnicalMeeting.pdf>

The Planning Act in Denmark, Consolidated Act No 813(2007).

Ministry of Transport. (2018). The Ministry of Transport, A brief organisational overview., from <https://www.trm.dk/media/3775/organisational-overview-netversion.pdf>

OECD. (2009). Metropolitan Governance in Copenhagen (pp. 207-239). OECD Publishing: Paris.

Prato, C. G. (2014). e-mail (11 November) on under-reporting to W. Pattinson.

Rigitano, E. (2016). Copenhagen is first in the Copenhagenize Index. Retrieved 21/01/2018, from <https://www.lifegate.com/people/lifestyle/copenhagen-copenhagenize-index-bike-friendly-cities>

Ruby, L. (2014). How Denmark became a cycling nation. Retrieved from <http://denmark.dk/en/green-living/bicycle-culture/how-denmark-become-a-cycling-nation/>

Schonberg, M. (2009, 22/02/2012 (translation)). Danmarks Cyklister kræver, Cyklestier langs Vejene. from <http://asp.vejtid.dk/Artikler/2009/09%5C5568.pdf>

The Capital Region of Denmark. (2017). Cycling Report for the Capital Region 2016. Kongens Vænge 2.

The Danish Ecological Council. (2016). Fact Sheet: The Danish motor vehicle taxes. Copenhagen. Council.

TomTom. (2016). Measuring Congestion Worldwide, Copenhagen. from https://www.tomtom.com/en_gb/trafficindex/city/copenhagen

2.3 Melbourne

Australian Transport Council. (1999). Australian Road Rules. Melbourne.

Bicycle Victoria. (2008). Priority bike route network for IMAP. Melbourne.

Carey, A. (2016, 29 June). Melbourne's cycling-friendly reputation on the line as bike budgets go flat. *The Age*. Melbourne

City of Maribyrnong. (2014). Maribyrnong Bicycle Strategy 2014. Maribyrnong.

City of Melbourne. (2016). Bicycle Plan 2016-2020. Melbourne.

City of Port Phillip. (2011). Bike Plan 2012-2020. St Kilda.

City of Port Phillip. (2018). Local area speed limit changes. St Kilda: City of Port Phillip, St Kilda.

City of Yarra. (2010). The City of Yarra Bicycle Strategy 2010-2015. Richmond.

City of Yarra (2019). Agenda and Minutes of Ordinary Council Meeting 17 December 2019. Retrieved from: <https://www.yarracity.vic.gov.au/about-us/council-information/past-council-and-committee-meetings/2019-council-meetings>
<https://www.yarracity.vic.gov.au/about-us/council-information/past-council-and-committee-meetings/2019-council-meetings>.

Cooper, A. (2012, 23 July). Baillieu put under the pump on cycling budget. *The Age*, p. 1. Melbourne

Corben, B., Stasinou, C., Bui, B., Healy, D., & Cockfield, S. (2009). Safe Road Infrastructure Program (SRIP3) Study Tour to High-Performance European Countries, October 2008. MUARC/TAC. Melbourne

Curtis, C., Babb, C., & Armstrong, R. (2010). Melbourne: Policy Position, Working Paper Number 2. Melbourne.

Department of Environment Land Water and Planning. (2017). Plan Melbourne 2017-2050. from <http://www.planmelbourne.vic.gov.au/>

Fildes, B., Oxley, J., & Lawrence, B. (2017). City of Yarra – 30 km/h speed limit: pre-trial final report. MUARC, Clayton.

Hall and Partners. (2010). Cyclist Segmentation Research - Final Report. Open Mind. Melbourne

Healy, D., Corben, B., Lyngcoln, J., Matta, J., Thompson, J., Cockfield, S., et al. (2012). Safe Road Infrastructure Programme (SRIP) study tour to high performing European countries, May/June 2012. TAC, MUARC. Melbourne

Inner Melbourne Action Plan. (2016). Inner Melbourne Action Plan 2016-2026. from <http://imap.vic.gov.au/uploads/Strategy%20Documents/Inner%20Melbourne%20Action%20Plan%20FINAL%20Website%20version.pdf>

Transport Integration Act (Victoria) (2010). Melbourne.

State Government of Victoria. (2015). Towards Zero. Retrieved from <http://www.roadsafety.vic.gov.au/images/TOWARDSZEROPUBLICATIONWEB.pdf>.

State Government of Victoria. (2016). Towards Zero. Retrieved 6/4/2016, from <https://www.towardszero.vic.gov.au/>

- Sweeney, E. Y. (2018, 26 September 2018). Transport Strategy Refresh, Participate Melbourne Community Engagement Analysis. from https://s3.ap-southeast-2.amazonaws.com/hdp.au.prod.app.com-participate.files/7015/4330/2824/Transport_Strategy_refresh_EY_Sweeney_Participate_Melbourne_Community_Analysis.pdf
- Transport Accident Commission (TAC). (2010). A Decade of Reducing Road Trauma. Geelong.
- Transport Accident Commission (TAC). (2018). 2017/18 Annual Report. Geelong.
- Transport Accident Commission TAC. (2016). Towards Zero 2016-2020. Victoria's Road Safety Strategy and Action Plan. Geelong, Victoria: Transport Accident Commission.
- Transport for Victoria. (2017). Victorian Cycling Strategy 2018-28, Increasing cycling for transport. Melbourne.
- VicRoads. (2012). 2011-2012 Victorian Speed Limit Review. Kew.
- Victorian Government (2019). Suburban Transport Blitz. from <https://bigbuild.vic.gov.au/budget>
- Victorian Auditor-General. (2011). Developing Cycling as a Safe and Appealing Mode of Transport. Melbourne: Victoria Auditor General.
- Victorian Planning Authority. (2018). Business Plan 2018/19. Melbourne
- Woolley, J., Crozier, J., McIntosh, L., & McInerney, R. (2018). Inquiry into the National Road Safety Strategy 2011-2020. Canberra.

Appendix 3 Melbourne: developed for profit, not to a plan

As noted in Section 7.4, this appendix outlines aspects of Melbourne's early history and development that provide a context for influences on the safety of the city for bicyclists.

From Melbourne's first settlement by Tasmanian businessmen in 1835, on land that had long been home to the indigenous Wurundjeri people, development was driven by individuals seeking profit. In 1837, the colonial government, based in Sydney, took charge of the settlement and a thoughtful plan for the central area was sketched by Robert Russell and implemented by Robert Hoddle. This plan was the closest that Melbourne ever came to having an implemented plan (Lay, 2018). To facilitate land sales beyond the central area, surveyor Hoddle laid out an extensive main road network, based on one-mile (1.6 km) square grids, with north-south and east-west one chain (20.1 m) roads, generally imposed without regard to topography, for example, putting roads straight up Melbourne's few steep hills. Over the basic grid, some 22 radial routes were superimposed, following tracks used by the indigenous people and for early stock movements¹; some of these wide routes were later converted to imposing avenues.

Followed the discovery of alluvial gold in Melbourne's hinterland in 1851, the colony experienced rapid population growth. By 1854 the population was 300,000, and the first train service from the Port to the City was privately constructed. Then, taking the opportunity to profit from the demand for housing, speculative private developers purchased surrounding land for subdivision and built, with borrowed money, a substantial suburban rail network and on-road tram infrastructure to serve the new suburban subdivisions (Cannon, 1967). Melbourne's growth was thus shaped by the 'Land Boomer' entrepreneurs (Cannon, 1967). Development 'controls', and the provision of roads and bridges, were the responsibility of the 52 small Municipalities, often under the influence of the entrepreneur developers. Many State politicians and municipal councillors pursued their governance responsibilities with an eye to personal gain (Cannon, 1967).

The period when bicycles became available overlapped with the period when the settlement had extremely pressing problems from rapid population growth, including contaminated drinking water, many poor roads that became impassable in wet weather, and the world renown 'Smellbourne' foul odours from open sewers. To avoid unpopular taxes to tackle public health problems, Victoria's politicians followed the UK public works model and in 1890 established a Melbourne and Metropolitan Board of Works (MMBW). The MMBW was a form of municipal government, overseen by 52 Commissioners, one from each of the metropolitan councils, who borrowed the money required for the works and imposed rates on metropolitan properties to

¹ For example, by 1851 there more than six million sheep grazed in the hinterland which were periodically herded to market in Melbourne.

repay the loans. The impetus for this action can be understood, in t'Hart's terms (see Chapter 2), as responding to crises rather than to a plan (t'Hart, 2014).

Pedal bicycles date from the 1869 high-wheeler or penny farthing design of Eugene Meyer of Paris that came to Melbourne in 1875 (Jarrat, 2016). The high wheeler bicycles were mostly used for recreation and had an image problem as they were seen as a dangerous plaything of reckless young male riders, rather than for transport (Carstensen & Ebert, 2012). The early design had inherent safety issues with the rider seated high above the ground and limited braking. Injuries followed any fall or crash from loss of control, such as from excessive speed down hills, from encountering physical obstructions and hazards, or collision involving pedestrians, horses, or other animals. In Melbourne, the high-wheelers provided no competition for the trains and trams.

In the 1880s, the 'safety bike' design arrived and was embraced for personal recreation and gradually for transport by a broader demographic, including women, see Figure A 3-1 (Fitzpatrick, 2015, p. 26).



Figure A 3-1 Early (1890) Melbourne, woman bicyclist

From the introduction of the bicycle, there were, what would now be called 'safe system' issues, including vehicle design, road environment, and road user behaviour. The design of the 'safety bicycle' with its lower seat position and better brakes was a significant improvement over the penny farthing. With the 'safety bicycle' operational hazards however continued, including: the possibility of excessive speed downhill, loss of control from poor road surfaces, physical obstructions (including tree stumps, pot-holes, and loose pavers), and the risk of collisions with trams, pedestrians, horses, and other animals (Carstensen & Ebert, 2012). Roads in Melbourne were also poor, developed from dirt tracks with a variety of pavements, including wooden blocks, with surface maintenance problems, and the foul-smelling open side drains. The need for rider competence was however acknowledged, with in-door rider training provided at the major department stores where bicycles were sold, see Figure A 3.2.

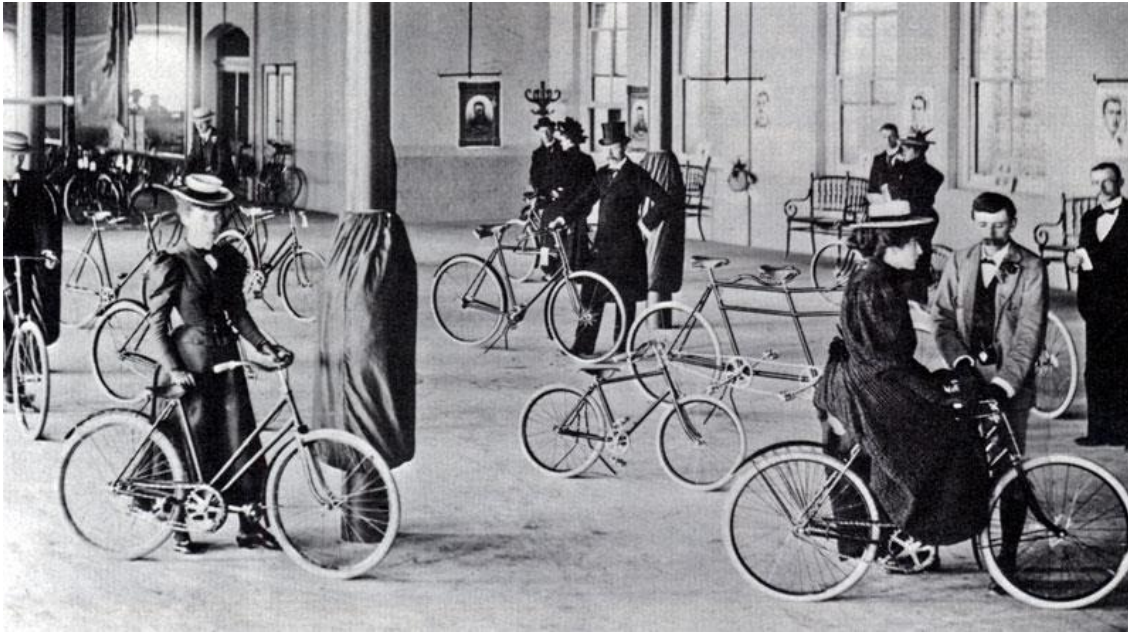


Figure A 3.2 Learning to ride, Georges Cyclatorium, Melbourne, c. 1890

Newspaper articles from the 1890s indicate that separate paths for bicyclists were contemplated, for example on Sydney Road, (Coburg Leader, Saturday 12 May 1900, p.4), and some were built, such as a 10 feet (3 m) wide track from Brighton Beach to Sandringham (Brighton Southern Cross, Saturday 7 November 1896, page 2), and others existed as informal tracks, such as in the Dynon Road reserve to the north of the City (Harland, 2016). ‘Cycle tracks’ were however generally understood to be ovals or reserves, for the popular bicycle races. Newspaper articles also indicate there that the right of bicycles to use roads was initially disputed, but, after a long legal fight, this right was confirmed (Australasian, Saturday 1 December 1900, p. 22). After the introduction of the ‘safety bicycle’, cycling boomed in the city (Fitzpatrick, 2015).

Melbourne of the 19th century and early 20th century was thus shaped, not by town planners, but by private developers and the linear and radial, mixed-use development along the tram lines and around the suburban train stations (Newman, 1992). Travel habits were based on homes and businesses being within walking distance of a tram stop, and often a railway station. With the extensive and well used public transport system, by the end of the 19th century, Melbourne was recognised as a model transit city of international standing (Davison, 1979 - 2004).

From the early 1900s, many politicians and other men² of influence were captivated by the technological promise of transport based on private motor vehicles (Tranter, 2005). Men who had been advocates for bicycling became advocates for motoring and the Yarra Bicycle Club transformed into an automobile club that later evolved into the RACV. The danger to bicyclists from motor vehicles was demonstrated as early as

² There were no women with overt influence until about the 1970s.

1905 when a car collided with and killed a cyclist (Tranter, 2005, p. 856). The first (Victorian) Motor Car Act 1909, regulated drivers and vehicles but did not impose speed limits, which many people had sought. Tranter describes the Act as ‘motorist friendly’...under the ‘influence of narratives of ‘progress’ and the desire to legislate for a certain ‘technological future’ (Tranter, 2005, p. 856).

Although public transport was the main means by which the people of Melbourne people got about, on the roads, there was also significant bicycle use. A search of early newspaper records by *cycle-helmets.com* found surveys that recorded significant bicycle use:

- in 1911 a week-long survey at Power St in Hawthorn recorded that bicycles were 31.8% of road traffic (the road traffic mix was: one-horse carts 4,053; two-horse wagons 835; cabs, buggies, etc. 2,280; motor cars 762; motorcycles 261; bicycles 3,822) *The Reporter*, 1911.
- in 1942³, bicycles were 15.3% of road traffic, *The Melbourne Argus*
- in January 1943, at the five bridges crossing the Yarra River, bicycles were 10.1% of road traffic (motor vehicles 40,821, other vehicles 2,433, bicycles 5,344) *The Melbourne Argus*.

With the increase in road traffic, there was also growth in transport-related deaths. In 1914 (at the start of WW1), 86 recorded road deaths were recorded:

- four deaths to bicyclists,
- six from motor bus accidents,
- eight from tram accidents,
- 45 from horse-drawn vehicles, and
- 23 from motor cars.

Source: Victorian Year Book 1915

Then in 1940, at the start of WW2, the Victorian Year Book recorded 551 road deaths, that included 62 bicyclists, making up more than half of all accidental deaths. Road deaths had increased six-fold over 26 years, with road deaths to bicyclists increasing 15 fold (Gawler, 1943).

For the first half of the 20th century, the people of Melbourne continued to make good use of the extensive train and tram public transport run by the State government. In 1911, when there were only 2722 motor cars and 2122 motorcycles registered, the Victorian Year Book records the importance of public transport, with people making 220,000 train journeys and 205,000 tram journeys per day. Trams and trains, with affordable ‘second class’ fares, were the most used means of personal travel until the end of WW2 (1945) (Moriarty & Mees, 2006). Over this long period the State Government was, however, preoccupied with paying off the public transport debt incurred by the ‘land boomers’, rather than improving services, and was also under public pressure to improve the roads in the State (Lay, 2003).

³ That is, under petrol rationing during WW2, 1940-45

Community concerns about the poor state of some parts of the city, including ‘slums’ and congestion, led to major Parliamentary inquiries (1913-14), a Royal Commission (1915), and in 1929 proposals for the first strategic plan (*The Plan for General Development of the Metropolitan Town Planning Commission*). The 1929 plan, highlighted concerns over traffic congestion and erosion of property values, but, as was the fate of most plans, was never implemented. In 1949 the MMBW was authorised by the State Government to prepare a comprehensive plan for the Metropolitan area (see below regarding the plan released in 1954). The MMBW planning role was, however, somewhat incidental to their the main mission of providing very significant civil engineering works and the raising of property rates to pay for such works.

At the National level, the policies to 1949 were aimed at increasing employment by growing the local car industry, initially by requiring local assembly of vehicles and progressively increasing protection for those companies who undertook complete manufacture (Richardson, 1997). A pivotal political event was the 1949 Federal election, a close contest between the incumbent Chifley Labor government and the Menzies Liberal-Country Party (LCP) Coalition. The LCP won by a narrow overall margin (less than 1%) but achieved many more seats (74 compared to 43). A key issue was the different stances on petrol rationing, opposed by the National Party (identifying with rural areas) and the Liberal party who was attacking the Labor party for upholding petrol rationing agreed to by WW2 allies and attacked the socialist objectives of the Labor Party (Richardson, 1997). The 1949 Federal election result had a long-lasting effect on political beliefs, including at State levels, that an anti-car stance was political suicide and that governments were not to make ‘socialist’ style interventions – like strategic planning – that interfered with the free-market economy⁴ (Davison, 2004). Support for motorised private mobility can also be understood as a response to the development of the Australian automobile industry, originally based in Melbourne, with Australian made cars (particularly the Holden) loved by drivers, symbolizing national aspirations and seen as contributing to decades of prosperity (National Museum of Australia).

In 1954, the MMBW released the *Melbourne Metropolitan Planning Scheme 1954 – Report*. The Planning Scheme envisaged by the report was implemented, but most planned infrastructure, and that which was subsequently proposed in the more than 20 planning reports that followed, were never fully implemented. Instead, there was ad-hoc transport investment, mostly in arterial roads (Lay, 2018). In the 1954 Metropolitan Plan and subsequent plans, public transport proposals, which could have benefitted bicycling by moderating growth in road traffic, mostly lapsed for lack of funding. The mobility needs of car occupants were thus privileged over the access needs of those who could have ridden if safer conditions had been provided. Policy and program interventions in Melbourne can be thus be understood as increasing dependence on motor traffic while failing bicyclists and public transport users (Moriarty & Mees, 2006; Stone, 2008) (Low & Astle, 2009).

⁴ It was not until 23 years later that an interventionist and reforming Whitlam Labor Government was elected in 1974.

A gendered aspect of the neglect of bicycling is that bicycling had greatly aided the emancipation of women, giving them ‘autonomy that was previously out of reach’ (Angus, 2015) p.2. Until the 1970s, the development and infrastructure decision-making power in Melbourne was a male domain. Most elected representatives⁵, and all appointed executives, engineers and planners were men. By 1970 only 2% of councillors were women (Garrard et al., 2008; Sinclair et al., 1987) and it was 1975 before the MMBW had a woman Commissioner Cr (Dr) Gwen Hardy, who was but one of 54 commissioners. An insight into the culture of the MMBW, as observed by Tsutsumi and Wyatt, was that professional personnel in the 1970s was some 7000 male engineers, and about 200 ‘planners’ – a number which including the metropolitan parks personnel. Strategic decisions in the Country Roads Board and the related and renamed organisations (RCA, RTA, TRB, RoSTA and VicRoads), and the Town and Country Planning Board until the mid-1970s were all made by men. The domination of infrastructure decision making by men, who strongly favoured motoring, incidentally, created unsafe cycling conditions that had a greater deterrent effect on women than men {Emond, 2009 #1354}.

The problem of motor traffic ‘accidents’ demanded attention from the 1950s (Davison, 2004). However, the 1951 Victorian Year Book reported that to reduce ‘accidents’, pedestrians and cyclists were to keep out of the way of motor vehicles (Tranter, 2005). The situation on Melbourne’s roads for cyclists in the 1950s was expressed by the famous cyclist and parliamentarian Hubert Opperman: ‘it is no use depending on other fellows to take care of you’ (Anon., 1954). The hostility of the Melbourne on-road environment was indicated by a dramatic decline in bicycling (Moriarty & Mees, 2006). The belief that road users were the ‘cause’ of road trauma persisted with the Victoria Police who stated in their 2012 strategic plan, that:

the causes of most road trauma are speed, drink and drug driving, distraction and vulnerable road users
(Victoria Police, 2012, p. 3)

Until the 1960s, the majority of people in Melbourne continued to be dependent on public transport, and Melbourne had one of the highest rates of public transport use in the world⁶. Moriarty and Mees noted that cars were used for only a minority of travel, for example, less than 20% of travel to work by car (Moriarty & Mees, 2006). Cars were, however, highly visible and clogged the roads used by decision-makers, who defined the main urban transport problem as road congestion. The congestion problem definition continued to hold sway into the 21st-century as shown by reports in 2006 and 2013 (Victorian Auditor General’s Office, 2013 1284; Victorian Competition and Efficiency Commission, 2006).

⁵ It was not until 1920 that the first woman (Mary Rogers) was elected to a Melbourne Council (Richmond) and not until 1933 that the first woman (Lady Millie Peacock) was elected to the Victorian Parliament.

⁶ See: (<http://www.emelbourne.net.au/biogs/EM01207b.htm>).

Road rules also evolved to privilege motor vehicle users. For example, priority at uncontrolled intersections (that is, not controlled by traffic signals) from 1964 to the early 1970s operated under a ‘give way to the right rule’ (Social Development Committee, 1982). From late 1974, the METCON program was implemented to improve safety and prevent motorists on minor roads from interrupting traffic by unambiguously establishing priority by Stop and Give Way signs. METCON was effective in reducing right-angle crashes between motor vehicles and improving main road capacity but reinforced the notion that drivers approaching an intersection on a priority road did not need to approach with caution (Quayle, 1979). METCON also established the common behaviour by motorists on minor roads (without priority) of focusing their attention on a gap in the motor vehicles⁷ using the priority road, leading to collisions with visible but unseen bicyclists (Sullivan, 2012; White, 2006). The rules at intersections are thus understood, in practice, as operating to minimise conflicts between motor vehicles. In Melbourne (and Australia) there was thus a failure to establish a culture of caution for drivers when approaching intersections that negated the rights of bicyclists (and pedestrians), to crossroads, as is recognised in Northern Europe and America⁸.

In the 1970s with public attention on road deaths and the OPEC oil crisis, bicycling briefly received attention in Victoria, championed by the journalist Keith Dunstan; Brian Dixon, the Minister for Youth, Sport and Recreation, and activists including Alan Parker. The Geelong and then the Melbourne Bicycle plans were developed by the State Bicycle Committee (SBC)⁹, who reported directly to the Minister for Transport and independent of the road authorities.

⁷ This practice, of drivers ignoring pedestrians and bicyclist, can be readily observed at uncontrolled intersections; it surely contributes to the ‘look but did not see’ crashes experienced by bicyclists, who, as legitimate road users have priority.

⁸ In 1974-75 I lived in West Lafayette, Indiana and studied traffic engineering at Purdue University, where I commuted daily by bicycle, including through winter.

⁹ I was involved with the State Bicycle Committee from 1975 to the mid-1980s (when it was transferred to the Road Construction Authority). My roles included Technical Advisor to the Geelong Bike Plan, Chairman of the Melbourne Bicycle Strategy, and Deputy Chairman of the Committee, and day to day management of the small SBC team.

Also, during the 1970s, in response to the detrimental effects on liveability from through traffic using local streets to avoid congested arterial roads, the MMBW Hierarchy of Roads Study was undertaken to develop a road-based transport strategy that could be cooperatively implemented by road agencies, including municipalities (Lee, 1981) (Pattinson, 1982). The Study involved extensive consultation with stakeholders and produced an agreed framework and guidelines for:

- the protection of residential and other traffic sensitive areas from unnecessary traffic
- the management of a designated arterial road system of existing roads to cater the current levels of through traffic, and
- the reduction of the conflict between people's mobility needs and amenity needs.

(Lee, 1981) p.(i)),

The measures proposed in the Hierarchy of Roads Study supported the 'Engineering' concepts advanced in the Geelong and Melbourne Bike Plans of a fine-grained, 'go-anywhere' network based on local streets. Implementation of the Hierarchy of Roads study was, however disappointing. The suggested lower speed limit on residential streets, a reduction from 60 km/h to 40 km/h, was not implemented by the Road Safety and Traffic Authority (RoSTA). There was no explicit recognition of the bicycle routes as proposed by the SBC and the Melbourne Bike Plan, as this would have required actions by the Road Construction Authority (later VicRoads) and RoSTA (later merged with VicRoads), to provide safe crossings at collector and arterial roads. Similarly, the calls to reinforce cyclist priority over motor vehicles at uncontrolled intersections and to have bicyclists rights fully recognised at controlled intersections, which would have required education by RoSTA and enforcement by the Police, were not implemented.

Although the integrated 4E's (Engineering, Education, Enforcement and Encouragement) approach of the Geelong and Melbourne Bike Plans was accepted by the State Government, it was only partially implemented (Scott et al., 1978). On 'collector' and some arterial roads, the treatment implemented by municipal councils and the Road Construction Authority was 'on-road' bicycle lanes, marked but unprotected. The bike lanes were often narrow, so as not to reduce motor vehicle capacity, often compromised by adjacent parked cars (with the risk of 'dooring'), and were routinely terminated before intersections so as not to reduce intersection capacity for motor vehicles. The few inner area off-road paths, such as the MMBW Yarra River Path and the foreshore path, were disconnected sections, typically narrow and usually shared with pedestrians who had priority. The Education theme, BikeEd through schools, was implemented but has not been explicitly supported by the Victorian Government; consequently, only a minority of children now receive Bike Ed.

In the 1970s and early 1980s, there was optimism around improvements for bicyclists. For example, in the 1981 Melbourne and Metropolitan Board of Works (MMBW)¹⁰, Metropolitan Strategy Implementation report, it was acknowledged that bicycles could have a role in city transport (Melbourne and Metropolitan Board of Works, 1981)p.96 (Luetjens, 2013). Yet, as the Chief Planner of the MMBW, said:

the motor vehicle made Melbourne's post-war development possible, and most people have come to regard it as a necessary part of life ...the car's dominance of the transport system is not something that will change in the short term

(Melbourne and Metropolitan Board of Works, 1981, p. 92)

In the late 1980s, the Road Construction Authority (RCA) took over the State Bicycle Committee (SBC) from the Ministry of Transport and dropped the integrated 4E's approach that included education, and the fine-grained network utilising local streets. The RCA shifted the focus to designating a coarse-grained, CBD focused Principal Bicycle Network (PBN) using arterial roads (Draft Victorian Bicycle Strategy, 1990), showing a lack of understanding of the dangers perceived by bicyclists of riding with high volumes of fast-moving motor traffic and the potential for bicycles to be used for local trips.

The Victorian Department of Infrastructure¹¹, strategic transport and land use plan: *Melbourne 2030, Planning for sustainable growth*, (Victoria, 2002) recognised a role for cycling, proposing more priority to cycling and walking in planning urban development and in managing the road system and neighbourhoods (Policy 8.7), and promoting the use of sustainable personal transport options (Policy 8.8), and a greater role for public transport, with a target of 20% mode share by 2020— which could have improved conditions for bicyclists. Health academic M17 recalled writing a review of *Melbourne 2030* with the strong sense that in proposing to provide for walking and cycling as transport, the Plan was responding to community desire. However, like much of *Melbourne 2030*, the proposals for bicycling remained unrealised.

The *Victorian Transport Plan 2008*, prepared as a stand-alone plan, noted an increase in the number of people cycling to work in the inner municipalities (Government of Victoria, 2008). The 2008 Plan identified barriers that stopped more people from cycling, that included lack of direct connections, discontinuities in bicycle routes and safety concerns. It promised a \$100 million package of improvements, responding to the needs of

¹⁰ The MMBW role as a metropolitan authority was apparently not appreciated by the Victorian Government as in 1992 the planning and parks functions were removed, and the water and sewerage functions privatised.

¹¹ I worked at the Department of Infrastructure from 2002 – 2006 including on transport aspects of *Melbourne 2030*.

bicyclists, including priority through key intersections and widening of off-road shared paths (Government of Victoria, 2008) P.113). However, like so many transport and land use plans for Melbourne, it was never implemented, being shelved by the Baillieu Government in 2011 who cut funding for bicycling infrastructure to zero (SMH July 23, 2012). Then, despite election promises, bicycle expenditure remained at zero under the subsequent Andrew's Labor Government.

In parallel with the growth in private motor traffic, was the growth in truck traffic on Melbourne roads. With the shared road use paradigm, people on bikes are expected to use a high speed and high-risk traffic mix that includes a significant number of trucks. For example, unlike the ports in Amsterdam and Copenhagen, Melbourne's port function and associated wharves have grown and developed at several locations close to the city centre, including Sandridge, Port Melbourne, Williamstown, Hobsons Bay, Queens Wharf, South Wharf, Victoria Dock, Appleton Dock, Webb Dock and Swanson Dock. The Port of Melbourne complex, in 2017, spread over 500 hectares and was the largest container port in Australasia, that also handled motor vehicles, and bulk cargos, generating significant truck movements. For example, Webb Dock alone attracted some 2300 truck and light vehicle movements per day (Port of Melbourne, Fact Sheet, Traffic Management).

Transport and land use development in Melbourne has thus never been strategic or integrated (Tsutsumi & Wyatt, 2006) (Lay, 2003). Dr Max Lay, author of several books on roads and transport planning recently made the observation¹² that the need remains for a strategic plan that covers population, transport and land use, with a program for implementation, and with assured funding (Lay, 2003, 2018). The recent history of strategic planning failure can thus be seen as a continuance of the practice of responding to demands created by private developers and private motor vehicle users. The consequences for bicyclist, of this strategic failure and the dominant the 'car culture' were illustrated in a 2013 survey by the TAC of bicyclists injured in crashes involving motor vehicles. The TAC found that 55% of the injuries resulting from crashes at intersections and that 87% of all injuries occurred when the bicyclists had the right of way (Nieuwesteeg, 2013).

Development of Melbourne can thus be understood as being led by major transport infrastructure – railways, trams and then roads – that implicitly supported private development, rather than following any strategic plan. In this context, bicycles failed to gain any political power.

¹² ITE Seminar in Melbourne, RMIT, 4 April 2018

Bibliography for Appendix 3

- Angus, H. (2015, 5 March 2015). Three women who changed the course of history on bicycles. From <https://momentummag.com/three-women-changed-course-history-bicycle/>
- Anon. (1954). Bicycle Safest Vehicle. *Argus*. 14/5/1954, Melbourne
- Cannon, M. (1967). *The Land Boomers* (2nd ed.). MUP: Carlton.
- Carstensen, T. A., & Ebert, A.-K. (2012). Cycling cultures in northern Europe: from 'golden age' to 'renaissance' *Transport and Sustainability* (Vol. 1, pp. 23-58).
- Davison, G. (1979 - 2004). *The rise and fall of marvellous Melbourne* (2nd ed.). Melbourne University Press: Carlton.
- Davison, G. (2004). *Car Wars*. Allen and Unwin: Crows Nest.
- Fitzpatrick, J. (2015). A glimpse of Australia's cycling history. In J. Bonham & M. Johnson (Eds.), *Cycling Futures* (Electronic ed., pp. 25-39). University of Adelaide: Adelaide.
- Garrard, J., et al. (2008). Promoting transportation cycling for women: the role of bicycle infrastructure. *Preventive Medicine*, 46(1), 55-59.
- Gawler, O. (1943). Victorian Year-Book 1940-41 (Vol. 61). Government Printer: Melbourne
- Government of Victoria. (2008). *The Victorian Transport Plan*. Victorian Government: Melbourne
- Harland, J. C. (2016), Email [Bikepaths] 7/4/2016)
- Lay, M. (2003). *Melbourne miles: The story of Melbourne's roads*. Australian Scholarly Publishing: Melbourne.
- Lay, M. (2018). Learning from History, Melbourne Miles. *Seminar*. RMIT University.
- Lee, R. (1981). Hierarchy of Roads Study, Steering Committee Final Report (pp. 39). Melbourne and Metropolitan Board of Works: Melbourne.
- Low, N., & Astle, R. (2009). Path dependence in urban transport: an institutional analysis of urban passenger transport in Melbourne, Australia, 1956–2006. *Transport Policy*, 16(2), 47-58.
- Luetjens, J. (2013). Cycling through the history of Melbourne. *Agora*, 48, 24.
- Melbourne and Metropolitan Board of Works. (1981). Metropolitan Strategy Implementaion. Melbourne and Metropolitan Board of Works: Melbourne.
- Moriarty, P., & Mees, P. (2006). *The Journey to Work in Melbourne*. Paper presented at the 29th Australasian Transport Research Forum, Surfers Paradise.
- National Museum of Australia. 1949 Model 48/215 Holden sedan. from [http://collectionsearch.nma.gov.au/?f\[0\]=obj_collectiontitle:Mary%20Munckton%20and%20Ian%20Metherall%20collection&object=76876](http://collectionsearch.nma.gov.au/?f[0]=obj_collectiontitle:Mary%20Munckton%20and%20Ian%20Metherall%20collection&object=76876)
- Newman, P. (1992). The compact city: an Australian perspective. *Built Environment* (1978-), 18(4), 285-300.
- Nieuwesteeg, M. (2013). *TACKling the risk - setting the scene*. Paper presented at the Bike Futures, Melbourne.
- Pattinson, W. H. (1982, 23 – 27 August 1982). *Review of the Hierarchy of Roads Study*. Paper presented at the 11th AARB Conference, University of Melbourne.
- Quayle, G. (1979). Rules of precedents at intersections: an examination of alternatives for Australia. Department of Transport: Canberra.
- Richardson, D. (1997). *Protection in the Motor Vehicle Industry*. (Brief 22). Parliament of Australia: Canberra. Retrieved from https://www.aph.gov.au/sitecore/content/Home/About_Parliament/Parliamentary_Departments/Parliamentary_Library/Publications_Archive/CIB/CIB9697/97cib22.
- Scott, M. J. C., et al. (1978). *The Geelong Bike Plan: practical planning for cyclist's real needs*. Paper presented at the 4th Australian Transport Research Forum, Perth.
- Sinclair, A., et al. (1987). *Getting the numbers: women in local government*: Municipal Association of Victoria in conjunction with Hargreen Pub. Co.: Melbourne.
- Social Development Committee. (1982). *Interim Report on Road Safety in Victoria*. (17/1982 – 83). Parliament of Victoria: Melbourne.
- Stone, J. (2008). *Political factors in the rebuilding of mass transit: an investigation of failure in Melbourne since 1970 through comparisons with Perth and Vancouver*. (Doctor of Philosophy Thesis), Swinburne University of Technology: Hawthorn, Victoria.

- Sullivan, J. (2012). A fighter pilot's guide to surviving on the roads: Whats wrong with you are you blind!
Retrieved from <https://www.londoncyclist.co.uk/raf-pilot-teach-cyclists/>
- t'Hart, P. (2014). *Understanding Public Leadership*. Palgrave Macmillan: London.
- Tranter, K. (2005). History of the Haste-Wagons: The Motor Car Act 1909 (VIC), Emergent Technology and the Call for Law. *Melbourne University Law Review*, 29, 843-879.
- Tsutsumi, J., & Wyatt, R. (2006). A brief history of metropolitan planning in Melbourne, Australia. *Applied GIS*, 2(2), 1-10.
- Victorian Government (2002). *Melbourne 2030: Planning for sustainable growth*. Melbourne: Retrieved from <https://www.planning.vic.gov.au/policy-and-strategy/planning-for-melbourne/melbourne-2030-planning-for-sustainable-growth>.
- Victoria Police. (2012). *Victoria Police Blueprint 2012 -15, Year 2*. Victoria Police: Melbourne.
- Victorian Auditor Generals Office. (2013). *Managing Traffic Congestion*. Parliament of Victoria: Melbourne
- Victorian Competition and Efficiency Commission. (2006). *Making the right choices: options for managing transport congestion*. Melbourne: Retrieved from <https://www.dtf.vic.gov.au/sites/default/files/2018-02/making-the-right-choices-options-for-managing-congestion.pdf>.