A Co-Benefit Analysis of Alternative Transportation in Adelaide, Australia:
Integrating Perspectives from Communities and Stakeholders for Sustainable Change

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PUBLICATIONS DURING CANDIDATURE

Peer-reviewed Journals:


Conference paper:

CONFERENCE PRESENTATIONS DURING CANDIDATURE


3. Ting Xia, Pushan Shah, Ying Zhang, Shona Crabb. Evaluating the PM change and health impact due to urban vehicle emissions reduction in Adelaide, South Australia (Oral). 21st International Clean Air and Environment Conference, Sydney, Australia, September 2013


AWARDS ARISING OUT OF THIS THESIS


- Postgraduate Travelling Fellowships. Faculty of Health Sciences Research Committee, University of Adelaide. 2013.

## LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
</tr>
<tr>
<td>ACS</td>
<td>American Cancer Society</td>
</tr>
<tr>
<td>ADM</td>
<td>Atmospheric Dispersion Modelling System</td>
</tr>
<tr>
<td>AF</td>
<td>Attributable fractions</td>
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<tr>
<td>ARI</td>
<td>Acute respiratory infections</td>
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<tr>
<td>BAU</td>
<td>Business-as-usual</td>
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<tr>
<td>BenMAP</td>
<td>Environmental Benefits Mapping and Analysis Program</td>
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<tr>
<td>BITRE</td>
<td>The Australian Bureau of Infrastructure, Transport and Regional Economics</td>
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<tr>
<td>CATI</td>
<td>Computer aided telephone interviewing</td>
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<tr>
<td>CI</td>
<td>Confidence interval</td>
</tr>
<tr>
<td>CNG</td>
<td>Compressed natural gas</td>
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<tr>
<td>CO</td>
<td>Carbon monoxide</td>
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<tr>
<td>CO₂</td>
<td>Carbon dioxide</td>
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<tr>
<td>CO2-e</td>
<td>Carbon dioxide equivalent</td>
</tr>
<tr>
<td>CRA</td>
<td>Comparative Risk Assessment</td>
</tr>
<tr>
<td>CSIRO</td>
<td>Commonwealth Scientific and Industrial Research Organisation</td>
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<tr>
<td>DALY</td>
<td>The disability-adjusted life year</td>
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<tr>
<td>dB</td>
<td>Decibel</td>
</tr>
<tr>
<td>DPTI</td>
<td>Department for Transport, Energy and Infrastructure</td>
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<tr>
<td>EC</td>
<td>Elemental carbon</td>
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<tr>
<td>EMMM</td>
<td>Expansion of the multi-city mortality and morbidity study</td>
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<tr>
<td>EPA</td>
<td>Environmental Protection Agency</td>
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<tr>
<td>EPA-MVEI</td>
<td>Environmental Protection Authority Motor Vehicle Emission Inventory database</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>ERG</td>
<td>Environmental Research Group</td>
</tr>
<tr>
<td>FPM/APM</td>
<td>Fine Particles/Aerosol Particle Mass Analyzer</td>
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<tr>
<td>GDP</td>
<td>Gross domestic product</td>
</tr>
<tr>
<td>GHGs</td>
<td>Greenhouse gases</td>
</tr>
<tr>
<td>HAPiNZ</td>
<td>Application of Health and Pollution in New Zealand</td>
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<tr>
<td>HEAT</td>
<td>Health Economic Assessment Tool</td>
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<tr>
<td>IPCC</td>
<td>International Panel on Climate Change</td>
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<tr>
<td>ITHIM</td>
<td>Integrated Transport and Health Impact Modelling Tool</td>
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<tr>
<td>LAEI</td>
<td>The London Atmospheric Emissions Inventory</td>
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<tr>
<td>LPG</td>
<td>Liquefied petroleum gas</td>
</tr>
<tr>
<td>MET</td>
<td>Metabolic equivalent task hours</td>
</tr>
<tr>
<td>Mton</td>
<td>Metric ton</td>
</tr>
<tr>
<td>NAEI</td>
<td>National Atmospheric Emission Inventory</td>
</tr>
<tr>
<td>NAM</td>
<td>Norm-activation model</td>
</tr>
<tr>
<td>NO₂</td>
<td>Nitrogen dioxide</td>
</tr>
<tr>
<td>NOₓ</td>
<td>Nitrogen oxides</td>
</tr>
<tr>
<td>O₃</td>
<td>Ozone</td>
</tr>
<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
</tr>
<tr>
<td>OSPM</td>
<td>Operational Street Pollution Model</td>
</tr>
<tr>
<td>PAFs</td>
<td>Population attributable fractions</td>
</tr>
<tr>
<td>PBC</td>
<td>Perceived behavioural control</td>
</tr>
<tr>
<td>PM</td>
<td>Particulate matter</td>
</tr>
<tr>
<td>PM₁₀</td>
<td>Particles with an equivalent aerodynamic diameter ≤ 10 μm</td>
</tr>
<tr>
<td>PM₂.₅</td>
<td>Particles with an equivalent aerodynamic diameter ≤ 2.5 μm</td>
</tr>
<tr>
<td>PROS</td>
<td>Population Research and Outcome Studies</td>
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<tr>
<td>QoL</td>
<td>Quality of life</td>
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<tr>
<td>RR</td>
<td>Relative risk</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>SA</td>
<td>South Australia</td>
</tr>
<tr>
<td>SDM</td>
<td>System dynamics modelling</td>
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<tr>
<td>SEM</td>
<td>Meta-analytic structural equation modelling</td>
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<tr>
<td>SIM-air</td>
<td>Simple Interactive Models for better air quality</td>
</tr>
<tr>
<td>SO₂</td>
<td>Sulphur dioxide</td>
</tr>
<tr>
<td>TAPM</td>
<td>The Air Pollution Model</td>
</tr>
<tr>
<td>TAT</td>
<td>Towards Alternative Transport</td>
</tr>
<tr>
<td>TPB</td>
<td>Theory of planned behaviour</td>
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<tr>
<td>VAPIS</td>
<td>Vehicle Air Pollution Information System</td>
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<tr>
<td>VEPM</td>
<td>Vehicle Emissions Prediction Model</td>
</tr>
<tr>
<td>VKT</td>
<td>Vehicle kilometres travelled</td>
</tr>
<tr>
<td>VOCs</td>
<td>Volatile organic compounds</td>
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<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
<tr>
<td>YLD</td>
<td>Years lost due to disability</td>
</tr>
<tr>
<td>YLL</td>
<td>Years of life lost</td>
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ABSTRACT

Background

The increasing number of motor vehicles in urban areas has a significant impact on the environment, as well as, on human health. Motor vehicle emissions contribute a considerable amount of energy-related greenhouse gases and cause non-negligible air pollution. In addition, over-dependence on cars has also encouraged a sedentary lifestyle and an obesity epidemic, which may lead to increased burden of diseases. These health and environmental costs of motor vehicle usage can be reduced by encouraging individuals to change their travel behaviours in order to increase their use of alternative transport. Such a strategy provides an opportunity for collaboration between people working in the transportation, environment and public health areas. However, limited studies currently exist to provide sufficient evidence for policy and interventions relating to this issue.

Aims

The aims of the research presented in this thesis are to improve our understanding of the co-benefit effects of alternative transport and to investigate perspectives from communities and stakeholders on sustainable travel behaviour change in Adelaide, South Australia.

Methods

A mixed-method study design was employed, with three interrelated studies conducted: two quantitative and one qualitative. The first study was focussed on a scenario-based modelling analysis. Separate models, including air pollution, health impact assessment, and traffic injury models, were developed in relation to scenarios for car reduction with
possible environmental and health outcomes, in order to evaluate the overall potential benefits of alternative transport.

The second study involved a cross-sectional survey conducted in the Adelaide metropolitan area. A total of 381 residents were interviewed using the computer-assisted telephone interviewing (CATI) system. Descriptive statistical analysis, factor analysis, Pearson correlations, and multiple logistic regressions were performed to investigate the relationships between participants’ attitudes and their travel behaviours and to explore predictors of participants’ intention to reduce car use.

The third study presented in the thesis adopted a qualitative approach to explore the perspectives of stakeholders relevant to changing transport behaviours. In-depth interviews with key stakeholders (n=13) were conducted, and a thematic analysis of the resulting transcripts identified some of the particular challenges that must be overcome in order to promote alternative transport.

Results

Results of the first study indicated that the major health benefits associated with the promotion of alternative transport policies related to increased physical activity. In the increased cycling scenarios, it was found that a small shift from car travel to cycling would reduce the burden of disease related to physical inactivity by 17-34% (1991-4132 disability-adjusted life years [DALYs] prevented), compared with a Business As Usual scenario by 2030. Results indicated that important health benefits can also be achieved by increasing public transport use, which involves increasing walking distance and a possible reduction in serious traffic injuries. Although findings from this study do not suggest a large reduction in PM$_{2.5}$ concentration (0.1-0.4 μg/m$^3$) associated with alternative
transport use, health benefits (39-118 DALYs prevented) from the reduction of air pollution exposure for the general population should not be ignored.

The results of the cross-sectional survey suggest that there are socio-demographic differences in people’s dominant mode of transport, annual driving distance and car use frequency. In general, “Push” measures to reduce car use (e.g., increasing costs associated with driving) were considered less efficient than “Pull” measures (e.g., making alternative transport more attractive). In addition, people’s attitudes towards traffic, the environment and health may influence their travel behaviours and intentions to reduce car use. Those who highly rated the importance of safety and comfort and who reported having more negative emotions towards public transport were likely to use cars more often and less likely to shift their travel mode. In contrast, those who indicated a high level of awareness of the benefits of alternative transport and of the problems of traffic were more likely to report an intention to shift travel mode and favour car reduction measures.

Key themes identified in the final qualitative study suggested that barriers to promoting active transport fall into four main areas: (1) existing gaps in knowledge of transport emission impacts, strategies from other countries and the overall benefits of alternative transport, (2) striking a policy balance between alternative transport strategies and economic viability, feasibility, population density, traffic demands, and budget distribution issues, (3) shared ownership of responsibilities, funding and regulations among governments and departments, and (4) public resistance to using alternative transport. Potential solutions suggested by participants to resolve these barriers included government actions, “Push” and “Pull” policy interventions, educational approaches, culture change and evidence-based research.
Conclusion

Findings from the first study reveal that alternative transport use can produce considerable health benefits associated with increased levels of physical activity. This may lead policy makers to pay more attention to transport strategies which especially favour active transport, rather than strategies aimed solely at reducing vehicular emissions (e.g. elevating standards for emissions). The study also revealed that, to achieve significant health benefits through transport policy, travel behaviour change at the population level is essential. Findings from the second study provided a better understanding of current travel behaviour in the study setting. This study also suggested that public education and community campaigns focusing on local residents with sufficient knowledge of traffic issues and benefits of alternative transport, combined with car reduction barriers, could encourage less driving and more pro-environmental travelling. To take the alternative transport agenda forward, high level leadership and commitment from governments are needed to assist in establishing and building collaborative efforts. The findings of the third study fill a gap between policy intention and implementation, and highlight the importance of a ‘whole-of-government’ policy approach which can strengthen collaborations across relevant policy-makers.
I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

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Signed ............................................. Date............................................
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Professional editor, Dr. Arthur Saniotis, was used in the preparation of the thesis for submission, following the guidelines of the Australian Standards for Editing Practice.

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