Methodologies to Increase Public Transport Mode Share in Sydney and Perth

Masters Thesis

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What is this projects value to society?

Increasing public transportation mode share is important in the context of the future economic development of our cities. Given recent published greenhouse gas emissions data attributable to private transportation, it is arguable that global growth in motor vehicle usage may be detrimental to the environment and therefore to our cities' sustainable growth.

This body of work seeks to describe methodologies and theories to increase the percentage mode share of alternative forms of transport and to deter the continued growth in sole occupant motor vehicle journeys. These methodologies are the result of significant research into existing systems in Australia, and where relevant additional research in Europe and the USA. Due to the nature of the problem, the methodologies presented are not intended to be revolutionary, however are intended to show a holistic view of how behavioural science methodologies, engineering infrastructure and technology could be incorporated. This analysis and research is provided as an alternative to "reactionary" measures.

The value of this project is delivered in four ways, namely: -

- A concise listing of transportation statistical analysis from the last 25 years for both Sydney and Perth.
- An analysis of contributors to human behaviour patterns and their impact on transportation mode choice, culminating in the offering of theories involving Maslow's Hierarchy of Needs and Elliott Wave Theory.
- An analysis of transportation infrastructure engineering and it's potential to impact human behaviour and therefore impact transportation mode choice. This section culminates in an examination of passive and active signal bus priority infrastructure measures.
- The conclusions which seek to show the importance of understanding both the behavioural patterns which impact transportation mode choice decisions and the potential for engineering infrastructure to create a positive influence.

After five years of research I believe that engineering and infrastructure improvements can have an impact upon mode choices, but the underlying trend away from public transport is behavioural. Understanding and implementing schemes which target both aspects will deliver improved opportunities for success. Reduction in traffic congestion, vehicle travel times and ultimately greenhouse gas emissions are all the ultimate goals for a mode share shift from private motor vehicles to public transportation systems.

This report expands upon the material covered in the Capstone Project report "*Traffic Congestion in Australian Cities – a Summary of Transport Planning and Modal Share Targets in Four Australian Cities*".

Can I help solve problems?

I have a strong interest in the provision of public transport infrastructure and believe it is important for engineers to have formative input into projects which promote sustainable transportation objectives.

Importantly, during the research phase I have become convinced that engineers need to appreciate the behavioural science aspect of society, or simply to understand why people utilise infrastructure and public spaces. This theory commenced from an inspiring speech delivered at the UTS graduation ceremony in September 2004 by one of the guest speakers. The topic centred on designing Darling Harbour as a space where people interacted with their environment. Therefore a key success factor of the project was the slower pace which people walked through Darling Harbour than through the rest of the Sydney CBD. As Darling Harbour was a more pleasant environment, people walked slower, talked more and appeared to enjoy their surroundings more. A course syllabus covering behavioural science and transportation, or expansion of subjects such as Uncertainties and Risks or Technology Assessment could be very useful at UTS for future engineering undergraduates.

I have been involved in infrastructure design for the last 15 years and my ultimate aim is to continue to develop my career in urban transport, land development and local and state government level infrastructure. I am currently a Senior Civil engineer at TABEC in Perth which focuses on these markets. My role is to develop

and expand business, which provides a strong practical background to complete this thesis. In my previous role at WorleyParsons I was the Project Manager for the consultant appointed to provide input into the Design and Specification of a Trial of Active Signalised Bus Priority on the Perth Circle Route, which provided further opportunity for research into this topic.

I have a sound theoretical grounding after completing the subject "*Transport In The Environment"* and the aforementioned Capstone Project. I look forward to enhancing my analytical skills and knowledge in transportation and urban infrastructure engineering in the coming years.

Project origin?

The origin of the project is borne from work and study experiences over the last 5 years and working with some of Sydney's and Perth's leading transport engineers. I have always had an interest in projects involving the principles of ecologically sustainable development, and transportation is a key issue for each city in Australia to resolve, as the current trends in transport modal share arguably are not environmentally, economically or socially sustainable. In addition, it is important that the general public further develop their understanding of transportation infrastructure, how it is funded and its place in the greater environment. As an engineer with an interest in the way we integrate with the environment, particularly within the context of the urban environment, I feel this is a worthy project to dedicate time to.

Where was the work carried out?

This Masters Research Thesis has been undertaken in Perth with 6-monthly reviews undertaken in Sydney. Statistics and relevant policy information have been researched and collated, with the internet used as the primary source of information. This research is updated every 6 months to reflect latest available data and verified by contacting transportation departments in Sydney and Perth to ensure sampling techniques have not changed to the point where figures and trends are distorted. Additional transport data, policies and viewpoints have been obtained through a number of books, newspaper articles, printed material and research via telephone. All quoted material has been appropriately referenced.

It is important to note that the data sources have been checked through the duration of this research and compared to ensure that where comparisons of data sets are provided, they are on a “like for like” basis and that sample sizes, or techniques have not shown an undue emphasis or bias.

Desktop traffic modelling has been undertaken in accordance with the NSW RTA’s Guide To Traffic Generating Developments, Version 2.2 October 2002 and in accordance with the data accumulated in this thesis. The author’s assumptions and methodologies have been clearly noted and explained where they have been applied.

Basic goal and rationale for the project?

The key hypothesis of this work is to: -

“Discuss and analyse transportation mode share statistics and to determine behavioural science and engineering infrastructure methodologies to increase public transport modal share in Sydney and Perth.”

To accomplish the key hypothesis, the work is broken into smaller goals based on a logical order of: -

- Analysis of transportation statistics;
    - Historical context.
    - Current context.
    - Comparative analysis between Sydney and Perth and opportunities for both cities to learn from successes / mistakes.
- Behavioural science aspects of transportation;
    - Analyse various behavioural science theories which impact transportation mode choice.
    - Discuss human behaviour in terms of our decision making capabilities at individual level – Maslow’s Hierarchy of Needs

        - Discuss human behaviour in terms of our decision making capabilities at group (or herd) level, and the potential to predict future transportation statistical performance based on the historical context – Elliot Wave Theory.

- Transportation engineering infrastructure methodologies;
    - Analyse various engineering infrastructure theories which impact transportation mode choice.
    - Discuss the emergence of active signal bus priority technology and its potential to initiate a shift in transportation mode share.
    - Discuss the emergence of passive infrastructure bus priority and its potential to initiate a shift in transportation mode share.
- Conclusions
    - The key conclusion is to show the importance of understanding that transportation mode choice decisions are influenced by both the provision of infrastructure but also other external factors which influence human behaviour.

The goal of the historical context research is to collate a reasonable quantity of data in Sydney and Perth to deliver an accurate summary of the trend of public transportation mode share. This includes examination of land use, patronage figures and compilation of data showing why people travel to deliver an understanding of the various factors which have contributed to the historical performance.

The goal of the current context research is to collate up-to-date data which delivers an accurate summary of the factors impacting transportation mode choice today. This is reviewed in the context of recent engineering improvements which may have impacted supply / demand and the underlying behavioural trends and psychology toward various forms of transport. It may be evident that the general attitude toward public transport is more positive in Perth than in recent years in Sydney, mainly due to capacity and comfort issues. This is seen in greater

patronage growth in Perth than in Sydney over the last decade. It is important however to note that patronage growth in Perth is growing off of a much lower base and that Perth has a much less complicated and more rudimentary transportation network than Sydney, making urban infill projects simpler to deploy in many cases.

The goal of the behavioural sciences research is to deliver an understanding of why people make travel choices. This is delivered through understanding existing theories and methodologies, and by developing theories and methodologies based on the data and information contained in this work. As a direct result of the research, I have developed theories associated with adapting Maslow's Hierarchy of Needs and Elliott Wave Theory to transportation.

The goal of examining and understanding engineering and infrastructure solutions is to understand the potential range of solutions available to deliver improved public transport performance. In particular, this work focuses on the development of active signal priority technology.

Progress achieved?

Over the five years of data compilation, analysis and reporting I have delivered a concise document which meets the basic goal and rationale for the project.

STATEMENT OF ORIGINALITY

I declare that I am the sole author of this report and that I have not used fragments of text from other sources without proper acknowledgment. All theories, results, designs and statistics incorporated into this report have been appropriately referenced and all sources of information and assistance have been appropriately acknowledged.

Signed

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Colin R Kleyweg

EXECUTIVE SUMMARY

This Masters' Thesis has evolved as an iterative learning process driven initially by the compilation and understanding of transportation usage data. The research phase began with a clear goal to understand the **historical context of transportation modal share**. The initial objective and scope of the research was therefore to collate as much data as possible to deliver an understanding of the recent trends in Sydney and Perth. This data built on the "Transportation / Land Use Cycle" theories which were evident in my Capstone Project work. The scope of the data collection was to discover statistically significant trends such as links between: -

- Accessibility to the CBD and trip generation;
- Accessibility to transportation options (socio-economic status and urban location) and its impact on public transport usage;
- Whether the purpose of the trip had an impact on the mode chosen; and
- Whether household composition and dwelling densities had an impact on motor vehicle usage.

During the compilation of the Capstone Project work, I had found there were a number of useful information sources, however there wasn't a single source of information available through internet searches which delivered an in-depth understanding of patronage trends and how societies' attitudes were evolving over time to trip generation. My first goal was to provide a reference to potentially aide future students to understand the recent history of transportation in Sydney and Perth. Perth was chosen, not as a direct comparison, but to compare a city with very different transportation networks to Sydney.

The second goal has evolved throughout the research phase over the last 3 years and has culminated in the last 12 months where I have used the data to consider the behavioural science aspect of transportation. The key understanding here is **why people generate trips and why a particular mode is chosen for those**

purposes. Transportation choice is arguably a personalised commodity. Vehicle manufacturers consider their target markets carefully and purchasers associate themselves with the various stereotypes shown. Public transportation and other alternative modes are also associated with stereotyping. This has been quantified in the material from studies in NSW which provide a user profile summary. If this information is compared to questionnaires which summarise user views on potential system improvements it provides the opportunity for analysis. I have undertaken the analysis based on our short term or 'reactionary' behaviour and our longer term or 'disposition' behaviour trends as follows: -

- The short term (or 'reactionary' behaviour) is described by **price elasticity theory** and by provision of infrastructure inducing demand through accessibility; and

- The long term (or 'disposition' behaviour) is described by analysis of long term patronage trends using **Elliott Wave Theory** and adapting **Maslow's Hierarchy of Needs** for use as a tool to understand consumer transportation mode choice.

The third goal is to **understand the impact of transportation engineering infrastructure on mode choice**. The purpose of this is to analyse potential infrastructure improvements to suit public transportation modes. Due to the open nature of this topic, I made a choice to focus on bus infrastructure. This has not been done to exclude other forms of alternative transportation, or to suggest that bus is in any way better than other forms of transportation – it has simply been done so that a reasonable amount of analysis and research could be undertaken on the one topic.

The fourth goal is to understand the emerging **active signal priority bus technology**, and how this technology can improve on-time running, maintenance of headway and ultimately patronage (as most bus passengers' rate on-time delivery of services as one of the highest priorities.)

Australian cities are encountering greater levels of traffic congestion which leads to a number of issues for engineers, planners, politicians and society in general.

These issues include the economic cost to society of traffic delays; damage to the environment and community health caused by vehicle exhaust fumes and the social effects upon communities coping with traffic congestion and segregation issues.

The research contained shows that growth in congestion is linked to a number of factors. These include increased percentage and number of single occupant vehicles as the primary mode of transport; population growth in outer-lying urban areas with a reduction in persons per dwelling; growth in car ownership outstripping population growth; increased urban sprawl contributing to greater travel distances and continued decline in the overall percentage share of alternative forms of transport. This research aims to provide an understanding of the reasons for the decline in public transport usage and modal share over the last 25 years.

The research focuses in particular on Sydney and Perth, as in many ways they have exhibited different growth and planning models. As such, the data sets contained provide an interesting comparison in terms of modal share percentages, patronage growth and general land-use in terms of dwelling density and household composition. In general, the research shows that while the use of public transport is greater in Sydney, growth levels are greater in Perth due to a greater un-used capacity in the public transportation system and provision of major new rail infrastructure promoting public transportation usage. It can be argued that the transportation system in Sydney operated at levels close to capacity in many areas which led to a greater level of dissatisfaction with the service in the early part of this decade. Recent improvements in service reliability and capacity however are slowly improving the situation.

The question of improving public transportation patronage is shown to be a complex issue with a variety of inputs to be considered including understanding behavioural science; providing reasonable excess capacity in the system to absorb variations in consumer behaviour; and delivering engineering and infrastructure improvements which promote increased speed of travel relative to other transport options.

The question of behavioural science is examined in detail by providing research on why people use various modes of travel, how this is changing over time and whether the reason for travel predicates an inclination to use one form of transport over another. An example of this is the general increase in trips generated for social and other purposes and the relative decline in trips generated for commuting purposes. Social, shopping and other trips tend to be discretionary in nature and as such users are biased towards using a motor vehicle for those trips. Commuting, (particularly to the CBD's in Sydney, North Sydney, Parramatta and Perth) however offers strong opportunities for mass-transit transportation modes. Information provided by various public transportation agencies shows that lower socio-economic denominations tend to utilise public and alternative transport modes for a higher percentage of their daily trips than those with a greater earning capacity. In essence, this explains the theory behind 'captive' and 'discretionary' users and points to continued latent growth in motor vehicle usage as economic conditions and availability and pricing of new motor vehicles increases accessibility to greater numbers of consumers. This is further exacerbated by an imbalance in relative travel times between public transport and private motor vehicle usage.

Behavioural sciences are further examined in terms of Maslow's Hierarchy of Needs which has been applied to transportation to show that short term variations in patronage growth and / or decline are influenced by external forces including accessibility to transportation options; variations in fuel prices and fares (price elasticity theory); and timeliness, cleanliness, frequency and degree of crowding on public transportation.

The Elliott Wave Theory is highlighted to show that short term variations in patronage are worthwhile to note, however these need to be understood in terms of the overall longer term trend which is for increasing private motor vehicle usage, unless there is a change to the phenomenon of the growing consumer market having an increased accessibility to motor vehicles and accessibility to cheap fuel and subsidised road networks. The purpose of this theory is not that it be misused as a tool to predict opportunities to cut transportation funding at various cycles. The purpose of the theory is to show potential trigger points for greater levels of investment in infrastructure and / or behavioural science programs.

Engineering and infrastructure case studies such as the Centenary Avenue Bus Lane project show the potential for engineering infrastructure improvements such as variation of road capacity to provide a net tangible benefit to the environment by promoting public transportation, whilst minimising excessive delays on other forms of traffic. It is important to note that the promotion of public transportation should not be at the expense of a net gain to the environment. The suggested infrastructure improvement shows a net travel gain to all forms of traffic.

Project expenditure is an important component, and this has been considered in the research through the delivery of active, signalised bus priority systems which utilise technology to provide time travel benefits to buses. Research in five locations shows the potential for tangible improvements in adherence to timetable for buses operating in a priority environment. The delivery of an active signal bus priority system can be achieved with minimal upgrade to existing infrastructure and has been shown to provide at least 10% improvements in on-time running. Where coupled with bus-only infrastructure such as bus transit lanes, the productivity gains have been shown to be even greater, as evidenced on the Liverpool to Parramatta Transit-Way.

In summary, this research has presented a concise understanding of the background dynamics involved in transportation engineering. For material gains to be made in alternative modal share there needs to be a consistent effort made at State and Federal Government level to promote the use of public transportation, while decreasing the access to sole occupancy motor vehicles in peak times on congested networks.

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