Research perspectives on the merits of Light Rail vs Bus

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Agenda

1. Introduction

2. People Prefer Rail!

3. Beware the Streetcar!

4. The Transfer Problem

5. Other Factors

6. Conclusions
This paper examines trade-offs in Light Rail vs Bus investment for urban Australia

• Authorities face difficult decisions in using limited funds
• Much debate is polarised within industry divides – we need ‘facts’ not ‘faith’ upon which to base decisions
• Includes results from 3 research papers to inform the debate:
It is structured as follows:

- People Prefer Rail!
- Beware the Streetcar!
- The Transfer Problem
- Other Factors
- Conclusion
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Behavioural research can be used to explore passenger preference for transit modes

How many will use on-street Bus vs Light Rail?

Same:
- Walk Access Time
- Wait Time (Frequency)
- Fare
- Reliability
- In-Vehicle Travel Time
- Walk Egress
- Reliability
When measured for on-street bus, light rail and heavy rail interesting results emerge.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Weighted Trip Time (Mins)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus (On-Street)</td>
<td>86</td>
</tr>
<tr>
<td>Light Rail</td>
<td>76</td>
</tr>
<tr>
<td>Heavy Rail</td>
<td>76</td>
</tr>
</tbody>
</table>

10 Minute Benefit for Rail (OR A 10 Minute MODE SPECIFIC FACTOR)

The evidence shows much variation by mode but a general trend to preference for rail

Why does rail have a perceived benefit over Bus?

- The cause of the mode specific factor benefit of rail is related to comparative quality of bus vs rail in relation to:
  - Stops/Stations
  - Network Knowledge
  - Ride Quality
  - Expectations of Reliability
  - Expectations of Priority
  - Expectations of Speed
Stations have more amenities and are easy to locate than bus stops

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  – Ride Quality
  – Expectations of Reliability
  – Expectations of Priority
  – Expectations of Speed
Rail lines are easy to understand – bus routes are spaghetti

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  – Expectations of Reliability
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  – Expectations of Speed
A rail ride is comfortable, buses require a hand hold

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  - Ride Quality
  - Expectations of Reliability
  - Expectations of Priority
  - Expectations of Speed
Traffic makes buses more unreliable than rail

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  - Stops/Stations
  - Network Knowledge
  - Ride Quality
  - Expectations of Reliability
  - Expectations of Priority
  - Expectations of Speed
Rail never waits at traffic signals – bus does

- The cause of the mode specific factor benefit of rail is related to comparative quality of bus vs rail in relation to:
  - Stops/Stations
  - Network Knowledge
  - Ride Quality
  - Expectations of Reliability
    - Expectations of Priority
  - Expectations of Speed
Rail is perceived as faster – bus in traffic with on-vehicle fare collection is slow

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  - Stops/Stations
  - Network Knowledge
  - Ride Quality
  - Expectations of Reliability
  - Expectations of Priority
  - Expectations of Speed
However (limited) evidence also suggests well designed bus systems can have similar MSC’s

Quality Stops/Stations
Simple Networks
Good Ride Quality
High Reliability
Priority Over Traffic
High Speed

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Melbourne has one of the world's largest light rail systems.
Unfortunately it’s a “streetcar” system
Indeed its probably THE biggest (western) city streetcar system

Tram/LRT Track Km in Mixed Traffic with Median Operations

MELBOURNE, AUSTRALIA

German Cities

French Cities

UK Cities

USA Cities
Mixed Traffic service impedes performance

Average Operating Speeds – World Tram/Light Rail Systems

Melbourne Tram Reliability
- 33% of services are considered to be NOT running on time
- On time defined as arriving more than 1 min early of more than 6 mins late

Source: Track Record

Source: UITP Databank
As traffic is growing, trams are getting slower and more unreliable.

Source: ITS analysis of ‘Track Record’ Data

Source: Department of Infrastructure
In addition it's not DDA Accessible and needs to be by 2032

How to gain safe vehicle-kerb access?

Despite Low Floor Tram Not DDA Accessible

Road is Blocked During Boarding
A good solution are ‘super stops’ – but these are feasible in few locations
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Passengers don’t like transferring between transit modes to complete journeys

**Typical Weighted Bus Travel Time**

- **Transfer Issue**
  - Represents over 30% of total perceived travel time
  - Evidence shows transfer penalties can vary considerably with quality of the transfer location:
    - Unprotected Area, Open Air, Uncoordinated Transfer, Low Frequency
      - 32 Minutes
    - Protected Area, Covered, Coordinated Transfer, High Frequency
      - 4 Minutes

  **Utility of Transfer Includes:**
  - Walk transfer time (weighted)
  - Wait transfer time (weighted)
  - PLUS a fixed transfer penalty

Source: Currie and Willis (98) Australasian Transport Research Forum
Evidence shows transfer ‘penalties’ vary but are generally significant in size.

They also vary by mode – quality of the transfer environment is again the determining factor.

The average transfer penalty for LRT is 19 minutes – a significant deterrent.

A major LRT design issue is how to avoid ‘forcing’ transfers from bus networks.
Bus services run DIRECTLY (No transfer) into the CBD
Only Light Rail Running the Full Length of the Route Would Avoid a ‘Forced’ Transfer

Key Question 1

- Can you afford to convert every bus route in Sydney to Light Rail?
- If Not Where (and who) has to have a ‘forced’ transfer?
Key Question 2

- Do you have CBD Space for LRT in one corridor PLUS buses from the rest of Sydney?
- IF NOT – Most of the Sydney Bus Network Would have Forced Transfers
Key Question 3

- Can you build an LRT system even in one Sydney corridor to avoid the Streetcar Problem?
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5. Other Factors

a) Cost

b) Capacity and Performance

c) Environment

d) Development Impacts
BRT is cheaper to build than Light Rail…

BRT is cheaper to build than Light Rail…

**Table 8: Examples of systems operating costs**

<table>
<thead>
<tr>
<th></th>
<th>UK light rail</th>
<th>UK bus</th>
</tr>
</thead>
<tbody>
<tr>
<td>£ per vehicle km</td>
<td>£3.79</td>
<td>£0.94</td>
</tr>
<tr>
<td>£ per passenger km</td>
<td>£0.14</td>
<td>£0.08</td>
</tr>
</tbody>
</table>

**UK Evidence**

**Table 10: Examples of out-turn capital costs (2002 prices)**

<table>
<thead>
<tr>
<th></th>
<th>Light rail</th>
<th>Bus lanes</th>
<th>Busways</th>
<th>Conventional guided bus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrastructure cost (£m/km, 2-way)</td>
<td>5-25¹</td>
<td>0.006-0.3</td>
<td>2.7-15</td>
<td>2.7-4.3</td>
</tr>
<tr>
<td>Vehicle cost (£'000)</td>
<td>850-2,150</td>
<td>120-200</td>
<td>120-200</td>
<td>120-200</td>
</tr>
<tr>
<td>Expected lifetime (yrs)</td>
<td>25-50</td>
<td>8-14</td>
<td>8-14</td>
<td>8-14</td>
</tr>
</tbody>
</table>
..so you can build more mass transit for the dollar available

- Curitiba’s BRT investment was 300 times less costly than an equivalent subway system (Hensher, 1999)
- Bogota – TransMilenio busway 100% city wide transit system for the same cost as one railway line covering a small share of the city (16%) (Cain et al., 2006)

How much of Australian cities can you cover for the cost of LRT?
Rouen (France) changed from LRT to BRT investment for sound financial reasons

- **Transit investment:**
  - 1994 – 2 light rail lines
  - 2001 – 3 BRT lines

- **Why BRT?**
  - Construction costs divided by 5
  - Operating costs divided by 1.4
  - Total construction period halved
  - Flexibility of buses vs LRT
5. Other Factors

a) Cost

b) Capacity and Performance

c) Environment

d) Development Impacts
LRT claims speed and capacity advantages...

![Graph comparing operating speeds of different transit systems](image-url)

- **Commuter Rail** at 80 Kph (50 MPH)
- **Heavy Rail** at 64 Kph (40 MPH)
- **Light Rail (Exclusive Right-Of-Way)** at 48 Kph (30 MPH)
- **Light Rail (Arterial)** at 48 Kph (30 MPH)
- **Bus Rapid Transit** at 32 Kph (20 MPH)
- **Rapid Bus** at 32 Kph (20 MPH)
- **Limited Stop Bus** at 16 Kph (10 MPH)
- **Local Bus** at 16 Kph (10 MPH)

**Peak Directional Capacity (Passengers per Hour)**

- **Commuter Rail**: 35,000
- **Heavy Rail**: 30,000
- **Light Rail (Exclusive Right-Of-Way)**: 25,000
- **Light Rail (Arterial)**: 20,000
- **Bus Rapid Transit**: 15,000
- **Rapid Bus**: 15,000
- **Limited Stop Bus**: 10,000
- **Local Bus**: 5,000
LRT claims speed and capacity advantages... ...but look at the EVIDENCE

5. Other Factors

a) Cost

b) Capacity and Performance

c) Environment

d) Development Impacts
Light Rail runs on “clean” electricity while bus runs on “dirty” diesel
But in Melbourne, there isn't much difference

Source: ‘Public transport’s role in reducing greenhouse emissions’ Position Paper July 2008 Commissioner for Environmental Sustainability, Melbourne Australia
5. Other Factors

a) Cost

b) Capacity and Performance

c) Environment

d) Development Impacts
The positive impact of LRT/rail on transit oriented development (TID) are well documented
Research aimed to identify TOD pros (and cons) of bus relative to rail – rail is a clear winner

<table>
<thead>
<tr>
<th>Weaknesses</th>
<th>Small Developments</th>
<th>Large Developments</th>
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<td>Permanence, Magnitude, Risk</td>
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<td>Newness</td>
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<td>Different Markets</td>
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<td>Park and Ride</td>
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<td>Industry Capabilities</td>
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<td>Pedestrian Access</td>
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<td>Parking Restraint</td>
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<td>Urban Density</td>
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<td>Scale Dilution</td>
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<tr>
<td>Noise and Pollution</td>
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<tr>
<td>Frequency/ Speed</td>
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<tr>
<td>Bus Stigmatization</td>
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<td>Track Record</td>
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<td>Complementarity</td>
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<td>Flexibility - Choice</td>
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<tr>
<td>Flexibility - Adaptability</td>
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<tr>
<td>Cost Effectiveness</td>
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<td>Service Frequency</td>
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<td>Transfers</td>
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The same research indicated well designed bus systems can (almost) match rail performance.

**Strengths and Weaknesses of BUS RAPID TRANSIT vs RAIL in Relation to Transit Oriented Development**

**Weaknesses**
- Permanence, Magnitude, Risk
- Newness
- Different Markets
- Park and Ride
- Industry Capabilities
- Pedestrian Access
- Parking Restraint
- Urban Density
- Scale Dilution
- Noise and Pollution

**Strengths**
- BRT with New Look Vehicles
- BRT with Grade Separated Pedestrian Access
- Frequency/ Speed
- If green fuels and vehicles are Segregated from pedestrians
- Complementarity
- Flexibility - Choice
- Flexibility - Adaptability
- Cost Effectiveness
- Service Frequency
- Transfers

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It is a ‘no brainer’ that Australian cities need quality public transport solutions.
Transit with rail like qualities is preferred by users and has urban development benefits.
However streetcars should be rejected
Segregated ‘traffic free’ rights of way are needed
Research indicates the user priorities for an optimum transit upgrade whatever the mode:

- Quality Stops/Stations
- Simple Networks
- Good Ride Quality
- High Reliability
- Priority Over Traffic
- High Speed
- Direct Transfer Free Trip