

Forecast Accuracy of Recent Australian Passenger Rail Projects

Yadi WANG^{1*} and David LEVINSON²

^{1*} School of Civil Engineering, The University of Sydney, Australia

² School of Civil Engineering, The University of Sydney, Australia

* Email for correspondence: ywan6506@uni.sydney.edu.au

Abstract

After decades of reliance on the bus and heavy rail as the primary transit mode connecting the inner and outer city, new fixed-guideway facilities have gradually revitalised in Australian public transport sector in the last two decades. However, whether the disproportionate investment in fixed-guideway, particularly light rail, over Bus Rapid Transit (BRT) is economically justifiable has been increasingly questioned.

This research collected 6 Australian passenger rail projects delivered before 2021 (consisting of 8 passenger rail segments in Sydney, Gold Coast, Newcastle, and Canberra), and attempts to disentangle whether the alternative reckoned to be worthwhile outperformed other candidates in *ex ante* stage and materializes its potential value as envisioned.

We find that BRT beat rail option in *ex ante* BCA analysis of G:Link in Gold Coast, Capital Metro in Canberra, and Metro Northwest in Sydney, although the BRT was ultimately rejected. The Sydney Dulwich Hill Line hit its opening-year ridership target, whereas the remaining five projects failed to achieve the target patronage in the corresponding year. In addition, the demand on all the rail lines aside from the Sydney CBD and South East line dropped since 2020, demonstrating the heavy blow of COVID-19 pandemic and government travel restrictions on public transport services. Last, both overestimating and underestimating of actual station-to-station in-vehicle travel times are observed.

1. Introduction

After decades of reliance on the bus and heavy rail as the primary transit mode connecting the inner and outer city, new fixed-guideway facilities have gradually revitalised in Australian public transport sector in the last two decades. One of the debates following this mania lie between light rail and Bus Rapid Transit (BRT). Claiming that light rail intensifies urban economic development and relieves road traffic congestion, almost all the states in Australia have heavily invested (or at least have planned to do so) to construct, retrofit, and extend light rail systems in the last a few decades (Currie and Burke, 2013, Keys, 2016). However, whether the overwhelming advocacy of fixed-guideway passenger rails, particularly light rail, over other alternative transit modes like BRT, is economically justifiable has been increasingly questioned after the renaissance. Hensher (2016) noted that in most cases where both light rail and BRT options were proposed and assessed by Benefit-Cost Analysis (BCA), BRT beat light rail but ended up with a rejection. Past research studied the Australian light rail boom from different perspectives, including but not limited to those published by (Currie and De Gruyter, 2016, Currie and Burke, 2013, Keys, 2016, *Performance of Australian Light Rail and Comparison with US Trends*, n.d.). Whereas many of the projects they covered were not completed at the time of study, the *ex post* actual operating performance was not considered.

This research collected 6 Australian passenger rail projects delivered before 2021 (consisting of 8 passengers rail segments in Sydney, Gold Coast, Newcastle, and Canberra), and attempts to disentangle whether the alternative reckoned to be worthwhile outperformed other candidates in *ex ante* stage and materializes its potential value as envisioned. Based on all the available evidence and data documenting project planning and operation, each project is assessed from the following two dimensions:

1. How good the preferred fixed-guideway option (primarily light rail) was demonstrated in *ex ante* BCA; and
2. To what extent the envisioned benefits of studied passenger rails have been realized.

The second dimension is approached from two perspectives: transit travel time between paired origins and destinations and the demand reflected by hourly boarding patronage.

2. Projects and Data

Table 1: An Overview of Recent Australian Fixed-Guideway Projects

ID	Project Name	State	Type	City	Year Open	Capital Cost (\$AUS mil)		Length (km)	No. of Stops
						Estimate	Outturn		
1	(G:Link) G:Link Stage 1&2	QLD	LRT	Gold Coast	2014	\$ 812	\$ 1300	13	16
2	(L1) Dulwich Hill Line	NSW	LRT	Sydney	2014	\$ 72.56	\$ 176	5.6	9
3	(CapMetro) Capital Metro	ACT	LRT	Canberra	2018	\$ 783	\$ 698	12	13
4	(NLR) Newcastle Light Rail	NSW	LRT	Sydney	2019	\$ 245	\$ 368	2.7	6
5	(Metro NW) Metro Northwest	NSW	Metro	Sydney	2019	\$ 7500-8500	\$ 8300	36	13
6	(L2&L3) CBD and South East Light Rail	NSW	LRT	Sydney	2020	\$ 1600	\$ 3147	12	19

Table 2: An Overview of Australian Fixed-Guideway Projects (Cont.)

ID	Project	Alternative Modes *		Demand Forecast Model	Year of Pub.	Report Type
		Rejected	Considered			
1	G:Link	MR TU	Base BRT LRT	GCRT VISUM	2008	Draft Concept Design and Impact Management Plan
2	Syd L1	-	Base LRT	NSW STM	2010	Preliminary Environmental Assessment 2010 Environmental Assessment 2010 Final Project Definition Report
3	CapMetro	-	Base BRT LRT	CSTM	2012	Concept Design Report 2012 IA Project Submission 2014 Full Business Case
4	NLR	Bus	Base LRT	PTPM	2010	Pre-Concept Design Report 2016 Review of Environmental Factors Submission Report
5	Metro NW	HR LRT TSW	Base LRT	PTPM	2006	Economic Appraisal Report 2006 Environmental Assessment 2011 IA Project Submission 2011 Project Definition Report 2012 Environmental Impact Statement
6	Syd L2&L3	-	Base LRT	PTPM	2013	Full Business Case 2013 Environmental Impact Assessment 2014 Preferred Infrastructure Submission Report

* MR- Elevated Monorail; TU- Tunnelling; HR- Heavy Rail; LRT- Light Rail; TSW- Transitway; BRT- Bus Rapid Transit.

Tables 1 and 2 outlines the basic project information and the primary sources. To the best we can, we collected information from the planning stages, including reports and documents produced in multistage. Although Infrastructure Australia (IA) ([Infrastructure Australia, 2021](#)) and Bureau of Infrastructure, Transport and Regional Economics (BITRE) ([Bureau of Infrastructure, Transport and Regional Economics, 2014](#)) issued federal-level planning and evaluation frameworks, the light rail project appraisal mechanism under each Australian state’s jurisdiction differs. The discretionary planning processes lead to difficulties retrieving *ex ante* planning documents with the same title and produced in similar planning stages.

Gold Coast Rapid Transit Project (G:Link) In the 1997 Integrated Regional Transport Plan for South East Queensland, Gold Coast proposed a rapid transit system targeting the light rail transit mode to relieve road traffic congestion. The new initiative intended to address environmental and safety concerns and accommodate the growing number of residents and tourists along the 13-km east coastal strip. After decades of planning, the Draft Concept Design and Impact Management Plan ([Translink, Gold Coast City Council, and Queensland Transport , 2008](#)) presented the most extensive analysis on stages 1 and 2, built in 2010 and 2016, and delivered in 2014 and 2017, respectively.

Sydney Dulwich Hill Line (Syd L1) The 5.6 km Dulwich Hill Line (previously known as Inner West Light Rail Extension Project) extended the existing light rail from Lilyfield to Dulwich Hill. It is the first stage of the 2010 NSW Government’s Metropolitan Transport Plan (MTP) ([NSW Government, 2012](#)). The L1 extension retrofitted the derelict freight rail corridor. It was to be

accompanied by a greenway component that was intended to promote active transport modes within the same corridor, an element that was subsequently discarded. Construction was initiated in 2010 and finalised in 2014, 2 years behind the initial schedule.

Sydney CBD and South East Light Rail (Syd L2&L3) As the second stage of the NSW MTP, the 12km project consists a mainline running through the City of Sydney that branched in two directions from Moore Park Station: L2 to Randwick and L3 to Junior's Kingsford. At the end of 2015, the closing of George Street symbolized the official commencement of construction. The construction progress underwent severe schedule delay, and the actual cost almost doubled the initial estimates. L2 traversing to Randwick was opened in December 2019, one year and seven months behind the initial schedule, and L3 was opened in March 2020, just prior to the first COVID lockdowns.

Newcastle Light Rail (NLR) The heavy rail line terminated at Newcastle terminus had been claimed to hinder the restoration of the town center, with suggestions about the cessation of operation for years since 2002 ([RailCorp, 2010](#)). The heavy rail stations east of Wickham were permanently shut down in 2014, following years of discussion and planning on the transit configuration and mode choice. Light rail was officially nominated and approved to be the key transport development component in the Newcastle Urban Transformation and Transport Program in 2016 ([Audit Office of New South Wales, 2018](#)). Construction work started in 2017 and was completed in the second half of 2018. The light rail opened to service in February 2019.

Sydney Metro Northwest (Metro NW) As the major transit service securing residents' access to jobs and manifold activities in the northwestern corridor, Sydney Metro Northwest (previously known as North West Rail Link) has experienced complicated planning processes since 1990s in the light of the best mode and route alignment linking Epping and regional hubs like Castle Hill and Rouse Hill ([Transport Infrastructure Development Corporation, 2006](#)). The 36km Metro line traverses between Tallawong (named Cudgegong in planning) and Cherrybrook and directly replaced the existing heavy rail line between Epping and Chatswood. The geotechnical work and tunneling started in 2011. Construction was completed in 2018, and the line officially began to operate in May 2019.

Canberra Capital Metro (CapMetro) In 1911, the American architect Walter Burley Griffin proposed a rapid transit line operating across the city center in his entry submitted to the competition of the Federal Capital of Australia plan ([National Capital Authority, n.d.](#)). After decades of discussion, the full business case of this project was completed in 2014. The winning of the Labour party in the 2016 election secured that the project would be implemented as planned. The construction of the 12-km CapMetro light rail line (stage 1) connecting the northern regional center Gungahlin to the center of Canberra commenced in 2016 and finalised at the end of 2018. Service opened in April 2019.

3. Methodology

Two methodologies correspond to the two dimensions are outlined in section 1. First, to address the effectiveness of the selected option over the other alternative options considered in *ex ante* BAC, all the available *ex ante* project planning and appraisal documents (listed in table 1) are scoured. Second, to reveal the extent to which the envisioned benefits were actually realised, forecast project capital costs, estimated station-to-station transit travel time, and projected patronage stated in *ex*

ante documents are extracted. Then, audit reports or media releases issued by associated government departments are used as the primary source of information for actual project capital costs. Actual station-to-station in-vehicle transit travel times are collected using Google Distance Matrix API, with a 10-minute interval looping through the light rail operating hour during one week (including weekdays and weekends). Actual patronage statistics are acquired from the Open Data Portal of the corresponding state government.

4. Preliminary Results

4.1. The Effectiveness of the Preferred Rail Option in *Ex ante* BCA

Table 3: *Ex ante* BCA Results for G:Link, CapMetro, and Metro NW

Mode	G:Link (6%)*		CapMetro (7%)*		Metro NW (7%)*					
	BRT	LRT	BRT	LRT	HR2	HR5	HR6	LR10	TSW7	TSW10
NPV Costs (\$m)	724	812	248.5	524.1	1533	1931	2198	1079	386	686
NPV Benefits (\$m)	1294	1346	491.8	534.9	2147	2285	2566	921	420	602
NPV (\$m)	570	534	243.3	10.8	614	354	368	(158)	34	(84)
Benefit Cost Ratio	2.53	2.3	1.98	1.02	1.4	1.18	1.17	0.85	1.09	0.88

* The 6% and 7% are the discount rates used in BAC analysis.

As shown by table 3, three out of the six passenger rail projects attached economic indicators output by *ex ante* BCA analysis. BRT (including the Transitway option for Metro NW, a grade-separated busway) beat the preferred alternative for all three projects. BRT option features low cost and higher unit benefit per unit cost (reflected by the Benefit-Cost Ratio (BCR)). For Canberra CapMetro, the BCR for BRT is roughly two times as large as that for LRT. Nevertheless, BRT was ultimately rejected because light rail was given a higher score (19 for LRT vs. 17 for BRT) under the economic, social, and environmental triple bottom line evaluation method ([ACT Environment and Sustainable Development Directorate, 2012](#)). The higher score of LRT was asserted to be because of its superiority in fitting strategic planning and policy goals (including the Griffin Legacy), propping up future land use, improving road safety, reducing environmental externalities, and relieving road congestion .

4.2. Patronage

Figure 1 visualises the actual patronage (total boarding per line per hour). The donut chart embedded in each line shows the percentage of actual patronage to the estimate for the same year. First, Syd L1 successfully hit its opening-year ridership target, and then it climbed in the following years of operation till 2020, when travel restriction was enforced as part of COVID-19 lockdown policy. Syd L1 was also non-operational for late 2021 and early 2022 due to cracks in the wheel arch were found on all 12 LRT vehicles [Harriet et al. \(2021\)](#). Second, the remaining five projects failed to achieve the ridership target in the corresponding year, ranging between 10% for Syd L2&L3 and 57.5% for G:Link. Third, the demand on all the studied lines but Syd L2&L3 dropped since 2020, demonstrating the heavy blow of COVID on public transport services. Syd L2&L3 opened in the middle of December 2019, followed by the Christmas and New Year holidays and the pan-

demic outbreak. Its actual boarding touched the bottom immediately after the commencement of operation. As a result, it is the only line with an upward trend in actual demand.

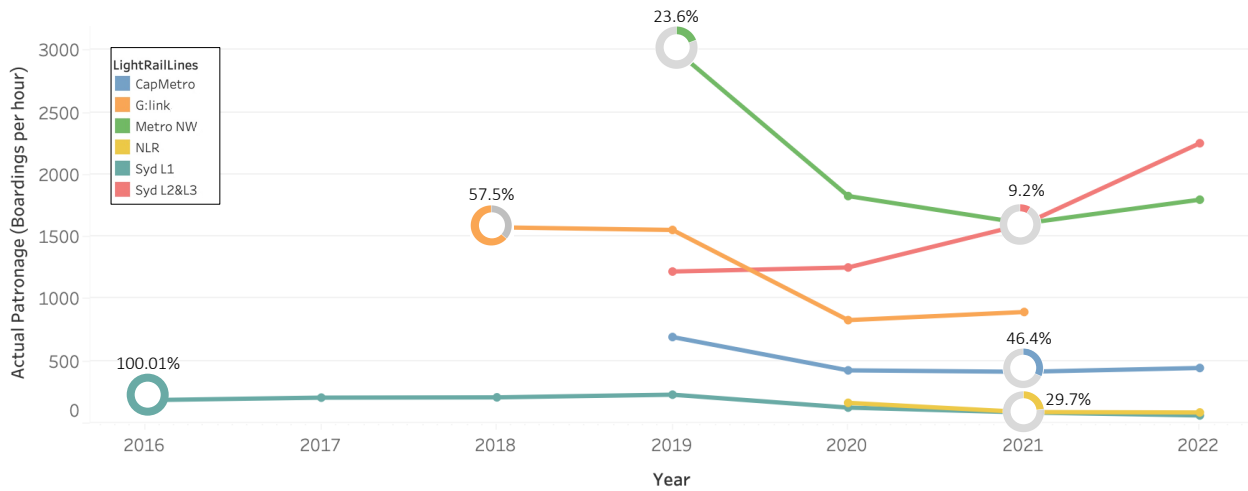


Figure 1: Actual Patronage vs. Forecast Patronage

4.3. Transit Travel Time

Figure 2 compares the forecast station-to-station in-vehicle travel time to the actual one for the given origin and destination pairs for five of the six passenger rails. First, the actual travel time of G:Link is, on average 8% shorter than forecast. Second, for the two projects in Sydney, the actual travel times delivered by Syd L1 and Metro NW are 4.5% and 4.8% longer than forecast, respectively. It is noteworthy that for Metro NW, the trips to Chatswood on Metro NW is either slightly faster than expected, but the trips to North Sydney require transfer to Sydney Trains are likely to be slower than expected. This could be attributed to Sydney Trains’ unreliable journey time rather than Metro NW. Last, the actual travel time between the initiating and terminal stations is the same as anticipated for NLR but is slightly faster for CapMetro.

5. Discussion and Recommendation

In summary, the first insight is that the BRT beat the preferred passenger rail option in *ex ante* BCA analysis of G:Link, CapMetro and Metro NW, although the BRT was ultimately rejected. Second, Syd L1 successfully hit its opening-year ridership target, whereas the remaining five projects failed to achieve the patronage target in the corresponding year, ranging between 10% for Syd L2&L3 and 57.5% for G:Link. In addition, the demand on all the studied lines other than Syd L2&L3 dropped since 2020, demonstrating the heavy blow of COVID-19 and concomitant travel restrictions on public transport services. Last, both overestimating and underestimating actual station-to-station in-vehicle travel time are observed.

Those preliminary findings substantiate that although the BRT option was demonstrated to be more cost-efficient, it was ultimately ruled out due to the alleged inability to contribute to the transformation of cities. In contrast, fixed-guideway passenger rails, particularly light rails, which dominated public transport construction in the last decade, have served fewer than the expected

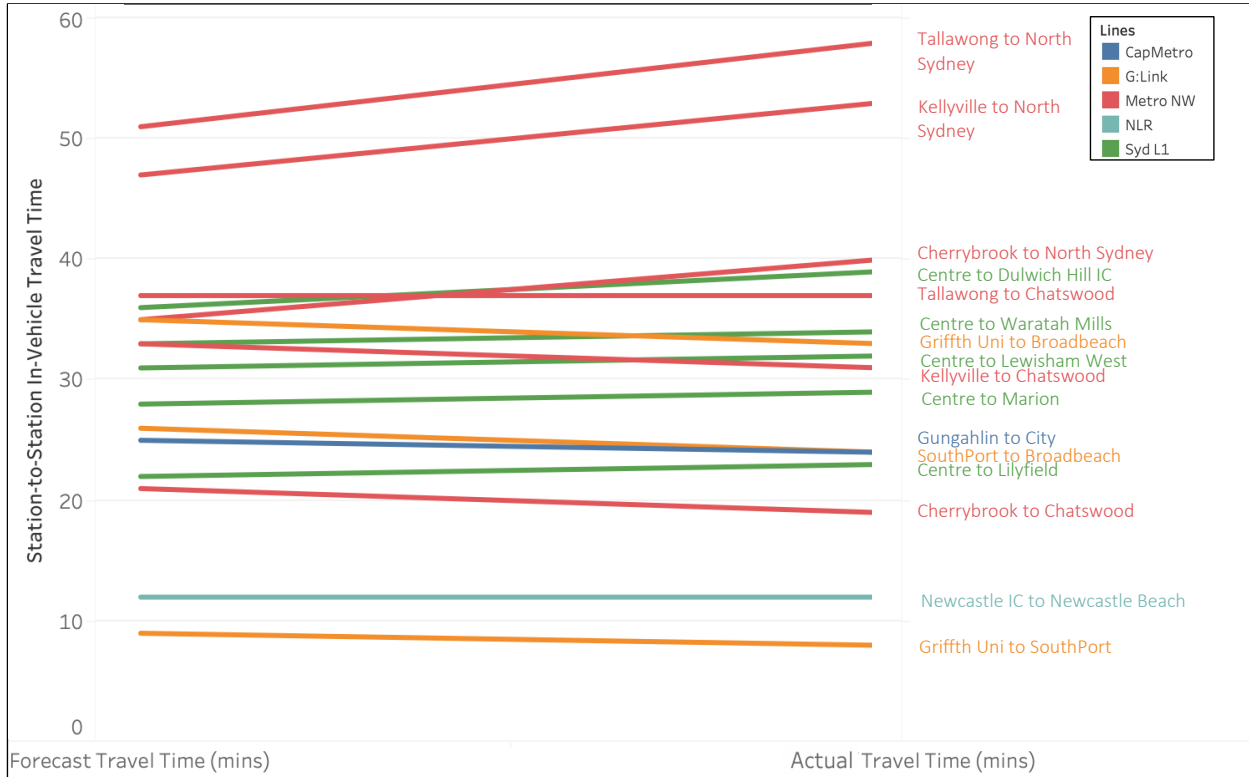


Figure 2: Actual Transit Travel Time vs. Forecast Transit Travel Time for given OD Pairs

number of users since opening, giving new relevance to questions about the economic justifications and worthiness of public transport investment decisions.

Future research could further explore the reasons behind the wide variation between cost estimates and actual costs. In addition, further research on discarded project alternatives is needed to disentangle how "do-something" options are evaluated and selected, providing lessons learned for future decision-making in *ex ante* stages.

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