RAPID TRANSIT

> Investing in Australia's Transport Future

Bus Industry Confederation
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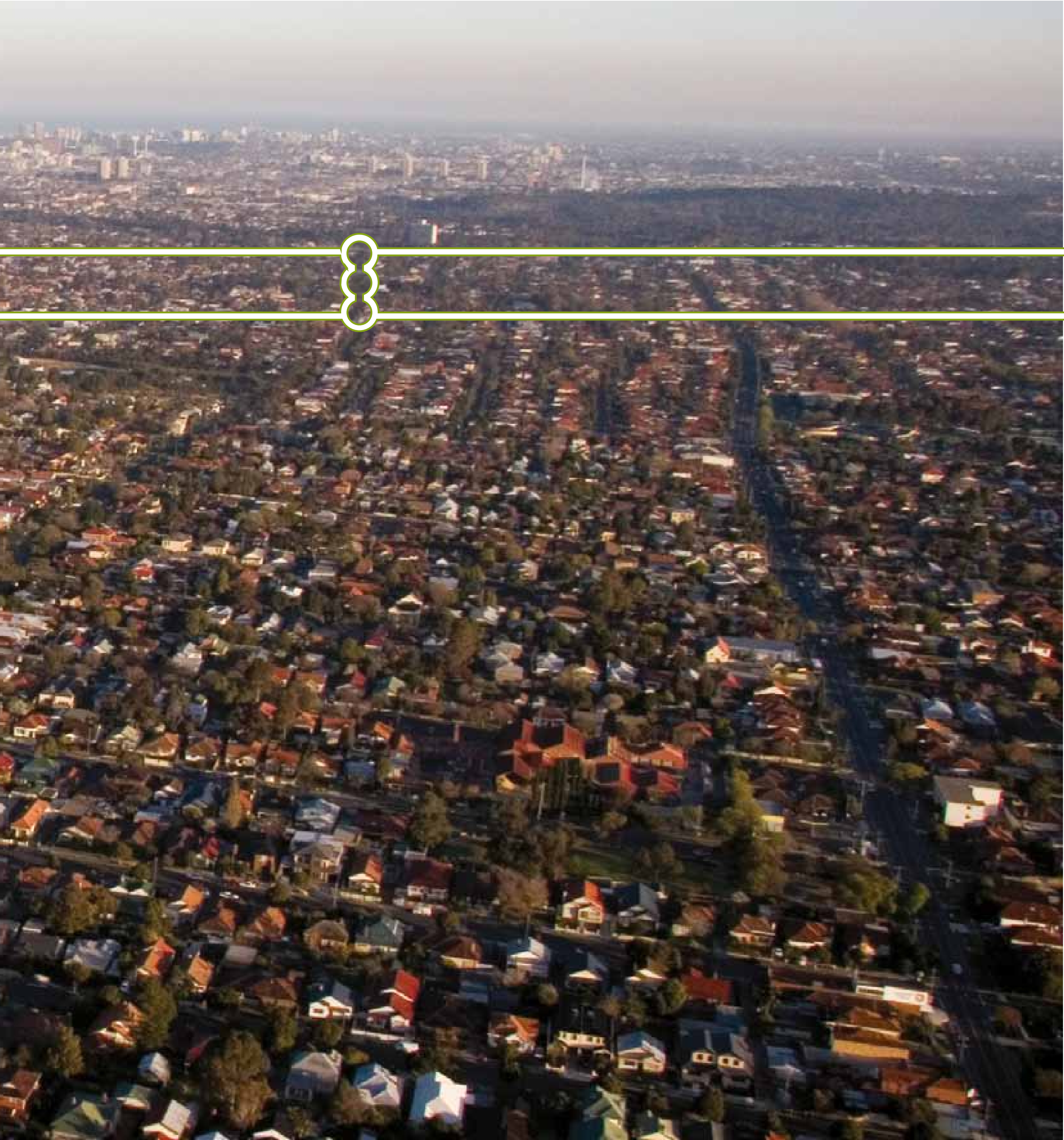

RAPID TRANSIT

> Investing in Australia's Transport Future

A report to Infrastructure Australia on the potential for Rapid Transit.

Produced by the Bus Industry Confederation of Australia for the consideration of all governments.

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> New York City Transit

> New York City Department of Transportation

> Greater Cleveland Regional Transit Authority

> City of Ottawa Transit Services Department

> Toronto Metrolinx System

> Brampton Transit

> York Region Transit.

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The BIC recognises the work of Benjamin Murphy, Customer Systems Officer, TransLink Division, Department of Transport and Main Roads.

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> Wayne Patch, Chairman, Bus Industry Confederation

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Foreword

This report has been developed for Infrastructure Australia by the Bus Industry Confederation (BIC), the peak representative body for the bus and coach industry in Australia.

The BIC Members are bus operators, bus manufacturers and parts and service suppliers to the industry. The BIC, which is based in Canberra, advocates for Australian and State Government investment and involvement in public transport and the efficient movement of people in our cities and regions.

The Rapid Transit Study Visit of North America

This report has been developed as a result of the Bus Industry Confederation undertaking a two week Rapid Transit Study Visit of North America in August and September of 2012 and information collected by the BIC's internal research program.

The USA and Canada were selected for the Rapid Transit Study Visit of North America rather than Europe or South America because of the similarities between Australia and North America in relation to the development of their cities and population densities in major centres.

The BIC delegation started the Rapid Transit Study Visit of North America with the aim of studying bus systems in their various forms, with a view to assessing their applicability to the Australian environment.

After experiencing systems in operation and consultation with the governments responsible for their construction and operation we quickly realised that our approach to the issue needed to be reconsidered. The focus needed to be placed on transport priority and the development of Rapid Transit corridors rather than specific modes of delivery.

Understanding the process of decision making in the development of Rapid Transit projects from existing public transport systems was a strong focus of the Rapid Transit Study Visit of North America.

As a consequence this report analyses the advantages of building Rapid Transit against benefits which can be achieved by simply improving existing transport networks, modal considerations notwithstanding. There is an emphasis placed, throughout this report, on the cost effectiveness of Rapid Transit as opposed to existing public transport. There is also an emphasis placed on the end user benefits and impacts of systems and how they relate to patronage on Rapid Transit systems.

Appendix A in this report outlines operational information about the systems visited and Appendix B in this report outlines an itinerary of meetings, events and site visits that took place as part of the Rapid Transit Study Visit of North America. Appendix C outlines the major elements of Bus Rapid Transit systems in the United States as identified by the US Department of Transportation and provides international examples in comparison.

Appendix D in this report outlines benchmarks for "Transit Supportive Plans and Policies and Performance" which are used in the assessment process for New Starts funding applications by the US Federal Transit Administration.

Appendix E in this report is a full presentation to the 2013 Bus Industry Confederation National Conference in Adelaide by Professor David Hensher, Founding Director of the Institute of Transport and Logistics Studies at the Business School University of Sydney at the University of Sydney.

Disclaimer

The views expressed in this report are those of the Bus Industry Confederation.


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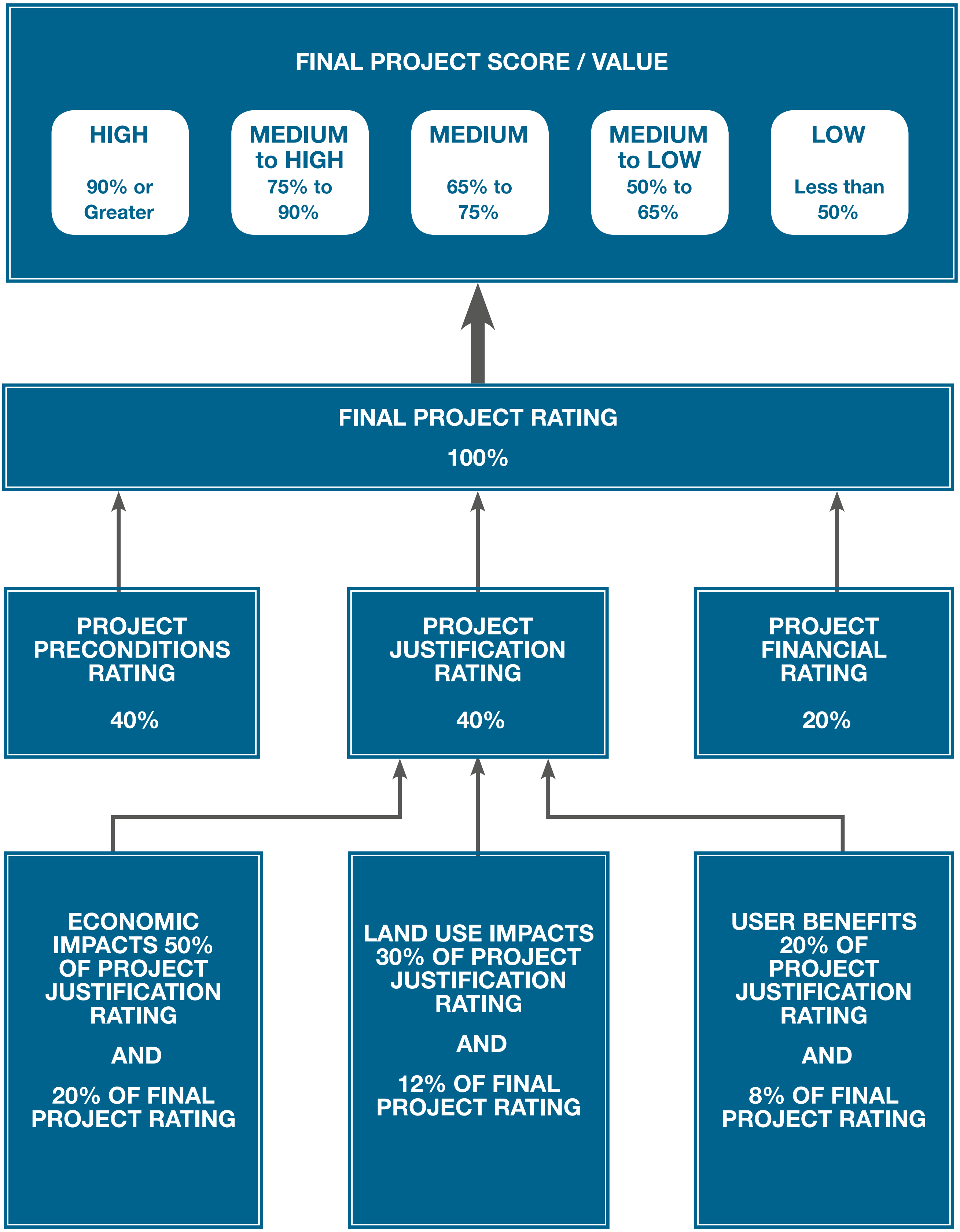

Executive Summary

This report takes a what, how, when and who approach to assessing and delivering Rapid Transit projects in Australia.

What constitutes Rapid Transit?

How should governments approach the assessment of Rapid Transit projects?

What are the options available to government when considering Rapid Transit?

What are the benefits of Rapid Transit systems?

When should Rapid Transit be built as an alternative to improving existing public transport systems?

Who uses Rapid Transit and why?

Rapid Transit systems are already in operation or proposed for development in Australian cities. Local and international examples demonstrate Rapid Transit can provide a range of public transport solutions including corridor based Rapid Transit and links between the suburbs and mass transit systems.

This report:

> Provides a prism through which Infrastructure Australia and the Commonwealth Government can assess Rapid Transit projects

> Provides State, Territory and Local Governments with tools to assist in identifying the right Rapid Transit project and right modal choice in the context of integration with the existing public transport network

> Assists Infrastructure Australia to better characterise the objectives for Commonwealth investment in public transport at a broader strategic level.

The Australian Rapid Transit Assessment Guidelines (ARTAG)

A key recommendation of this report is the adoption of a National assessment model for proposed Rapid Transit projects.

This assessment model will assist governments in answering three key questions:

1. Is the project sound in the context of public transport investment and land use planning across an entire network?
2. Does the project deliver economic, land use and user benefits to justify its cost?
3. Is the project financially sound?

The model developed by the BIC is referred to as the Australian Rapid Transit Assessment Guidelines (ARTAG).

The explicit purpose of ARTAG is to engender a National approach to assessing applications for Rapid Transit infrastructure funding from State Governments seeking financial support from the Commonwealth Government.

ARTAG can be equally useful as a tool to assist in the development of Rapid Transit project proposals by State and Local Governments. It is intended that by satisfying the pre-conditions required for high value ratings in the ARTAG model, the project proponent can identify good design principles for Rapid Transit projects. It is concerning that many Rapid Transit project proposals put forward by State Governments, for funding from Infrastructure Australia, have not been thorough in outlining a clear business case and benefit cost analysis. This has the potential to engender poor investment decisions and bad project design.

The ARTAG criteria identify the economic, population, housing, environmental and social preconditions for developing Rapid Transit. In applying these criteria to the determination of "when" to build Rapid Transit it is possible for governments to make a parallel determination of what form of Rapid Transit system and design best suits the specific needs of a proposed corridor and fits within a broader policy framework related to improving public transport in a region.

A key recommendation of this report is the adoption of ARTAG by Australian Governments.

ARTAG comprises three ratings mechanisms:

> Project Preconditions Rating (40per cent)

> Project Justification Rating (40 per cent)

> Project Financial Rating (20 per cent)

> Final Project Rating = Project Preconditions Rating + Project Justification Rating + Project Financial Rating (100 per cent).

The Final Project Rating would be used to "score" applications for Rapid Transit infrastructure funding to provide an indicative evaluation which could be used to compare applications in the pipeline for Commonwealth and State Government agencies. These scores would then be assigned a value according to the following delineations for Final Project Rating:

> High Value – 90 per cent or greater

> Medium to High Value – 75 to 90 per cent

- Medium Value – 65 to 75 per cent
- Medium to Low Value – 50 to 65 per cent
- Low Value – Less than 50 per cent

This value system could be used by governments in prioritising projects for investment or green lighting investment applications in a budgetary cycle.

Project Preconditions Rating

The Project Preconditions Rating allows the funding body to assess whether the application for Rapid Transit infrastructure funding is predicated on a sound approach to public transport investment and planning across the entire network.

The Project Preconditions Rating will require a demonstration of measures undertaken and measures proposed prior to the construction of the Rapid Transit system to improve the public transport network in areas surrounding the proposed Rapid Transit corridor and across the entire public transport network.

This requirement will take the form of a statement accompanying the Rapid Transit project proposal that summarises measures underway and proposed measures relating to the existing public transport network and how these will integrate with or relate to the proposed Rapid Transit system. The statement will also include a demonstration that all modes were considered in developing the Rapid Transit project proposal. This will allow project proponents to demonstrate that the proposed Rapid Transit system is part of a wider integrated land use and transport strategy.

There are no core components identified as being essential to this measure, but the attribution of 40 per cent of the Final Project Rating is intended to ensure a high quality response to this measure.

Project Justification Rating

Core principles in the assessment of a Project Justification Rating are:

- Economic impacts (50 per cent of Project Justification Rating/ 20 per cent of Final Project Rating)
- Land use impacts (30 per cent of Project Justification Rating/12 per cent of Final Project Rating)
- User Benefits (20 per cent of Project Justification Rating/8 per cent of Final Project Rating).

These principles incorporate the monetised value and other key quantitative elements of environmental benefits, user benefits and cost effectiveness considerations (where they have economic impacts) into the economic impact component of the criteria.

While the three core principles still receive their own rating based on limited qualitative and quantitative factors, the higher value attributed to economic impact takes into account the crossover between the economic impact of a Rapid Transit project and the quantifiable impact of the project on land use and public transport users. The land use impacts and user benefits ratings outside of the economic impact rating are intended to capture the qualitative aspects of these elements and to ensure that a balance is achieved between the drivers of demand for mass transit and the outcomes sought from a project seeking funding.

Project Financial Rating

The intention of this measure is to ensure the Rapid Transit project is delivered in full and can be maintained at operational levels that will deliver its desired outcomes on an ongoing basis.

The Project Financial Rating is valued at 20 per cent of the Final Project Rating. An agreement between the Commonwealth and State Governments on how Project Financial Ratings are measured could be based on the following guiding principles:

> A demonstrated ability from the proponent to meet the capital costs of the project

> A demonstrated ability from the proponent to absorb any cost overruns and unexpected expenses or delays in delivering the project

> A demonstrated ability from the proponent to meet the ongoing costs of operating the Rapid Transit system.

Report Structure

This report is presented in four chapters based on learnings from the BIC Study Visit of North America and a major literature review. This report includes case studies to provide examples of Rapid Transit systems in operation and makes a range of findings, recommendations and proposals for future research for the consideration of Infrastructure Australia and all Australian Governments.

Chapter 1: What is Rapid Transit?

This chapter explores Rapid Transit options available for infrastructure investment and operation in the Australian environment. Examples of multi-modal rapid transit systems and networks are explored and alternative definitions and typologies are identified so that Rapid Transit is defined primarily by the outcomes sought rather than by the mode of operation.

Rapid Transit both Road and Rail Based is defined and explored in depth. Road Based Rapid Transit typologies explored are:

> Bus Rapid Transit

> Bus Rapid Transit Lite

> Buses with a High Level of Service

> Branded Services.

The exploration of Rail Based Rapid Transit focuses primarily on Light Rail systems with investigation of the differences between Light Rail as a mode and Streetcars. The defining characteristics of both Light Rail and Bus Rapid Transit are explored in Chapter 1.

Attention is given to the elements that differentiate Rapid Transit from existing public transport services and in particular the impacts it has on user experience and the built environment.

The convergence in the objectives, elements and impacts of different forms of Rapid Transit are explored with consideration of the need for a new nomenclature to better describe these systems.

The concepts of "Dedicated Corridor Rapid Transit" (See Appendix E) and "Rapid Light Transit" used as a term to encompass a common set of elements and experiences of Rapid Transit systems including Bus Rapid Transit and Light Rail are explored.

The physical infrastructure needs of Rapid Transit are mapped and the Chapter concludes with an analysis of the marketing strategies used to promote Rapid Transit and differentiate it from pre-existing public transport services.

Chapter 2: Criteria for Building Rapid Transit

This Chapter defines criteria for governments to use in determining when to move from existing public transport services to the development of Rapid Transit projects and for the Commonwealth Government or other funding bodies to assess the value of prospective Rapid Transit projects.

ARTAG was developed by the BIC based on a review of similar assessment systems and consideration of how they might be applied to Rapid Transit projects in an Australian context.

ARTAG identifies the economic, population, housing, environmental and social preconditions for developing Rapid Transit. In applying these criteria to the determination of "when" to build Rapid Transit, it is possible for governments to make a parallel determination of what form of Rapid Transit system and design best suits the specific needs of a city or major town.

Chapter 3: Rapid Transit Demand Drivers and User Benefits

This chapter examines factors impacting on patronage of Rapid Transit systems and the benefits to public transport users from the development of Rapid Transit. It features a literature review of research into the patronage impacts and the patronage drivers on Rapid Transit systems. This is complemented by an analysis of the core principles underlying patronage growth on Rapid Transit.

A case study is presented of patronage drivers from the Metro Los Angeles Rapid Transit system, which was visited during the BIC's Rapid Transit Study Visit of North America. The site visit to the Metro Los Angeles Rapid Transit system was pivotal in the BIC forming the view that end user perceptions of Rapid Transit are less related to modal choice and more related to a set of core principles for providing good services.

Based on this principle, the report finds that a well designed Rapid Transit system which meets user requirements of frequency, reliability, and high quality of service (stations, ride comfort, safety) will attract ridership irrespective of the modal choice and level of investment required to deliver it.

End user benefits of Rapid Transit explored in this chapter are:

> Travel time savings

> Travel cost savings

> Health benefits

> Social inclusion benefits.

Where possible the report has attempted to identify the distinct benefits of Rapid Transit as opposed to benefits arising from the use and operation of public transport in general. Where data is not available we have identified the gaps and suggested possibilities for future research.

This chapter also presents a before and after assessment which highlights the benefits arising from the construction of the Euclid Corridor Rapid Transit Project in Cleveland Ohio (*Healthline*) another system visited on the BIC's Rapid Transit Study Visit of North America. The Cleveland Rapid Transit Network (*The Rapid*), like the Los Angeles Metro Rapid was pivotal in highlighting the importance of a multi-modal approach to Rapid Transit focusing on the end user outcomes rather than the mode of delivery.

Chapter 4: Benefits of Investment in Rapid Transit

This Chapter of the report explores the benefits of investment in Rapid Transit systems that go beyond the user benefits of Rapid Transit covered in Chapter 3. This chapter focuses primarily on the economic impacts of Rapid Transit systems.

The benefits explored in depth in this chapter are:

> Economic and land value benefits

> Environmental benefits

> Secondary benefits including employment impacts, demographic changes and congestion reduction benefits.

Summary of Findings

1. Rapid Light Transit or Dedicated Corridor Rapid Transit as a concept presents an opportunity for governments to view Rapid Transit as a non-modal set of outcomes being sought from investment in Rapid Transit for the benefit of the entire network and its users.

2. The primary use of Rapid Transit should be to provide increased capacity in corridors within a transport network.

3. Economic and urban development benefits from Rapid Transit should be viewed as a flow on effect of an integrated approach to land use and transport planning.

4. Where Rapid Transit is used to increase capacity feeding into Central Business Districts both Light Rail and Road Based Rapid Transit will deliver significant agglomeration benefits.

5. In order to maximise the benefit of Rapid Transit investment, regardless of mode, the number and frequency of existing bus services that feed into and integrate with the Rapid Transit system should be increased.

6. In value for money terms a well designed Rapid Transit system which meets user requirements of frequency, reliability, and high quality of service (stations, ride comfort, safety) will attract ridership irrespective of the modal choice and level of investment required to deliver it.

7. There is a strong link between Rapid Transit, regardless of the mode, and increases to property values and economic development in areas along, and adjacent to the corridor of operation.

8. Research indicates both Rail and Road Based Rapid Transit have similar modal shift impacts.

9. Stop spacing is a decisive element in distinguishing Light Rail and Bus Rapid Transit from Tramways, Streetcar systems and existing bus services.

10. An over-reliance on modal shift and patronage growth data can cloud a genuine assessment of the end user and community benefits produced by a proposed Rapid Transit project.

11. A clear brand distinction from existing bus and rail services is required to overcome negative associations with existing public transport and delineate the Rapid Transit system from existing public transport operations.

12. A significant emphasis in marketing Rapid Transit needs to be placed on the key elements in driving patronage and modal shifts to the system such as frequency and reliability.

13. Road Based Rapid Transit can be delivered in small scale forms and incrementally ramped up. These require minimal expenditure on physical and network infrastructure and include change of service measures, branded buses and priority measures for existing routes through to dedicated right of way, where practical, on the existing road network.

14. Road Based Rapid Transit provides the flexibility to operate on a closed and/or open system, including the provision of similar operation and customer service characteristics of Rail Based Rapid Transit.

15. Road Based Rapid Transit due to its wider range of service types and flexibility of operation can uplift the community and social inclusion value of an entire public transport network.




Future Research

> Patronage Drivers of Rapid Transit

Research to be undertaken into the patronage drivers of existing and proposed Rapid Transit projects in Australia. This would involve the aggregation of research undertaken by State Governments in the development, implementation and operational stages of Rapid Transit projects combined with additional primary research.

> Value of Travel Time Savings on Rapid Transit

Research the Value of Travel Time Savings of constructing Rapid Transit as either a new public transport system on a corridor or an improvement to an existing one. This research to be undertaken with the following parameters considered:

- Comparative Value of Travel Time Savings of Rapid Transit versus pre-existing forms of public transport in corridors and areas of operation
- Value of Travel Time Savings of modal shift to Rapid Transit from other modes to the end user
- Value of Travel Time Savings of modal shift to Rapid Transit from other modes to other road/ transport system users.

  The data from this research could form a valuable element of an assessment model for Rapid Transit projects. It is proposed that this research be undertaken with mutual agreement between the Commonwealth and State Governments.

> Travel Cost Savings from Rapid Transit

Research the specific travel cost savings that Rapid Transit presents with a focus on the following parameters:

- Travel cost savings to existing users of the public transport system
- Travel cost savings to users of other modes who shift onto the Rapid Transit system
- Travel cost savings or increases to users of other modes in the corridors or areas of operation of the Rapid Transit system.

> Social Benefits from Rapid Transit

Future research in this area might focus on the value of Rapid Transit trips using a model outlined by Stanley et al. (2011) in *Social Exclusion and the Value of Mobility*. The model factors in variables and data items such as wellbeing measures, sense of community and contact with members of family to assess the risk of individuals being socially excluded, and as a corollary the social inclusion value of higher levels of mobility. [1]

The research found a lowered risk of social exclusion was related to higher rates of connection with community, household income, realised mobility and personal growth. The value of additional trips, for an individual with two or more social exclusion risk factors, was found to be AUS$20 using this model.[2]

It would be valuable in the context of assessing applications for Rapid Transit investment to determine the value for Rapid Transit trips due to the different nature of design and location of Rapid Transit. An evaluation of the social inclusion benefits of the Smart Bus network in Victoria and the Gold Coast Light Rail should be considered.

> Land Value and Socio Economic Benefits of Rapid Transit

Update and expand on existing research into the direct financial, land value and socio-economic (employment, tax revenue) benefits of Rapid Transit systems in Australia.

The hedonic pricing models employed in Ge et al. (2012) and in Mulley and Tsai (2013) could be applied to existing and proposed Light Rail and Bus Rapid Transit projects to assess their land value benefits. Parameters for research would include:

- Land value effects of Rapid Transit on private housing and rental prices
- Land value effects for commercial property rentals and sales
- Changes to land use reflected in density of residential and commercial space
- Changes to land use reflected in the collection of rates by local councils
- Demographic shifts in areas of operation.

1 Stanley, J, Hensher, D.A, Stanley, Janet, Currie, G, Greene, W.H. and Vella-Brodrick, D, 2011, *"Social Exclusion and the Value of Mobility"*, Journal of Transport Economics and Policy, 45 (2), 197-222

2 Ibid.,^


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What is Rapid Transit

Chapter 1: What is Rapid Transit?

1.1 Introduction

This chapter explores Rapid Transit options available for consideration in infrastructure investment and operation in the Australian environment.

In this report, Rapid Transit is defined as a single entity encompassing various forms and modal choices – Rail Based or Road Based. For example a suburban corridor bus service can be replaced by a Bus Rapid Transit system or a Light Rail system.

The infrastructure needs of different Rapid Transit systems are explored as vital elements in differentiating them from existing forms of public transport and in identifying the different service roles, performance and public transport outcomes provided by systems.

1.2 Defining Rapid Transit

1.2.1 Introduction

Rapid Transit is presented in a number of modal and vehicle types encompassing bus systems operating on dedicated road space, guided bus systems, and surface rail systems such as Light Rail. While the implications of modal choice in delivering Rapid Transit will be explored throughout the report, this section broadly examines Rapid Transit as separate from pre-existing urban, outer urban and regional public transport systems.

Any investment in Rapid Transit corridors should include improvements in the wider network to ensure existing services can integrate and feed into the Rapid Transit system. This report argues, in fact, that this should be the starting point for any Rapid Transit project proposal and this is reflected in the Australian Rapid Transit Assessment Guidelines (ARTAG) model that features in Chapter 2.

A modally integrated Rapid Transit system can be defined by the presence of the following factors:

1. Increased and consistent frequency of service, timetables may still be used in off peak but headways in peak operation are set at consistent intervals. For example a bus every ten minutes at every station during morning and afternoon peaks.

2. An increased carrying capacity on vehicles and along the network of the rapid transit system.

3. A reduction in travelling time on the rapid transit system from pre-existing travel times along the route of operation.

4. A high uptake of new technology in vehicles, ticketing and operations.

5. Integration between the transit system and the built environment surrounding it. For example the development of Transit Oriented Development (TODs).

Rapid Transit can be delivered as an integrated network across multiple modes using priority for passenger transport. Two good examples of modally integrated rapid transit were visited on the BIC's Rapid Transit Study Visit of North America. These were the Greater Cleveland Regional Transit Authority's Rapid Transit system (The Rapid) and the Los Angeles Metro Rapid. Both of these systems are explored in detail throughout this report.

Although this multimodal Rapid Transit approach is relatively uncommon, it is easily retrofitted to systems where a number of modes are already in operation. An example of this opportunity is presented in Melbourne where integration and improved operation of the bus, tram and train systems through measures such as integrated ticketing, increased investment in priority measures and increased service levels could in effect produce a whole of network and multimodal Rapid Transit system.

1.2.2 A New Approach to Nomenclature?

While this report focuses on both Road and Rail Based Rapid Transit as distinct Rapid Transit systems, there is a significant amount of convergence in the objectives, elements and impacts of these systems. So much so that some analysts have suggested the need for a new nomenclature to better describe these systems.

Hensher (2013) suggests that Bus Rapid Transit should be renamed Dedicated Corridor Rapid Transit to disassociate itself from pre-existing prejudices related to bus services (See Appendix E).

> *"...any PT option associated with the word 'bus' (I have suggested that BRT be renamed as Dedicated Corridor Transit (DCRT)) conjures up images of noisy polluting buses in mixed traffic congestion; yet BRT can, if designed appropriately, deliver a service that is equivalent to or better than LRT..."*[3]

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3 Hensher, D, 2013, *"Why is Light Rail Starting to Dominate BRT Again"*, BusNSW Bulletin, August 2013.

More broadly there is a school of thought that suggests the merging of Rail and Road Based Rapid Transit into a single concept, which is focussed on the outcomes from Rapid Transit rather than specific mode.

McBrayer's definition of Rapid Light Transit provides:[4]

> **Minimal passenger waiting times**

A timetable free system should underpin peak frequency considerations in the design of Rapid Light Transit systems and non-peak frequencies should be highly legible, for example every fifteen minutes. McBrayer states Light Rail and Bus Rapid Transit can fulfil this requirement, especially if operating mainly in reserved right of way, with traffic signal priority, and with advanced-technology operations management.

> **Minimal station dwell times**

Features identified as contributing to this outcome include off vehicle ticketing and the streamlining of access through the use of vehicles with multiple doors and compliance with disability access requirements in a way that minimises vehicle dwell time. McBrayer states both Light Rail and Bus Rapid Transit have the potential to achieve this outcome.

> **Minimal in-vehicle times**

This outcome combines efficiency in road use through dedicated right of way, arrival and departure at stations through good design and improvements in travelling speed through the use of modern and innovative vehicles. McBrayer states both Light Rail and Bus Rapid Transit can achieve this.

> **High capacity**

The system should have ample capacity for anticipated passenger demand within major transit corridors. McBrayer identifies both Light Rail and Bus Rapid Transit as capable of providing this level of capacity.

> **A readily understandable route**

Both Light Rail and Bus Rapid Transit systems can be designed to provide highly legible trunk and feeder routes:

- A smooth, quiet ride
- "Presence" and sense of permanence.

This is a key not only to public understanding of and comfort in using the system, but also in attracting transit-oriented sustainable development. Suitably prominent well-designed infrastructure (guideway and especially stations) satisfies this requirement.

According to McBrayer the physical and service elements of Rapid Light Transit include:[5]

- Reserved right of way, and high quality track or running surface
- Level entry and exit, full accessibility for disabled passengers, off-vehicle fares, and multiple doors
- Limited-stop operation, ample acceleration, deceleration, and maximum speed
- High frequency of service
- Large vehicles or trains that are distinctive and high-quality
- Quiet, clean for passengers and "neighbours"
- Visible, substantial, high quality investment.

While this report makes the distinction between Road and Rail Based Rapid Transit the terminology of Rapid Light Transit proposed by McBrayer or Dedicated Corridor Rapid Transit proposed by Hensher, should be adopted by Australian Governments in future.

Rapid Light Transit or Dedicated Corridor Rapid Transit as a concept presents an opportunity for governments to view Rapid Transit as a non-modal set of outcomes being sought from investment in Rail and Road Based Rapid Transit for the benefit of the entire network and its users.

1.2.3 Rail Based Rapid Transit

For the purposes of this report Rail Based Rapid Transit can be identified as Light Rail systems. Rail Based Rapid Transit systems are differentiated from Heavy Rail systems already in operation by the objectives, travelling speed, location and efficacy of the system. This report will regularly provide comparison between Light Rail and Road Bus Rapid Transit systems in identifying the when, where and what type of Rapid Transit to build.

The literature reviewed in defining Rail Based Rapid Transit emphasises the need for priority in decision making to be placed on the outcomes sought from Rapid Transit projects rather than on the mode of operation.

4 McBrayer, D, 2003, *"Light Rail Transit and Other Modes: Blurring the Light Rail Transit–Bus Rapid Transit Boundaries, Rapid Light Transit"*, Transportation Research Circular E-CO58: 9th National Light Rail Transit Conference pp 133-147.

5 Ibid., ^

1.2.4 Characteristics of Light Rail

In developing an *Overview of Light Rail Technology and Its Potential within an Australian Environment* for the Western Australian Planning Commission, Ginn (1998) identified the conceptual and technical characteristics of Light Rail and how it might be adopted in Australia.

Technical characteristics identified were:[6]

- Rail based – designed for vehicles to run on a vibration free track
- Can turn easily around corners (25 metre turning radius being common and in some cases less)
- Flexible up steep gradients (10 per cent on one section in Sheffield UK, this is refuted in the City of London's assessment, see table 1.5)
- Can travel along streets, run in its own reserve, run on an elevated track, share track with Heavy Rail and metro systems and go underground
- Uses clean, mainly overhead, electric current 600/750V (can run on dual current 750V/15KV as in Karlsruhe, Germany)
- Vehicle cars are very quiet, light, modern and "futuristic"
- Carrying capacity per car can be up to 275 passengers (150-200 is more common) when articulated
- Low-level floor-entry cars are very common
- Light Rail vehicles can be run in 2,3,4,5 car sets pushing potential passenger capacity to more than 1000 passengers, although normally a higher frequency would be used to move these numbers
- Operates in town at about 25-30km/h and up to 100km/h when operating in dedicated right of way. Technically opportunities may present themselves to increase speeds to 120km/h
- Headways can be as low as one minute although 4 to 6 minutes is more common
- Track is usually 1,435mm standard gauge.

In conceptual terms Ginn recognises the fluidity of distinctions between Light Rail and Tram systems, particularly in the eyes of the travelling public.

> *"The difficulty in making the distinction in light rail and tram is likely to remain, with many continuing to view LRT as simply a supertram."*[7]

Ginn identifies differences in the functionality of Light Rail and the history of its development as the key delineators from Tram systems.

> *"....Light Rail, unlike its predecessor the conventional tram, presents the flexibility to run easily in downtown, congested urban areas and then switch immediately to operate like a fast heavy rail commuter system when it is given its own right of way with priority."*[8]

Norley (2010) draws on the UITP definition of Light Rail as *"a rail-borne form of transport, which can be developed in stages from a modern tramway to a form operating underground or on viaducts"* (Groche 1979 p1). There is a less clear distinction between Light Rail and Tram in Norley's analysis, with Light Rail being a "metamorphosis" from Tram systems driven by the movement against Trams in the mid-20th century. In outlining the typology of transit modes Norley establishes a hierarchy for both Rail and Road Based Rapid Transit systems, moving beyond the nomenclature, which are of value to understanding the discussions of Rapid Transit in this report.[9] (See tables 1.1 and 1.2)

1.2.5 Light Rail vs Trams

While Ginn (1998) and Norley (2010) indicate that there are more similarities between Light Rail and Tramways/ Streetcars there are clear distinctions identified between the typologies. These are reiterated and expanded on by Walker (2009). He identifies stop spacing as a decisive element in distinguishing Light Rail from Tramways/ Streetcar systems.[10] Figure 1.1 produced by Walker visually represents this concept.

In relation to the operation of streetcars Walker goes further to suggest that they are not a mobility improvement in comparison to pre-existing forms of public transport unless they are accompanied by "other improvements". By this he is referring to end user considerations impacting on patronage and benefits from Rapid Transit that are discussed further in chapters 3 and 4 of this report.

6 Ginn, S, 1998, *"An Overview of Light Rail and its Potential within an Australian Environment"*, Western Australian Planning Commission and Ministry of Transport, Perth, Australia.

7 Ibid.,^

8 Ginn, S, 1998, *"An Overview of Light Rail and its Potential within an Australian Environment"*, Western Australian Planning Commission and Ministry of Transport, Perth, Australia.

9 Norley, K, 2010, *"Light Rail the Semi-Metro Concept"*, Paper delivered at the 33rd Australasian Transport Research Forum Conference held in Canberra, on 29 September - 1 October, 2010.

10 Walker, J, 2009, *"Streetcars: An Inconvenient Truth"*, Human Transit Blog, Accessible online at: http://www.humantransit.org/2009/07/streetcars-an-inconvenient-truth.html

"Streetcars that replace bus lines are not a mobility improvement. If you replace a bus with a streetcar on the same route, and make no other improvements, nobody will be able to get anywhere any faster than they could before… Where a streetcar is faster or more reliable than the bus route it replaced, this is because other improvements were made at the same time… these improvements may have been politically packaged as part of the streetcar project, but they were logically independent, so their benefits are not really benefits of the streetcar as compared to the bus." [11]

In warning transport planners and governments to "beware of streetcars" Currie (2009) identifies the following characteristics as defining Streetcar systems:[12]

- Track kilometres in mixed traffic with median operation
- Lower average operating speeds than Light Rail
- A quantified relationship between lower overall traffic speeds and lower operating speeds for the Streetcar system.

Stop spacing is a decisive element in distinguishing Light Rail and Bus Rapid Transit from Tramways, Streetcar systems and existing bus services.

1.2.6 Road Based Rapid Transit

For the purposes of this report Road Based Rapid Transit encompasses full Bus Rapid Transit, Bus Rapid Transit Lite, Branded Buses and Buses with a High Level of Service.

Road Based Rapid Transit can be delivered in small scale forms and incrementally ramped up. These require minimal expenditure on physical and network infrastructure and include change of service measures, branded buses and priority measures for existing routes through to dedicated right of way, where practical, on the existing road network.

The four levels bus service related improvements that constitute Road Based Rapid Transit are:

> Branded Services

> Buses with a High Level of Service

> Bus Rapid Transit Lite

> Full Bus Rapid Transit.

According to the comprehensive *Bus Rapid Transit Planning Guide* (2007) Bus Rapid Transit is a "high-quality bus based transit system that delivers fast, comfortable, and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, rapid and frequent operations, and excellence in marketing and customer service".[13] Bus Rapid Transit can be delivered in a number of forms including:[14]

> High capacity bus systems

> High quality bus services encompassing vehicle design, comfort, ticketing, frequencies and more

> Express bus systems

> Busway systems.

In a report to Infrastructure Australia, Deloitte identified "the distinguishing feature of a Bus Rapid Transit system is the use of bus right-of-way technology, which can vary from an entirely grade-separated busway, to a designated lane on an existing roadway in combination with traffic prioritisation technology (Intelligent Transportation Systems, ITS)".[15]

Bus Rapid Transit provides the added operational benefit of the ability of buses to enter and exit at various points and act as both Rapid Transit vehicles and public transport vehicles. Norley's typology of transit modes addresses the difference between different levels of bus service and Bus Rapid Transit (see table 1.2).

11 Ibid., ^
12 Currie, G, "*Research Perspectives on the Merits of Light Rail vs Bus*", Presentation to BTRE Colloquium Canberra 18-19 June 2009, Commonwealth Government, Australia.

13 Wright, L, and Hook, W, 2007, *"Bus Rapid Transit Planning Guide"*, Institute for Transportation Development and Policy, New York.
14 Ibid.,^
15 Deloitte, 2011, *"Infrastructure Australia: Bus Rapid Transit – Best Practice Review", Commonwealth Government, Canberra.*

Table 1.1 Typology of Transit Mode Applications (Rail Based)

Application	Description	Examples
Light Rail – Street Tramway	Light Rail (tram, streetcar) on ordinary streets in mixed traffic, possibly with some level of dedicated lanes and signal priority.	Melbourne – Australia, Lisbon – Portugal
Light Rail – Surface	Light Rail (tram, streetcar) on ordinary streets and highways with dedicated lanes and signal priority.	Gold Coast – Australia, Adelaide – Australia, US Interurban electric railways
Light Rail – Pre-Metro or Stadtbahn (Semi-Metro)	Light Rail on reserved right of way over congested parts of the line, typically in tunnel or viaduct for grade separation designed to metro standards, with priority surface light rail in other sections.	Köln – Germany, Frankfurt – Germany, Pittsburgh, San Francisco, Cleveland – US
Metro	Reserved right of way over full route fully grade separated. Rapid transit multiple unit trains designed for fast loading and rapid station stops.	Paris (Métropolitain) – France, London (Underground, Docklands Light Railway) – UK, Washington DC, San Francisco (BART) – US, Hong Kong – China, Singapore.
Heavy Rail – Regional Rapid Transit	Reserved right of way over full route, multiple unit suburban trains, penetrates city core usually in tunnel.	Frankfurt (S-Bahn) – Germany, Paris (RER) – France, Sydney (CityRail CityMet) – Australia, Melbourne – Australia
Heavy Rail – Commuter Rail	Reserved right of way over full route (some grade crossings), multiple unit or locomotive hauled trains, normally to edge of city core only.	London (Southeast) – UK, Sydney (CityRail) – Australia, Melbourne (Regional Fast Rail) – Australia, New York (Long Island RR, Metro North) – US

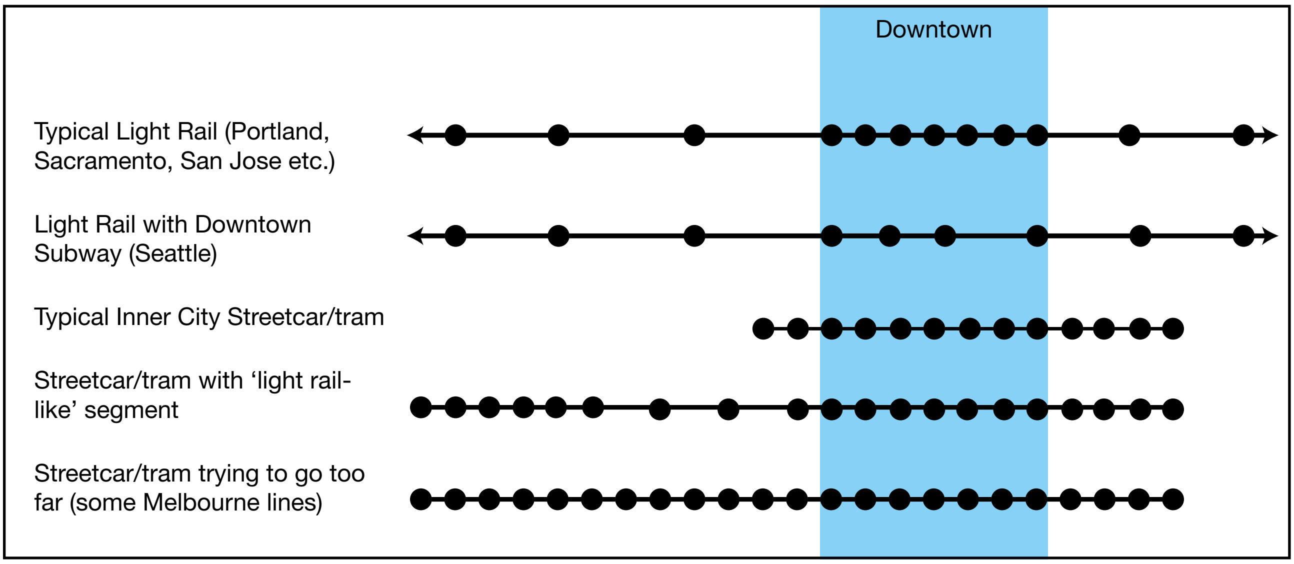
Source: Norley. 2010

Table 1.2 Typology of Transit Mode Applications (Road Based)

Application	Description	Examples
Street Bus	Bus on ordinary streets in mixed traffic	Many in Australia and internationally
Bus Rapid Transit – T-way	Bus on dedicated road way (reserved right of way) over part of route, typically with bus priority in more congested sections	Sydney – Australia, Adelaide – Australia (O-Bahn)
Bus Rapid Transit – Quickway (Hoffman 2008)	Bus on dedicated roadway (reserved right of way) over full route, typically in tunnel or viaduct for grade separation	Brisbane – Australia (Busways)

Source: Norley, 2010

Figure 1.1 Comparison of Stop Spacing in Determining Rail Based Rapid Transit Typologies



Source: Walker, 2010

The Deloitte report identified 20 key design principles for best practice Bus Rapid Transit systems. These included:[16]

> Segregated busways
> Enhanced stations
> At level boarding
> High quality/capacity bus fleet
> Traffic light/intersection priority
> Intelligent transport systems
> Network of services
> Local and express services.

Appendix E of this report includes visual representation of Bus Rapid Transit types, including full Rapid Transit addressed in a presentation by Professor David Hensher in 2013.

1.2.7 *Branded Bus Services*

Branded bus services, which operate in Australia, are closely related to the idea of Buses with a High Level of Service. Branded bus services are in operation in Australian capital cities Brisbane, Sydney, Canberra, Melbourne and Perth. Branded bus services have been implemented in many cities to make the bus network more legible, to improve the image of bus public transport and to increase the awareness of bus services for greater patronage.[17]

Bus service branding can be done with the vehicle livery, route design, service frequency, infrastructure, signage, information and promotion. The purpose and intent of bus service branding is to give bus services a distinct identity from other modes and existing bus services, and to raise the profile of specific routes in a bus network.[18]

Branded bus routes aim to:[19]

- Increase patronage on the bus network and reduce traffic congestion in the CBD and along busy traffic corridors
- Improve legibility for existing and new users to make bus services more attractive and easier to understand
- Change the perception and profile of bus public transport without the high infrastructure costs of dedicated busways and transitways.

Examples of branded bus services in operation in Australia include the SmartBus service in Melbourne, the BUZ in Brisbane, the Central Area Transit (CAT) bus service in Perth and the Red and Blue Rapid services in Canberra.

The following case study illustrates the success of the BUZ branded bus system which has been in operation in Brisbane for more than 10 years.

16 Deloitte, 2011, *"Infrastructure Australia: Bus Rapid Transit – Best Practice Review", Commonwealth Government, Canberra.*
17 Deveny, J, 2011, *"Changing Perceptions of the Bus with Branded Services",* Australasian Transport Research Forum 2011 Proceedings 28 - 30 September 2011, Adelaide, Australia.
18 Ibid.,^
19 Deveny, J, 2011, *"Changing Perceptions of the Bus with Branded Services",* Australasian Transport Research Forum 2011 Proceedings 28 - 30 September 2011, Adelaide, Australia.

Case Study: Buz In Brisbane

In 2003, Brisbane City Council and Brisbane Transport introduced the Bus Upgrade Zone or "BUZ" concept to Brisbane. BUZ was established along the parameters of a Branded Bus Services outlined in section 1.2.7.

The BUZ brand was used to identify services running at least 15 minute frequencies between 6am and 11pm, 7 days week. In combination with the segregated busway corridors, these services provide Brisbane's Bus Rapid Transit backbone. Initially the concept was rolled out on just the one route – the 111. This service ran entirely along the South East Busway corridor and maximised the utility of the busway for passengers.

It ensured that all busway stations received a high level of service all day, every day. The success of the BUZ brand saw the concept rolled out right across the Brisbane area. There are now 20 BUZ high frequency routes operating throughout Brisbane. The BUZ routes cover large parcels of Brisbane that do not have direct access to the Heavy Rail system, and are designed to take maximum benefit from the busway infrastructure. Many BUZ routes were in fact rolled out in conjunction with the opening of the new busway infrastructure (for example 330 and 340 in 2012 and 222 in 2011).

While most of these services operate as express buses, with stops spaced between 800m and 1.2km apart, there are a few BUZ routes that operate as all stops services, particularly in heavily built up areas, or towards the suburban end of the route. This flexibility allows for a large number of people to be serviced by each route, while still ensuring fast travel times.

It is estimated that currently 70,000 Brisbane City Council residents are within 800m of a high frequency BUZ route.[20] Additionally, the BUZ routes make up less than 10% of Brisbane Transport's routes (20 out of 231), and 35% of the total kilometres run across the network, however they carry more than 44% of all Brisbane Transport passengers.[21]

In order to maximise the benefit of Rapid Transit investment, regardless of mode, the number and frequency of existing bus services that feed into and integrate with the Rapid Transit system should be increased.

Case Study: Red And Blue Rapid In Canberra[22]

Red and Blue Rapid Branded Bus Services commenced in Canberra between 2009 and 2010. The Red and Blue Branding denoted the operational aspect of the service. The Blue service provides high frequency trunk connections between town centres at 5 minutes during between 7 am and 6pm and at 15 minutes from 6pm onwards. The Red service provides an express service between the City and Inner South areas of Canberra.

Rapid Services are 8 of the 105 weekday route services – 8% of total routes. In 2012/13 the Rapid services accounted for 37% of all weekday boardings. The Blue Rapid service accounted for 31% of all boardings – the Blue Rapid does, however, extend from the Rapid Route and into the suburbs.

The Red Rapid service accounted for 6% of all boardings and boarding the Red Rapid increased 27% from 2011/12 to 2012/13. In this period, peak hour frequency also increased from 15 minutes to 10 minutes.

20 Queensland Government, 2013, *"Frequency is the Bus Word"*, Media Release, accessible online at http://translink.com.au/about-translink/reporting-and-publications/media-releases/release/637

21 Queensland Government, 2013, *"TransLink Bus Network Review"*, Queensland Government.

22 Data courtesy of ACTION Buses, August 2013.

1.2.8 Buses with a High Level of Service

The term Buses with a High Level of Service is a relatively new one being employed in European public transport systems.[23]

Table 1.3 describes the operating conditions required for a system to be described as a Buses with a High Level of Service system.

Buses with a High Level of Service takes a service and perceptions focused approach to system design to make bus use more attractive to users and attract patronage to a public transport network.

Professor David Hensher's 2013 presentation included in this report at Appendix E touches on the key components of Buses with High levels of Service and findings from their implementation.

Buses with a High Level of Service is a relatively new concept. Further data on the success of Buses with a High Level of Service systems and lessons learned in their implementation and operation will be available in the future.

1.2.9 Bus Rapid Transit Lite

Bus Rapid Transit Lite is a lower specification mode of Bus Rapid Transit that can be delivered at a lower cost, but can bring significant improvements to the end user such as improvements in travel time and user experience.

Based on experiences of Bus Rapid Transit operating within a mixture of priority infrastructure and small scale measures to improve service quality and reduce travel time, this report defines Bus Rapid Transit Lite as:

Bus Rapid Transit Lite is primarily focused on improving existing bus routes by implementing a range of bus priority measures that reduce travel times and make the bus service more competitive with the car and provides improved convenience for passengers at a relatively low capital cost.

Priority measures include traffic signalling priority, bus priority lanes or segments where available, real time information and improved service frequency. The BIC's Rapid Transit Study Visit of North America to the New York Metropolitan Transportation Authority's *Select Bus Service* identified that bus priority measures and accessible and improved bus stops increased the average speed of bus travel through down town New York from 4miles (6.5 km) per hour to 8 miles (13km) per hour. This had an impact on patronage as bus speeds exceeded walking speeds at peak times.

23 Centre for the Study of Urban Planning, Transport and Public Facilities, 2010, "*Buses with a High Level of Service: Choosing and Implementing the Right System*", Certu, France.

Table 1.3 Desired Features of Buses with a High Level of Service System

Frequency	Headways of 8 to 10 minutes maximum at peak times, depending on the size of the urban area. Headways of 15 to 20 minutes maximum in off peak, depending on the size of the urban area. No distinction made between term time and school holiday periods.
Service Span of Hours	Service between the hours of 5 a.m. and midnight with simple timetables across the whole of the system.
Reliability/ Punctuality	Buses with a High Level of Service vehicles should be evenly spaced along the route and arrive punctually at stations. Journey times should vary as little as possible.
Journey Time	Door – to – door journey time must be the same, if not shorter, than the equivalent journey made by car. Uniform speed along the whole route throughout the day.
Comfort	Should offer a similar degree of comfort to trams: Limited vehicle movement (i.e. a smooth ride). Comfortable seats and standing facilities; ease of movement within the vehicle. High quality interior (lighting, ambience) Provision of real time passenger information (waiting time, next station, delays) both on board at stations. For headways of more than 10 minutes, display of wait times is essential for passengers.
Accessibility	Buses with a High Level of Service vehicles in the network should benefit from better accessibility than non conventional vehicles. The accessibility approach adopted should integrate other modes of transport including walking, cycling, park and ride.
Image/ease of use	Users must be able to identify the line on maps and within the town or city and associate it with a high level of service. Services should benefit from a modern "high performance" image in order to attract users. The creation of Buses with a High Level of Service lines should be accompanied to a greater or lesser degree by enhancement to the urban fabric.

Source: Centre for the Study of Urban Planning, Transport and Public Facilities, 2010

1.3 What Makes Rapid Transit Different?

There are a range of factors that set Rapid Transit apart from existing forms of public transport. These factors include the impact of Rapid Transit on:

- User perceptions and experience of public transport systems
- The built environment surrounding transit stations and stops and along corridors of operation.

This section defines some characteristics which are identifiably manifest in Rapid Transit, and distinct from other forms of public transport.

Rapid Transit is defined as design and service improvements to an existing public transport system, or the implementation of a new public transport system, that results in the following outcomes for ***users***:

- Reductions in travel time relative to pre-existing public transport options
- Increased span of hours of service where relevant and coverage of system
- Increased frequency of service across all hours of operation
- Consistently high frequency of services during peak periods
- Increased capacity across the system
- Improved service levels and comfort
- Simplified route design
- Simplified ticketing and boarding systems
- An easily identifiable brand and a clear product differentiation of the Rapid Transit system from pre-existing systems.

Rapid Transit is defined as design and service improvements to an existing public transport system, or the implementation of a new public transport system, that results in the following impacts on the ***built environment*** along routes of service and around stations:

- Land value uplift along routes of operation
- Value uplift for existing properties along routes of operation
- Land value uplift around key stations
- An impetus for changes to land use along routes of operation and at stations
- An impetus for changes to the built form along routes of operation to accommodate changing needs, for example more commercial space to service a higher demand for shopping
- An impetus for densification of residential development along the routes of operation and around stations.

1.4 Rapid Transit Physical Infrastructure Needs and Costs

Rapid Transit systems bring with them the need for specific network and physical infrastructure in their construction. In the primary research and literature review undertaken for this report the key difference that emerges between Road Based Rapid Transit and Rail Based Rapid Transit is that Rail Based Rapid Transit, through its fixed nature is more intensive and rigid in its infrastructure needs than Road Based Rapid Transit. Road Based Rapid Transit can be delivered in small scale forms that require minimal expenditure on physical and network infrastructure; these include change of service measures, branded buses and priority measures for existing routes. This makes Road Based Rapid Transit, in most cases, a cheaper option than Rail Based Rapid Transit.

There are, however, exceptions to this principle with "rolled gold" examples of Road Based Rapid Transit being as infrastructure intensive as equivalent Rail Based systems. An example of this can be found in the Brisbane Busways system which was built with the intention of retrofitting Light Rail services at such a time the capacity of the bus system could no longer service demand. Busways' patronage, however, has never exceeded the projected capacity of the proposed Light Rail system. The Busways model has skewed design and cost assessment principles for Road Based Rapid Transit systems in Australia.

Work being undertaken in the development of the Gungahlin to City Transit Corridor (Capital Metro) in the Australian Capital Territory has identified the specific requirements of Rail Based Transit and Road Rapid Transit for the same corridor in Canberra.

Table 1.4 demonstrates that the key physical infrastructure needs, cost differentials and cost impositions brought about by the choice of Rail Based Rapid Transit are encountered as a result of:

- Track work required for the operation of Rail Based Rapid Transit
- Stations, building and structures related to Rail Based Rapid Transit, these could include additional depots for rolling stock, larger stations and required engineering structures
- Rolling stock for Rail Based Rapid Transit, while higher capacity is priced higher for the same approximate capacity on a corridor, this is offset in small part by an additional 15 years of operating life for rail rolling stock.

Hensher and Golob's (2008) analysis of 44 Bus Rapid Transit systems, which weighted for variations in specifications and input costs found a cost of approximately $10m US per kilometre.

> *"In general, the great majority of systems with all manner of variation cost less than $US10m per kilometre, and what is most notable about this is that these systems are not all confined to economies with relatively low input costs (especially labour) but are spread throughout developed and developing nations (such as USA, UK, Australia, Canada, France, Mexico, Korea, Brazil, and China)."*[24]

Difficulties in identifying an accurate Australian comparison of per kilometre costs of Light Rail with Bus Rapid Transit are twofold:

1. There is a lack of recent post construction cost data for new Light Rail systems. A recent analysis of the last decade of infrastructure costs in Australia found the per kilometre cost of Light Rail to be $11.9m per kilometre, based on 2010 AUD rates, but this estimate was based on three Light Rail extension projects rather than full Light Rail.[25] This figure is often misused by modal advocates to underestimate the cost of Light Rail in an Australian context.

   A more accurate approach, particularly given the tendency of infrastructure projects to be delivered at a final cost higher than development phase estimates, would be to base per kilometre cost assumptions on Light Rail projects in development. In this regard the per kilometre cost of Bus Rapid Transit for the Capital Metro is approximately $23m per kilometre versus approximately $51m per kilometre for the Light Rail option. Infrastructure NSW estimates a $70m per kilometre cost for the proposed ANZAC Parade Light Rail and cites this as roughly consistent with the costs for the Gold Coast Light Rail project.[26]

2. The available data on per kilometre costs for Bus Rapid Transit in Australia are skewed by the cost of constructing the Brisbane Busways Bus Rapid Transit, which was delivered at high specification and cost with the intention of transferability to Light Rail in future.

Light Rail brings significantly higher start up costs than Bus Rapid Transit.

This is due to a number of factors including:

- The core infrastructure requirement (roadway) for Road Based Rapid Transit being already available while the track work and the electricity supply required for Rail Based Rapid Transit needs to be installed
- The rolling stock for Road Based Rapid Transit is already available while rolling stock for Rail Based Rapid Transit needs to be purchased. Road Based Rapid Transit rolling stock has the added advantage of not being confined to the Rapid Transit corridor.

24 Hensher, D and Golob, T, 2008, *"Bus Rapid Transit Systems A Comparative Assessment"*, Institute for Transport and Logistics Studies, University of Sydney.

25 Martin, S, 2011, *"Reviewing the Last Decade of Public Transport Infrastructure Projects in Australasia"*, Australasian Transport Research Forum 2011 Proceedings 28 - 30 September 2011, Adelaide, Australia.

26 Infrastructure NSW, 2012, *"State Infrastructure Strategy"*, NSW Government.

Table 1.4 Physical Infrastructure and Cost Comparison Light Rail vs Bus Rapid Transit Gunghalin to City Rapid Transit

Asset	Cost Component	Cost Type	Assumed Life (Years)	LR: Median Alignment	BRT: Median Alignment
Enabling works	Planning	Direct Costs	0	$13.355	$13.355
Other general planning and management	Planning	Direct Costs	0	$9.713	$9.713
Traffic management/temporary works	Planning	Direct Costs	0	$5.095	$5.095
Track work	Below rail infrastructure	Direct Costs	30	$101.984	N/A
Road infrastructure	Bridges	Direct Costs	30	$13.520	$13.520
Road infrastructure	Segregated Rapid Transport Lanes	Direct Costs	30	$25.440	$25.440
Road infrastructure	Road works/footpaths and cycle lanes	Direct Costs	30	$8.937	$8.937
Road infrastructure	Medians/Landscaping	Direct Costs	30	$5.200	$5.200
Road infrastructure	Drainage	Direct Costs	30	$4.589	$4.589
Road infrastructure	Utilities	Direct Costs	30	$28.880	$28.880
Signalling	Electrical	Direct Costs	15	$9.713	$9.713
Power supply, transformers and sub-stations	Electrical	Direct Costs	40	$72.000	N/A
Other electrical and mechanical systems	Electrical	Direct Costs	15	$15.589	$12.821
Passenger ticketing	Passenger interface and communications	Direct Costs	0	N/A	N/A
Passenger information displays and Platform control systems	Passenger interface and communications	Direct Costs	10	$10.927	$7.285
Vehicle monitoring systems	Passenger interface and communications	Direct Costs	10	N/A	N/A
Bus stops	Existing stops relocated from kerb	Direct Costs	20	$3.642	$3.642
Bus/Light rail stations		Direct Costs	50	$27.7317	$18.212
Other buildings and structures	Depots	Direct Costs	100	$91.058	$48.000
Bus fleet	Fleet	Direct Costs	20	N/A	$11.250
Light rail rolling stock	Fleet	Direct Costs	35	$54.635	N/A
Preliminaries and design 20% of direct costs	Preliminaries and design	Indirect Costs	0	$100.319	$45.130
Government costs 2.5% of direct costs	Project delivery costs	Indirect Costs	0	$12.540	$5.641
Subtotal: Indirect costs				$112.859	$50.772
TOTAL ($mil)				$614.452	$276.423

Source: ACT Government, 2012

1.4.1 Network and Physical Infrastructure Needed for Rail Based Rapid Transit

Rail Based Rapid Transit, due to its fixed nature has a more specific set of infrastructure needs. A significant difference from Road Based Rapid Transit is the need for electrical infrastructure in the operations of rail systems.

Rail Based Rapid Transit can be built on top or within existing road infrastructure or it can be built separate to roadways.

As demonstrated in Table 1.4, where Rail Based Rapid Transit is built on top of existing road infrastructure the difference in infrastructure needs from Road Based Rapid Transit relates primarily to the construction of tracks and their electrification.

In a comparative assessment of physical infrastructure needs the City of London identified the two key differences between Road and Rail Based Rapid Transit as being the gradient and roadway width requirements (see Table 1.5).

Table 1.5 Physical Infrastructure Needs of Light Rail and Bus Rapid Transit

Criteria	Bus Rapid Transit (Road Based)	Light Rail (Rail Based)
Gradient Needs	Flexible	Grades must be no greater than 5 to 7 per cent and even less at stations.
Minimum Width of an Exclusive Two Way Right of Way Lane	8.5 to 9.8 metres	9.1 to 10.7 metres

Source: City of London 2012

1.4.2 Network and Physical Infrastructure Needed for Road Based Rapid Transit

More so than Rail Based Rapid Transit the infrastructure needs of Road Based Rapid Transit are defined by the design of the project and capacity for future growth built into the system.

With several options available for the delivery of Road Based Rapid Transit, there is a wider range of infrastructure options than Rail Based Rapid Transit.

Infrastructure requirements of a Road Based Rapid Transit system can include:[27]

- Busway infrastructure
- Feeder infrastructure
- Stations
- Intermediate transfer stations
- Terminals
- Depots
- Control centre
- Traffic signals, including priority signals
- Integration infrastructure
- Commercial space
- Public utilities (gas, electricity, water, sewerage, telephone, internet)
- Landscaping and medians.

Road Based Rapid Transit provides the flexibility to operate on a closed and/or open system, including the provision of similar operation and customer service characteristics of Rail Based Rapid Transit.

27 Wright, L, and Hook, W, 2007, *"Bus Rapid Transit Planning Guide"*, Institute for Transportation Development and Policy, New York.

1.5 Marketing of Rapid Transit

1.5.1 Introduction

This section examines marketing strategies specific to the marketing of Rapid Transit systems as distinct from existing and broader public transport marketing strategies.

There is a range of evidence to suggest that marketing of Rapid Transit presents a different set of challenges to broader public transport marketing. This section will explore those differences and the factors underlying them with a view to identifying a set of principles for successful marketing of Rapid Transit.

The marketing of Rapid Transit systems, during design, construction and implementation phases, is identified in the literature as being integral to the success and uptake and development of Rapid Transit systems with "buy in" from the community that they are intended to service. The BIC examined a range of marketing strategies for Rapid Transit systems during the Rapid Transit Study Visit of the North America.

Key findings about the relationship of marketing to the successful operation of Rapid Transit systems are outlined in this section of the report. Data arising from the study of some of the systems by the American Public Transportation Association and research undertaken on the Rapid Transit Study Visit of North America are presented in this section.

1.5.2 Marketing of Road Based Rapid Transit

The key challenge of marketing Road Based Rapid Transit, in particular Bus Rapid Transit, flows from the "negative stigma" attached to bus public transport systems.[28]

This challenge is unique to Bus Rapid Transit with a different set of challenges for Light Rail, which is more related to gaining acceptance of the cost of the system and disruption from its construction rather than the perceived amenity of the vehicles or aesthetic considerations.[29]

In identifying a *Recommended Practice* for Bus Rapid Transit branding, imaging and marketing, the American Public Transportation Association (2010) identified a set of key benefits that arise from good branding of Bus Rapid Transit systems.

While this *Recommended Practice* is focused on Bus Rapid Transit systems the broader principles are applicable to improved and new bus services including Buses with High Level of Service, Bus Rapid Transit Lite and Branded Bus Services:[30]

> **Clearly differentiated transit service**

Branding which is distinct from existing services can denote the Bus Rapid Transit system as a premium service with a different look and feel from existing bus services.

The impact of differentiation on user perceptions is also achieved through Branded Bus Services which were examined in section 1.2.7 of this report.

> **Enhanced outreach efforts**

A common brand proposition among the various components of a Bus Rapid Transit system will simplify marketing efforts and will allow an agency to more effectively reach its target customers.

> **Increased customer loyalty**

A consistent brand identity will help customers navigate the system by making the Bus Rapid Transit system easily identifiable and distinguishing it from other services. Consistent delivery of the brand promise will create loyal customers.

> **Improved employee satisfaction and retention**

A consistent and compelling brand creates pride and a sense of contribution for employees.

> **Increased brand value, as measured by added revenue and increased market share and potential for attracting development activity**

> **An attractive and compelling brand can help attract new economic development or intensify existing land uses around the Bus Rapid Transit corridor.**

The American Public Transportation Association identified the "brand promise" and key messages as the critical factors in the differentiation of Bus Rapid Transit from existing bus services. Table 1.6 tracks brand promises and key messages of systems including those visited during the BIC's Rapid Transit Study Visit of North America.

A recurring theme in the messaging around the marketing of these systems was the speed and frequency of operation, while some systems touched on the rail like feel of the system. The importance of "rail like" qualities in Rapid Transit is examined in section 1.5.7 which looks at the impact of the "Psychological

28 Wright, L, and Hook, W, 2007, *"Bus Rapid Transit Planning Guide"*, Institute for Transportation Development and Policy, New York.
29 Ibid.^

30 American Public Transportation Association, 2010, *"Recommended Practice: BRT Branding, Imaging and Marketing"*, APTA Standards Development Program, Washington DC.

Rail Factor" in public transport user perceptions.

The emphasis on frequency and rail-like qualities reflects the findings of end user expectations featured in the case study of the Metro Los Angeles network in this report. As the case study highlights end users place a high value on Rapid Transit systems offering more frequent and higher quality services.

> *A clear brand distinction from existing bus and rail services is required to overcome negative associations with existing public transport and delineate the Rapid Transit system from existing public transport operations.*

Wright and Hook (2007) identify four key components in the marketing of Bus Rapid Transit:

- System name
- System logo and slogan
- Campaign strategy
- Public education plan.

These relate to the process of their proposal, design and implementation.[31]

31 Wright, L, and Hook, W, 2007, *"Bus Rapid Transit Planning Guide"*, Institute for Transportation Development and Policy, New York.

Table 1.6 Brand Promises and Messages of Bus Rapid Transit Systems in North America

City	Service	Features
Boston	Silverline	Mixed and dedicated roadway and tunnel operations; some Light Rail-type stations.
Cleveland	HealthLine	Dedicated and mixed roadways; precision docking stations.
Eugene, Oregon	EmX	Dedicated lanes, bi-directional in places, stations, attractive landscaping, dedicated and distinctively designed vehicles.
Everett, Washington (State)	Swift	Dedicated lane, station
Los Angeles	Metro Rapid	Arterial Bus Rapid Transit. The Metro Rapid system is a multimodal Rapid Transit network which includes Bus Rapid Transit Lite and Light Rail systems in addition to the Orange Line Bus Rapid Transit system.
Los Angeles	Orange Line	Dedicated roadway, Light Rail-like stations, dedicated and distinctively designed vehicles
Las Vegas	MAX	Arterial Bus Rapid Transit
Pittsburgh	Martin Luther King Junior East and West Busways	Dedicated roadway, distinct station design, linear park along East Busway
York Region Ontario	Viva	Arterial Bus Rapid Transit

Source: Modified by the BIC from American Public Transportation Association, 2010

	Brand Promise	Comments
	Part of Rail network, quality of service.	Also generates significant land-use development around stations.
	Fast, first class, "rail like".	The original brand name for the system was 'Silver Line" the naming rights were sold to a major health care institution. The name represents the corridor of operation of the Bus Rapid Transit through the Cleveland healthcare precinct on Euclid Avenue. (Featured in the Rapid Transit Study Visit of North America)
	Fast, environmentally friendly.	EMX is short for "Emerald Express".
	Fast, environmentally friendly.	Use of the bird logo taps into the environmental ethic of the U.S Northwest.
	Faster, more frequent	Sales slogan was "Fast, Frequent, Fabulous," taps into the Los Angeles ethos. (Featured in the Rapid Transit Study Visit of North America)
	Part of Rail network	Color chosen to reflect citrus heritage in valley. (Featured in the Rapid Transit Study Visit of North America)
	Faster, glitzier, futuristic	Use of the MAX acronym connotes maximum service. (Featured in the Rapid Transit Study Visit of North America)
	Fast, frequent, flexible service	Significant developments at several stations along the East Busway route.
	Frequent, convenient, modern, innovative, fun, environmental	York Region Transit logo was updated to reflect connectivity with Viva services.

System name

In naming Bus Rapid Transit, Wright and Hook (2007) assert that the "bus" implication within the system is best avoided, especially where existing services are inadequate or unpopular and the use of names which engender a modern and innovative connotation are more successful.[32] These are reflected in the names of some of the systems visited during the BIC's Rapid Transit Study Visit of North America. The Metro Rapid in Los Angeles captures both this innovative feel and implies improvements in travelling time while the Metropolitan Area Express (MAX) in Las Vegas uses a dual meaning to connote service improvement and improvements to travel time. According to Wright and Hook (2007) qualities and themes that can be adopted for successful system naming are:[33]

> Sophisticated
> Modern
> Serious
> Rapid
> Efficient
> Elegant
> Convenient
> Comfortable
> Social
> Fun and playful.

System logo and slogan

The colours within the logo and branding of a Bus Rapid Transit system can impact on the acceptance of the system. A slogan can enhance public recognition of the system and create a distinction between the Bus Rapid Transit and the existing public transport system.

A slogan or tagline can deliver a message about the Bus Rapid Transit system and highlight its distinguishing features. As highlighted in table 1.6 the sales slogan for the Metro Rapid system in Los Angeles "Fast, Frequent, Fabulous" while identified as tapping into the Los Angeles ethos, serves the dual purpose of identifying key improvements to service frequency, speed and customer service levels that distinguish the Metro Rapid from pre-existing public transport.

Campaign strategy

Wright and Hook recommend a comprehensive marketing strategy aimed at achieving the following objectives:

- Maximising interest and ridership in the system
- Overcoming misperception and doubts related to the system and the bus mode
- Identifying customer groups and developing different messages to target them.

The key to this strategy is in the identification of stakeholders and customer groups and tailoring messages to attract them to the Bus Rapid Transit system. Stakeholders and customer groups include:[34]

- Existing public transport users (bus users, rail users etc)
- Existing car users
- Workplace commuters
- Business professionals
- Students and parents
- Disabled commuters.

Table 1.7 outlines potential messages that can be aimed at different customer groups and how they can attract users to the Bus Rapid Transit system.

32 Wright, L, and Hook, W, 2007, *"Bus Rapid Transit Planning Guide*", Institute for Transportation Development and Policy, New York.
33 Ibid.,^
34 Ibid.,^

Table 1.7 Potential Marketing Messages for Customer Groups

Market Segment	Potential Messages
Students	• Availability of special discounts • Highlight technological aspects such as payment with mobile phone or the availability of wireless internet • Social atmosphere of the system • Ability to study while using the system
Parents	• Security aspects • Safety aspects • Cost-effectiveness of the system
Business professionals	• Work or relax while commuting • Travel time savings • Technological aspects of the new system • High quality image of new system (status issue) • Savings in maintenance on the car • Comfort and convenience • Cost savings
Existing public transport users	• Improvement in system quality • Travel time savings
Disabled commuters	• Easy use features of systems

Source: Wright and Hook, 2007

Public education plan

The public education plan allows users and potential users of the Bus Rapid Transit system to familiarise themselves with the key features of the system.

> *"Prior to the new transportation system's commissioning the general public must be instructed on available routes, services, fare purchasing, pricing schemes, service attributes, boarding procedures, rules, restrictions, system advantages etc..."*[35]

It is recommended that the public education campaign start well before the implementation phase of the Rapid Transit project.[36] An example of public outreach is seen in Brisbane where "Go Busway" information kiosks are available throughout the city to engage potential users of the system and provide information on its operation. In our field research during the Rapid Transit Study Visit of North America the BIC examined the marketing practices of systems we visited. The following three sections examine the marketing, communications and consultation strategies of the Cleveland, Brampton *Zum* and New York MTA Bus Rapid Transit systems. The development of the Rapid Transit concept and gaining acceptance by the community is a vital part of ensuring patronage success.

1.5.3 Cleveland

The Euclid Corridor Transportation Project formed a key element of the BIC's Rapid Transit Study Visit of North America.

The Euclid Corridor project comprises a 13km Bus Rapid Transit facility and almost 4km of bus-oriented street improvements in a "transit zone" within downtown Cleveland. The project was developed and is now operated by the Greater Cleveland Regional Transit Authority. The Bus Rapid Transit component operates as the *HealthLine* after the purchase of naming rights by a consortium of the Cleveland Clinic and University Hospitals, two major health care institutions in the Euclid corridor.[37]

35 Wright, L, and Hook, W, 2007, *"Bus Rapid Transit Planning Guide", Institute for Transportation Development and Policy, New York.*
36 Ibid.,^

37 Office of Planning and Environment, Federal Transit Administration, U.S. Department of Transportation, 2012, *"Before and After Studies of New Starts Programs: Report to Congress"*, US Department of Transportation, Washington DC.

The *HealthLine* carries 14,300 trips on the average weekday compared to 8,900 weekday trips on Route 6 that it replaced. This increase reflects faster travel times and moderately more-frequent peak-period service, increased customer satisfaction with the *HealthLine* service, and the elimination of local bus routes on Euclid Avenue. Total ridership in the Euclid Corridor increased from 16,200 to 21,200 trips per average weekday, a gain of 31 percent.[38]

In constructing the *HealthLine*, the City of Cleveland engaged in an intensive outreach campaign with the existing businesses and business partnerships along Euclid Avenue to gain support from that community. This strategy delivered the best economic development results observed on the Study Visit. All businesses were given the opportunity to comment on plans, and plans could not move forward until each business signed off on the specific design and construction plans. In the end, business owners became so supportive that many demanded additional stations, thereby increasing the number of stations along the corridor. Though some businesses suffered during the construction phase, $4.3 billion of new investment has been made, to date in the corridor, significantly exceeding original expectations.[39]

The construction process was strategically timed and well-managed, with businesses being informed well in advance. Construction impacts should be minimised through well-planned phasing and area-wide traffic impact and environmental mitigation measures to address construction impacts that are unavoidable. Enthusiasm generated for the project across all sectors was a key success factor for the project.

1.5.4 Toronto/Hamilton

The City of Brampton is a suburban city in the Greater Toronto area with a population of approximately 520,000.

AcceleRide, eventually branded *ZUM*, was an initiative to introduce enhanced, uniquely branded Bus Rapid Transit. The *Acceleride* initiative addressed needs identified in the city's Transportation and Transit Master Plan as well as the Province's "Places to Grow" plan for the Greater Toronto and Hamilton Area. Awareness for the proposed project was raised amongst elected officials through workshops and council meetings at all phases of the project. Public awareness was raised through public information centres for the development of the Transportation and Transit Master Plan. In addition an environmental assessment process was completed for the project, specifying the frequency and type of public consultations.

Prior to the launch of the Queen Street Bus Rapid Transit a marketing campaign was conducted to make the public aware of the new Bus Rapid Transit service. Pre-implementation community consultation was done through marketing the *ZUM* brand. Methods included holding pavilions at specific major events that showcased the proposed system and newly branded buses. The response was positive.

Primary stakeholders were identified as:

- Current Brampton Transit users
- Corridor specific groups
- Brampton Transit employees
- Federal and Provincial Government representatives.

Secondary stakeholders were identified as:

- Mayor, City Council, senior management and all City of Brampton employees
- Brampton business associations (Board of Trade, Brampton Downtown Development Corporation)
- Special interest groups (environmental, heritage, smart commute, etc.)
- GO transit system users
- Media (local, regional, national and trade publications).

As part of the *ZUM* project a committee called The Future of Brampton Transit was established, which developed a newsletter for employees and organised open-house sessions for employees prior to the launch. These open-house sessions presented content about the *ZUM* service, but also other features i.e. intelligent transportation systems details and implementation of the fare card.

1.5.5 New York MTA

The New York Metropolitan Transportation Authority established its *Select Bus Service* (Bus Rapid Transit) system in New York City in 2008.

The *Select Bus Service* was a joint effort between Municipal and State Governments. Key stakeholders in the project were identified as:

- New York City Transit
- New York City Department of Transportation
- New York State Department of Transport
- Local businesses and community groups.

38 Ibid., ^
39 Zicari, P, 2008, *"The Rebirth: Euclid Corridor Project has Already Brought $4.3 billion Investment to the City"*, accessible online at http://blog.cleveland.com/pdextra/2008/06/the_rebirth_euclid_corridor_pr.html.

The ZUM Bus Rapid Transit System in Brampton

Rapid Transit Elements: public consultation, limited stops to get there sooner, real-time information and innovative marketing

Viva Bus Rapid Transit, York Region Transit in Toronto

Rapid Transit Philosophy: improve services on the network, increase patronage, then build towards dedicated transit lanes along major corridors

Community meetings were held in all communities along the extent of the Bus Rapid Transit route with informational boards, formal presentations, and Q&A. Primary planning, marketing and implementation were done by the New York City Transit Operation Planning Department and the New York City Department of Transportation Transit Development Group. Specific roles were not established in the development and planning phases of the project.

The New York Metropolitan Transit Authority (MTA) Bus Rapid Transit is comprised of a *Select Bus Service* which operates on a mix of priority and general roadway conditions. The service commenced in 2008 and operates six services on five corridors with an expansion of the service scheduled for 2013. A Communications Team was established for the project drawn from New York City Transit and New York Department of Transport staff. The overall marketing and communications budget for the MTA Bus Rapid Transit system was allocated at US$100,000.

The system name was established based on an executive decision from the project team while the process for the development of the logo and branding system for the *Select Bus Service* was developed by the Communications Team for the project. No specific slogan for the system was applied.

Community consultation in the areas directly affected by the service was ongoing from the concept phase to the implementation phase of the project. A public education campaign was undertaken which included announcements on existing bus services and in subway stations. New York MTA ensured the presence of "Customer Service Ambassadors" at all Bus Rapid Transit stations in the first several weeks of service to assist riders on the system and answer enquiries. Advertisements were also placed in local newspapers about the system.

1.5.6 Marketing of Rail Based Rapid Transit

The marketing of Rail Based Rapid Transit provides a different set of challenges to the marketing of Road Based Rapid Transit. Unlike Road Bus Rapid Transit, Rail Based Rapid Transit systems do not have to contend with perceptions of existing bus services.

It is possible to market Light Rail as a new form of transport and for Light Rail systems to open new markets such as the social and recreational traveller market that would not ordinarily use public transport services in the area of operation.[40] Ginn (1998) contends that Light Rail is a "trendy new way to travel around our cities, compared with the car." This speaks to the almost automatic appeal produced by the look and feel of Light Rail.[41] Light Rail in effect is able to sell itself by tapping into new market segments and presenting a novel travel choice to commuters in the areas of operation.

It is important to note that the instant appeal of Rail Based Rapid Transit might not be sustained if the underlying factors driving patronage on Rapid Transit are not satisfied in the design and operation of the system. These factors are discussed in further detail in Chapter 3.

This look and feel appeal in marketing Rail Based Rapid Transit can be mimicked by Road Based Rapid Transit, but as outlined in the previous section the priority for Road Based Rapid Transit systems is to overcome perceptions of existing bus services by promoting the increased utility and benefit to users produced by the Rapid Transit system. In promoting this improvement in services it is vital to promote the rail like qualities of Road Based Rapid Transit.

There is less research conducted into the specific marketing of Rail Based Rapid Transit systems than the marketing of Bus Rapid Transit and other Road Based Rapid Transit systems. The automatic appeal of Rail Based Rapid Transit touched on in this section is better described in analysis of the "psychological rail factor" explored in the following section and revisited as the "Sparks Effect" later in this report.

1.5.7 Psychological Rail Factor

The identification of the "Rail Factor" as an element in driving demand and improving perception of public transport concords with the idea that Light Rail through its look and feel will produce an automatic appeal to commuters.

Research by Scherer and Dziekian (2012) produced the following key finding:

> *"…A psychological rail factor (i.e., a preference for using rail assuming equal service conditions) of 63 percent for regional train and 75 percent for trams when compared with bus services. The rail factor is highly loaded with emotional and social attributions. They account for 20–50 percent of the share in the different schemata for bus, rail, and tram."*[42]

40 Ginn, S, 1998, *"An Overview of Light Rail and its Potential within an Australian Environment", Western Australian Planning Commission and Ministry of Transport, Perth, Australia.*

41 Ibid., ^

42 Scherer, M, and Dziekan, K, *"Bus or Rail: An Approach to Explain the Psychological Rail Factor"*, Berlin Institute of Technology.

The emotional and social attributions in the "Rail Factor" identified across the two case studies in the research were:[43]

- Convenience
- Nostalgia
- Attractiveness
- Space on vehicle
- The ability to communicate and socialise.

While these findings highlight the difficulty that bus based services have in relations to rail in terms of "hearts and minds" they highlight the possibility that if the "Rail Factor" can be duplicated in Road Based Rapid Transit services the same levels of patronage and community acceptance will and can be achieved. This can be achieved if the right consideration is given to the replication of the positive emotional and social factors associated with rail services and how they translate into the design and operation of a Road Based Rapid Transit system. The researchers contend:

> *"…Thinking of barriers toward public transport use in general or buses in particular, the schema shows that implementing small individual measures to improve bus service are not likely to be effective since the bus schema is highly loaded with emotional factors, based on experiences and habits.… Overcoming one negative attribution is not simply a matter of creating a more positive image for a public transport mode."*[44]

A significant emphasis in marketing Rapid Transit needs to be placed on the key elements in driving patronage and modal shifts to the system such as frequency and reliability.

43 Ibid., ^

44 Ibid.,^


ANYWHERE
ANYTIME
INTUITIVE
DIRECT

two

Criteria for Building Rapid Transit

Chapter 2: Criteria for Building Rapid Transit

2.1 Introduction

This Chapter defines criteria for governments to use in determining when to move from existing public transport services to the development of Rapid Transit projects and for the Commonwealth Government or other funding bodies to assess the value of prospective Rapid Transit projects.

These criteria can also serve as an assistive tool in the development of funding applications developed by State Governments for funding through the Infrastructure Australia process. It is intended that by following the pre-conditions required for high value ratings in the Australian Rapid Transit Assessment Guidelines (ARTAG) model for assessment the project proponent can identify good design elements.

These criteria identify the economic, population, housing, environmental and social preconditions for developing Rapid Transit. In applying these criteria to the determination of "when" to build Rapid Transit it is possible for governments to make a parallel determination of what form of Rapid Transit system and design best suits the specific needs of a proposed area of service. These criteria have been developed through a review of international examples for determining the funding and construction of Rapid Transit by governments.

At the end of this chapter a case study is included that outlines the assessment process Euclid Corridor Transportation project under the US Government New Starts funding system. This highlights the New Start assessment criteria in action and how a similar model like ARTAG would work in Australia.

2.2 When to Build Rapid Transit: A National Approach to Assessment for Australian Governments

2.2.1 Introduction

The adoption of a formula based funding model for Rapid Transit infrastructure projects, based on a modified version of the United States Federal Transit Administration (FTA) model and international examples for impact assessment, should be considered by Australian Governments.

The explicit purpose of ARTAG is to engender a National approach to assessing applications for Rapid Transit infrastructure funding from State Governments seeking financial support from the Commonwealth Government.

To ensure value for money and that the right investment decisions are made to deliver improved public transport services, addressing the ARTAG assessment criteria should be a compulsory requirement of any Rapid Transit project that seeks Commonwealth Government funding.

The Federal Transit Administration's New Starts is aimed specifically at developing Rapid Transit projects with State and Local Government agencies in the United States. While no such program exists in Australia, a set of justification criteria and model for assessment specific to Rapid Transit could be adapted to fit into existing funding arrangements.

ARTAG is comprised of three key ratings mechanisms:

- Project Preconditions Rating (40 per cent)
- Project Justification Rating (40 per cent)
- Project Financial Rating (20 per cent)
- Final Project Rating = Project Preconditions Rating + Project Justification Rating + Project Financial Rating (100 per cent).

The Final Project Rating would be used to "score" applications for Rapid Transit infrastructure funding to provide an indicative evaluation which could be used to compare applications for Rapid Transit investment in the pipeline for Commonwealth and State Government agencies. These scores would then be assigned a qualitative value according to the following delineations for Final Project Rating:

- High Value – 90 per cent or greater
- Medium to High Value – 75 to 90 per cent
- Medium Value – 65 to 75 per cent
- Medium to Low Value – 50 to 65 per cent
- Low Value – Less than 50 per cent.

This value could be used by governments in prioritising projects for investment or green lighting investment applications in a budgetary cycle.

Assessment Process

ARTAG does not prescribe a structure or nominate a decision making body for conducting assessment.

Ideally assessment against ARTAG would be undertaken by an independent body either conducting a wider infrastructure investment assessment process or undertaking a Rapid Transit infrastructure investment assessment process. An example of this in the Australian context would be Infrastructure Australia.

There is a fundamental need for considerations external to this assessment process to play a role in the prioritisation of funding decisions from both the Commonwealth and State Governments. While ARTAG attempts to capture the key elements underpinning the Rapid Transit project development, it cannot be all encompassing.

Impact on Modal Choice

Due to the nature of our experience on the Rapid Transit Study Visit of North America the report deliberately avoids the specification of modal choice. The choice of mode when proposing a Rapid Transit project presents a significant challenge for decision makers and incorporates considerations that do not fit within an objective model, such as ARTAG.

Leeway must exist for governments to base decisions on considerations that may not be readily quantifiable or related to transport outcomes. There are, however, elements of the ARTAG, particularly in the economic impacts model that may favour a specific modal choice over another or advise against the construction of Rapid Transit regardless of the mode proposed. The Project Financial Rating element of the Final Project Rating would also capture cost considerations that may affect modal choice when developing project applications.

ARTAG should not be a prescriptive decision maker, but rather present a set of choices to governments when developing Rapid Transit project proposals. ARTAG as an objective model can clarify the value being placed on external considerations or outcomes sought from projects, presenting a clearer set of options for governments in designing, implementing and funding Rapid Transit.

Benchmarking

While the Federal Transit Administration establishes qualitative and quantitative benchmarks under the New Starts Program for each assessment criteria, the ARTAG model at this stage does not attribute benchmarks for specific "transport measurements." This is primarily because there is no nationally adopted table of "transport measurements." The benchmarks for ARTAG could be identified within the eventual adoption of the updated National Guidelines for Transport System Management.

Project Preconditions Rating

The Project Preconditions Rating allows the funding assessment body to determine whether an application for project funding is predicated on a sound approach to public transport investment and planning across the entire network.

The Project Preconditions Rating will require a demonstration of measures undertaken and proposed to improve public transport, and other transport demand management approaches that are targeted at increasing demand for public transport and reducing congestion e.g. parking strategies. This requirement would apply along the entire corridor proposed for Rapid Transit and across the project proponents region. For example in the context of the Capital Metro (Australian Capital Territory Light Rail) project this requirement would apply to the Gunghalin to City corridor and to the ACT region.

This requirement will take the form of a statement accompanying the Rapid Transit project proposal that summarises measures underway and how these will integrate with or relate to the proposed Rapid Transit system. The statement should also include a demonstration that all modes were considered in developing the Rapid Transit project proposal.

There are no core components identified as being essential to this measure, but the attribution of 40 per cent of the Final Project Rating is intended to ensure a high quality response to this measure by the project proponent.

Project Justification Rating

Core principles in the assessment of a Project Justification Rating are:

- Economic impacts (50 per cent of Project Justification Rating/ 20 per cent of Final Project Rating)
- Land use impacts (30 per cent of Project Justification Rating/12 per cent of Final Project Rating)
- User Benefits (20 per cent of Project Justification Rating/8 per cent of Final Project Rating).

This weighs economic impact of a project higher than the Federal Transit Administration's model by incorporating the monetised value and other key quantitative elements of environmental benefits, user benefits and cost effectiveness considerations (where they have economic impacts) into the economic impact component of the criteria.

While these core principles still receive their own rating based on limited qualitative and quantitative factors the higher value attributed to economic impact takes into account the crossover between the economic impact of a Rapid Transit project and the quantifiable impact of the project on land use and public transport users. The land use impacts and user benefits ratings outside of the economic impact rating are intended to capture the qualitative aspects of these elements and to ensure that a balance is achieved between the drivers of demand for mass transit and the outcomes sought from a project seeking funding.

This section goes into further detail and itemisation of the processes, measurements and calculations of the four elements in the Project Justification Rating. The effectiveness of these assessment criteria would rest on account being taken of the relative difference in population densities, geographical scale, economic and population growth, etc. of Australia's Capital and Major Cities in the development of benchmarks.

Project Financial Rating

This report recognises the evolving nature of financial arrangements between the Commonwealth and State Governments in Australia and as a consequence this proposed model for assessment of Rapid Transit funding applications does not go into depth in outlining requirements for cost sharing between tiers of government.

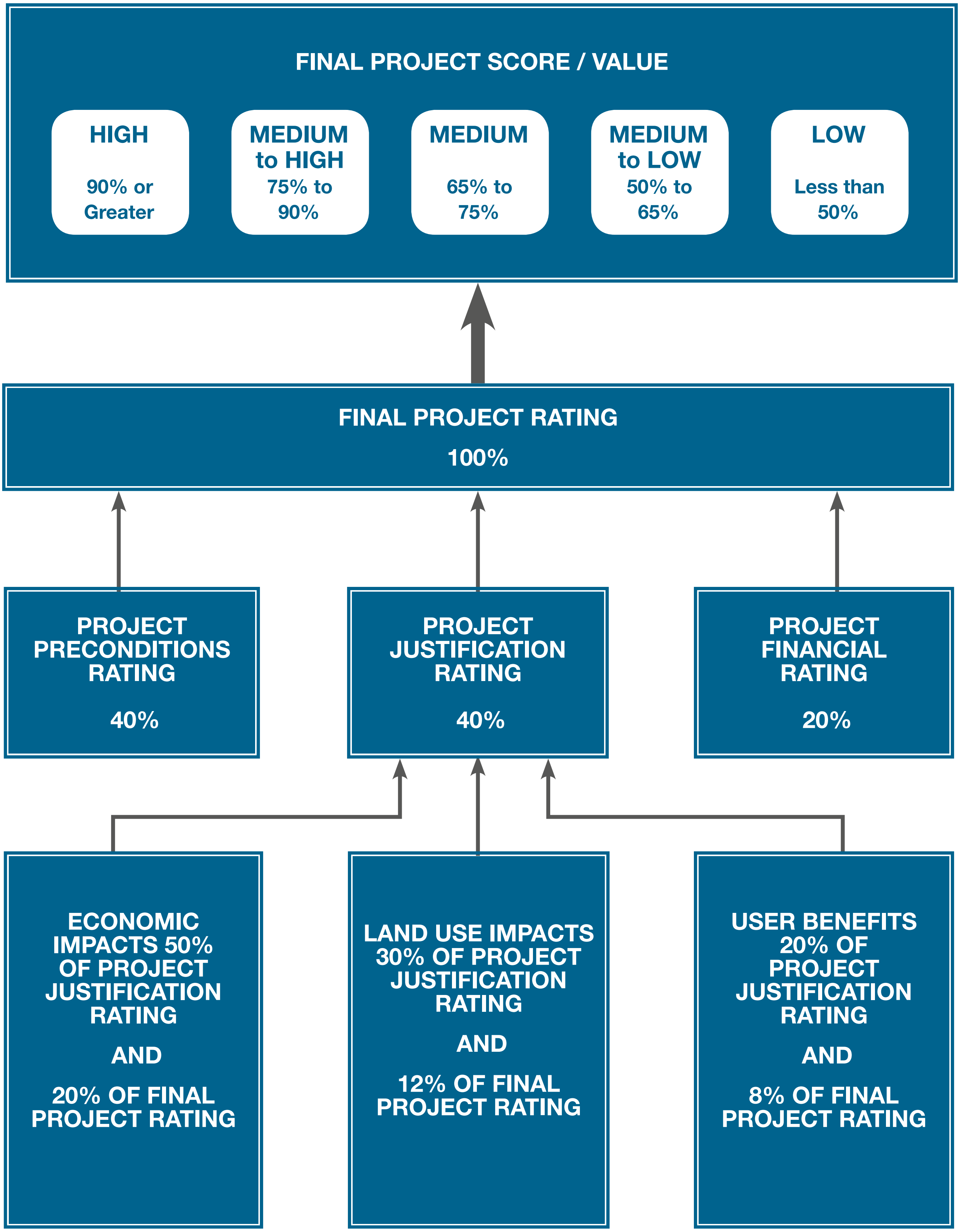
While there is no prescribed requirement for the financial and cost sharing component of project evaluation, these considerations should be incorporated into the Final Project Rating. The Project Financial Rating is valued at 20 per cent of the Final Project Rating.

As outlined in figure 2.1 and in the recommendations of this report, an agreement between the Commonwealth and State Governments on how the Project Financial Rating is measured could be based on the following guiding principles:

- A demonstrated ability from the proponent to meet their share of the capital costs of the project
- A demonstrated ability from the proponent to absorb any cost overruns and unexpected expenses or delays in delivering the project
- A demonstrated ability from the proponent to meet the ongoing costs of operating the Rapid Transit system.




Figure 2.1 Representation of ARTAG



2.2.2 Economic Impacts

Elements of the Federal Transit Administration's New Starts Justification Criteria and other models of economic impact analysis can form the basis of an economic impact assessment. A Multiple Account Evaluation Approach for assessing the impacts of Rapid Transit is shown in Figure 2.2 can be modified for the purposes of ARTAG.

A Multiple Account Evaluation Approach was used in a recent Economic Potential study conducted into a proposed Rapid Transit initiative for the Hamilton area in Toronto Canada, which would see the construction of Light Rail incorporated into an existing network of Rapid Transit. The BIC visited the Rapid Transit systems in the Hamilton/Greater Toronto area during the Rapid Transit Study Visit of North America.

Categories under the Multiple Account Evaluation Approach taken in the Hamilton study are:[45]

> Direct Financial Account
> Direct Transportation User Benefits Account
> Urban Development Account
> Economic Development Account
> Environmental Account
> Social and Community Account.

These categories are simplified in ARTAG within the 50% value in the Project Justification Rating given to Economic Impacts. Economic Impacts for consideration could include:

> Direct Financial and Economic Impacts
> User Benefit (Economic Impacts)
> Economic Development Impacts
> Land Use (Economic Impacts)
> Environmental Benefit (Economic Impacts)
> Social and Community Benefit (Economic Impacts).

These categories present an opportunity to quantify the economic impacts of proposed projects and incorporate qualitative value considerations into the final assessment of applications.

A more detailed itemisation of categories, their measures and the scale of their impact is outlined in Table 2.1.

45 US Department of Transportation and Federal Transit Administration, 2013, "Proposed New Starts and Small Starts Policy Guidance", Federal Transit Administration, Washington.

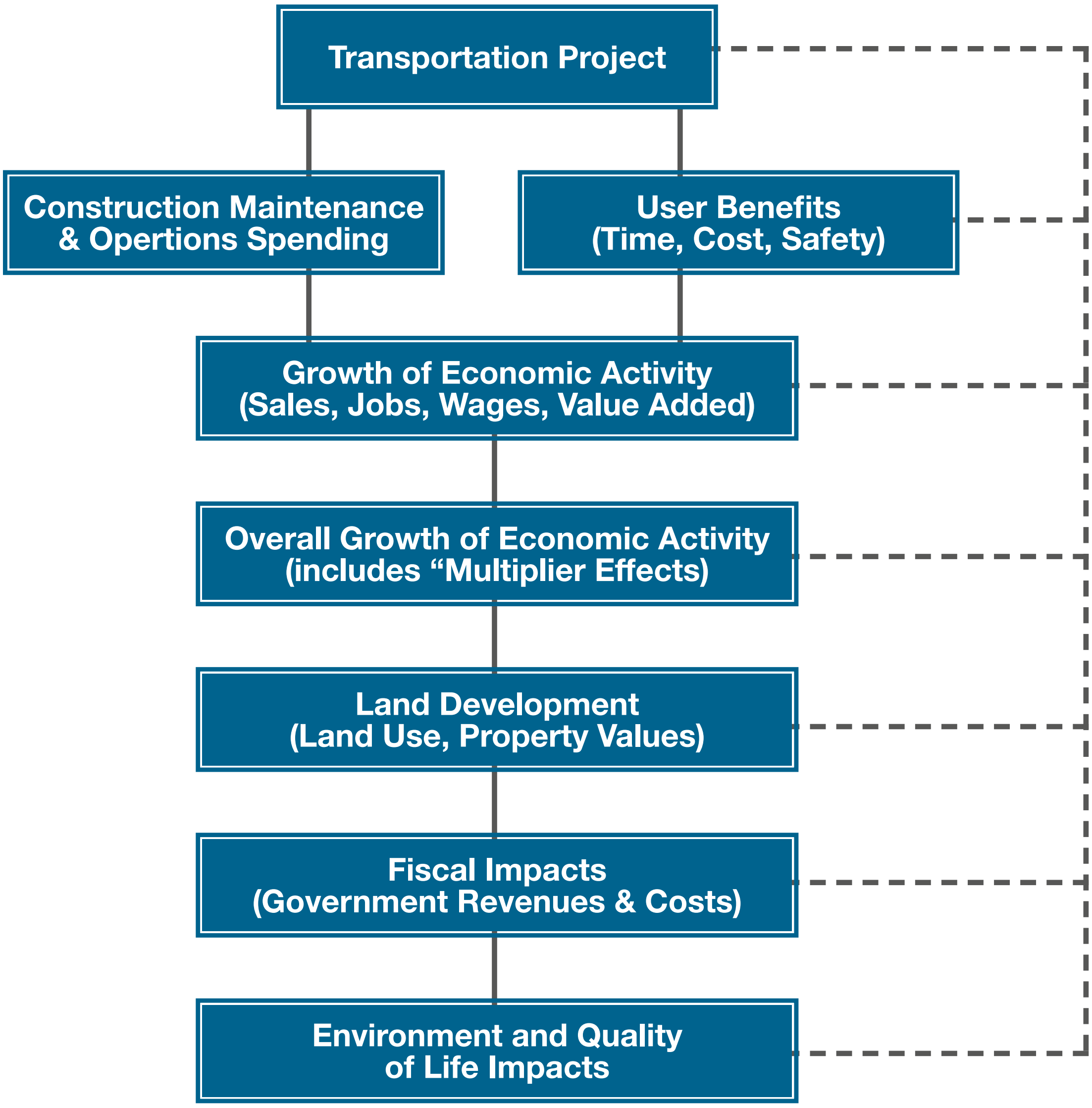
Process and Calculation

The funding applicant would address both the qualitative and quantitative parameters outlined in Table 2.1.

Note: The quantitative benchmarks ("transport measurements") for ARTAG could be identified within the eventual adoption of the updated National Guidelines for Transport System Management.

An applicant would have the option of providing their own set of calculations, but these would be subject to review by the body responsible for assessing project applications. Scoring would be conducted by the body responsible for assessing project applications.

Figure 2.2 Economic Impacts of Transport Projects (Multiple Account Evaluation Approach)



Source: City of Hamilton, 2009

Table 2.1 Economic Impacts Measurements for ARTAG

Category	Description	Indicators	Qualitative/ Quantitative	Scale of Impact
Direct Financial and Economic Impacts	Financial and economic impacts arising from the project	Capital costs	Quantitative	Limited to corridor of operation
		Annual operating budget and maintenance costs	Quantitative	Limited to corridor of operation
		Passenger revenue	Quantitative	Limited to corridor of operation
		Direct employment in operating the system	Quantitative	City/Region wide
		Private sector investment in consulting	Quantitative	City/Region wide
		Private sector investment in construction surrounding project	Quantitative	City/Region wide
		Disruption to business during construction and implementation	Both	Limited to corridor of operation
		Delivery access	Both	Limited to corridor of operation
		Permanent loss of access	Both	Limited to corridor of operation
		Impact on local retail sales	Both	Limited to corridor of operation
		General tourism impacts	Both	City/Region wide
		Impact on hotel/hospitality stays	Both	Limited to corridor of operation
		Connections to other modes in region	Both	Limited to corridor of operation
		Potential for public and private partnerships	Qualitative	City/Region wide

Source: Developed by the BIC, modified from City of Hamilton 2009

Category	Description	Indicators	Qualitative/ Quantitative	Scale of Impact
User Benefit (Economic Impacts)	Personal costs, user experience and reliability of services, impacts on transport accessibility, parking	Savings from not owning a private vehicle	Quantitative	City/Region wide
		Savings from not operating a private vehicle	Quantitative	City/Region wide
		Difference between parking and public transport costs	Quantitative	Limited to corridor of operation
		Average wait time for service	Quantitative	Limited to corridor of operation
		Reliability of service	Quantitative	Limited to corridor of operation
		Average travel time by mode	Quantitative	Limited to corridor of operation
		Customer satisfaction	Quantitative	Limited to corridor of operation
		Percentage of stops and stations which are wheelchair accessible	Quantitative	Limited to corridor of operation
		Density or number of major institutional destinations (e.g. hospitals, universities)	Both	Limited to corridor of operation
		Density or number of major cultural, retail and entertainment destinations	Both	Limited to corridor of operation
		Change in total passenger capacity (private vehicle added with public transport) in corridor of operation	Both	Limited to corridor of operation
		Average pedestrian wait time at intersections	Both	Limited to corridor of operation
		Non-motorised transport severance effects created by project	Quantitative	Limited to corridor of operation
		Connections with other modes of public transport and other rapid transit lines	Both	Limited to corridor of operation
		Connection to pedestrian and bike facilities	Both	Limited to corridor of operation
		Change in publicly owned on and off-street parking	Both	Limited to corridor of operation

Category	Description	Indicators	Qualitative/ Quantitative	Scale of Impact
Land Use (Economic Impacts)	Improvements to property values, diversification and improved efficiency of land uses and policies	Land value (adjacent to and surrounding stations)	Both	Limited to corridor of operation
		Change in land rates collected adjacent to and surrounding system	Both	Limited to corridor of operation
		Developable vacant land	Quantitative	Limited to corridor of operation
		Growth in non-residential density	Quantitative	Limited to corridor of operation
		Growth in residential density	Quantitative	Limited to corridor of operation
		Development charges	Quantitative	Limited to corridor of operation
		Compatibility with national, state and local land use and transport policies and strategies	Qualitative	National, City/region wide
Environmental Benefit (Economic Impacts)	Emissions reductions and energy use savings	Greenhouse gas emissions	Quantitative	National, City/region wide
		Other emissions (NOx, SOx, particulate matters	Quantitative	National, City/region wide
		Noise	Quantitative	National, City/region wide
		Energy use (fossil fuel, electricity)	Quantitative	National, City/region wide
		Potential for local energy use in project	Quantitative	National, City/region wide
Social and Community Benefits (Economic Impacts)	Improvements in public health, safety and social inclusion arising from the project	Property crime	Qualitative	City/region wide
		Violent crime	Qualitative	City/region wide
		Perception of crime	Qualitative	City/region wide
		Reduced accident risk	Qualitative	City/region wide
		Decreased health care costs from improved air quality	Quantitative	City/region wide
		Changes to transport as a percentage of household expenditure	Quantitative	City/region wide
		Impact on indicators of social need	Both	City/region wide

Source: Developed by the BIC, modified from City of Hamilton 2009

2.2.3 Land Use Impacts

An assessment of land use impacts would comprise 30 per cent of the Project Justification Rating, and 12 per cent of the Final Project Rating. Having already incorporated an assessment of the land *value* impacts of applications in the Economic Impacts measurements of the ARTAG model this component would focus primarily on changes to land *use* practices and policies arising from a project proposal.

The aim of this component would be to identify the impact on land use decision making, both strategic and long term, arising from a proposed Rapid Transit project and to assess the value of this impact in the context of the Project Justification Rating.

The intent behind this approach is to ensure the retention of space for future Rapid Transit development and the immediate and long term improvement of the corridor or area of operation in the location proposed for the Rapid Transit project. A further aim is to ensure that Rapid Transit systems are designed to interrelate with, and positively shape, ongoing urban growth rather than being built in the hope of engendering it.

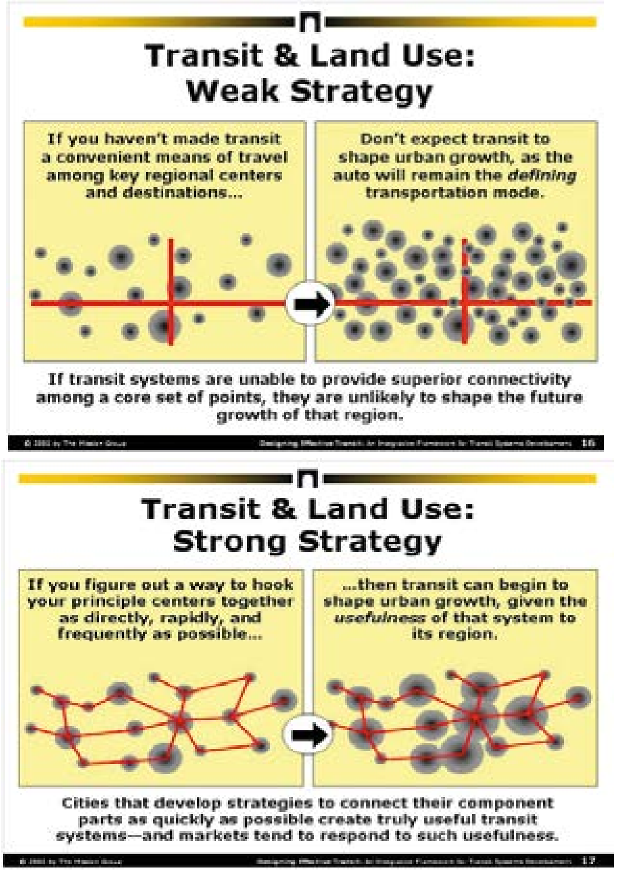
There is a trend in Australian Rapid Transit project development of placing urban and land development expectations on systems rather than designing systems to improve and expand existing growth; the ACT and Hobart Light Rail project proposals are examples of this trend. In their 2012 Legislative Assembly election campaign materials on Light Rail, the ACT Greens made the following claim:

> *"Building light rail tracks to suburbs before they are developed is advantageous because it is a fraction of the cost of retrofitting, and new suburbs are able to develop around the fixed light rail route."*[46]

Good principles for assessing land use impacts from Rapid Transit, as proposed in ARTAG, can avoid incidences of Rapid Transit systems becoming "trains to nowhere." Figure 2.3 provides a visual representation of the desired interrelationship between Rapid Transit and land use by comparing weak and strong strategies. This form of assessment is used to ensure that Rapid Transit is a flow on effect of the indicators of economic development and need for mass transit (population growth, commercial growth, congestion, land development, land use variation, etc.) being present in an area prior to its construction. This is a combined quantitative and qualitative assessment of potential outcomes and as such benchmarking for delineation within the component is a relatively difficult task.

46 ACT Greens, 2012, *"ACT Greens 2012 Election Initiative - Canberra's Transport Future: Light Rail"*, ACT Greens, Canberra, Australia.

Figure 2.3 Comparison of Weak and Strong Land Use Strategies in Rapid Transit Development



Source: Hensher, 2008

The benchmarks for "Performance of Land Use Polices" and "Potential of Transit Project on Regional Land Use" under the New Starts Program outlined in Table 2.2 can serve as an indicative guide on how to develop a set of qualitative benchmarks for assessing Land Use Impacts. The impact on land use arising from Rapid Transit has been examined in depth by the Federal Transit Administration initially in 1977[47] and more recently through the development of an assessment model for the land use impacts of Bus Rapid Transit.[48] The full set of benchmarks for "Transport Supportive Land Use" from the Federal Transit Administration is available at Appendix D.

47 Knight, R, and Trygg, L, 1977, *"Land Use Impacts of Rapid Transit: Implications of Recent Experience"*, US Department of Transportation – Assistant Secretary for Policy Plans and International Affairs", Washington DC.

48 Perk, V, et al, 2012, *"Land Use Impacts of Bus Rapid Transit: Phase 2 – Effects of Bus Rapid Transit on Property Values along the Boston Silver Line Corridor"*, Federal Transit Administration, Washington DC.

Key elements assessed in land use impacts would be:

- The availability of developable land
- Development which has already occurred within the framework of local and state level land use policies
- Local land use policies
- Regional and State level land use policies (short, medium and long term)
- The interaction between state and national level strategies and local land use policies
- Applications for land use variation in the area proposed for the project
- Applications for development in the area proposed for the project
- Development underway in the area proposed for the project.

Figure 2.4 presents a set of considerations for land use impacts in the ARTAG model, modified from Federal Transit Administration research.

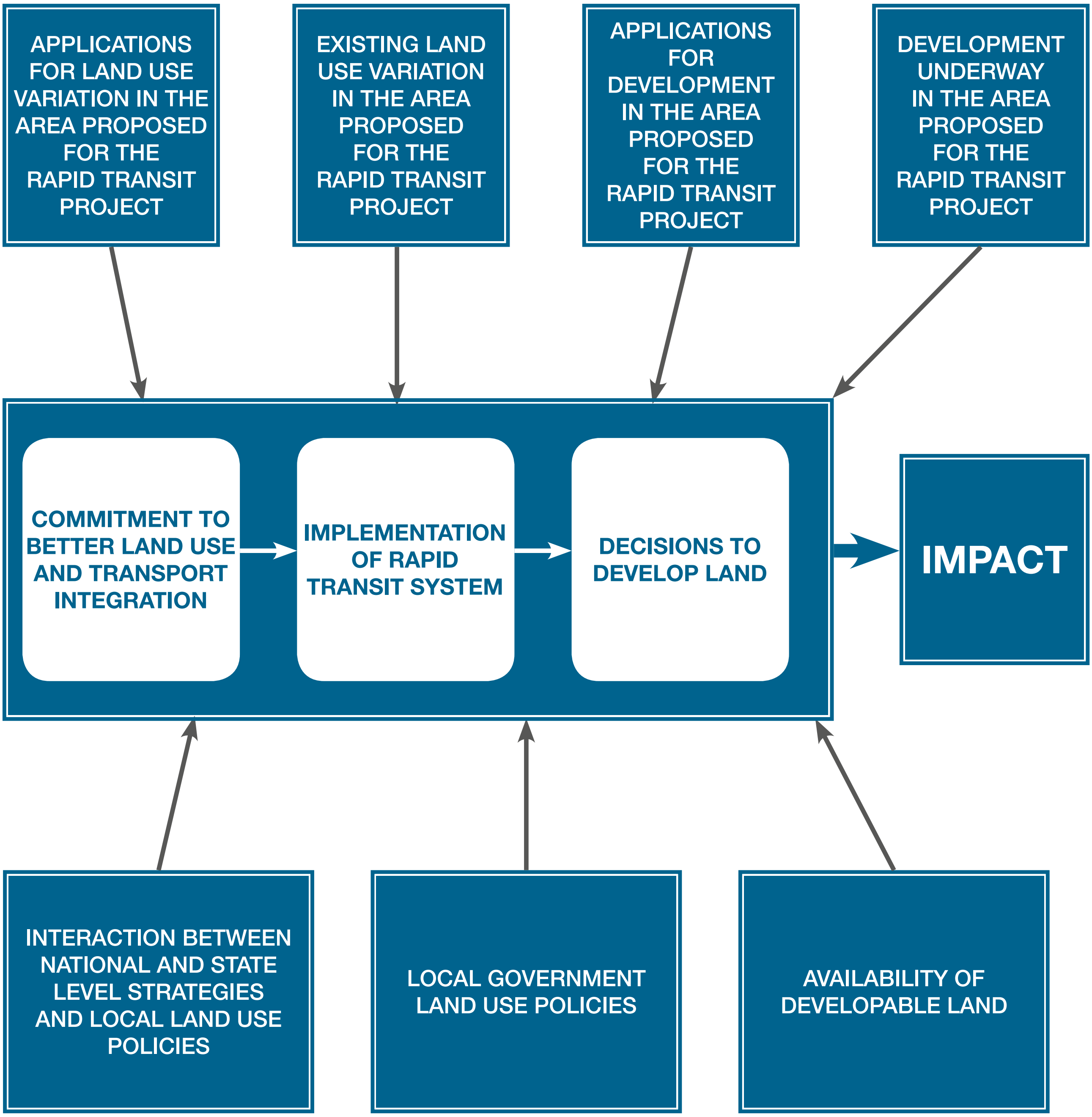
Process and Calculation

The funding applicant would address both the qualitative and quantitative parameters outlined in Figure 2.4.

Note: The quantitative benchmarks ("transport measurements") for ARTAG could be identified within the eventual adoption of the updated National Guidelines for Transport System Management.

An applicant would have the option of providing their own set of calculations, but these would be subject to review by the body responsible for assessing project applications. Scoring would be conducted by the body responsible for assessing project applications.

Figure 2.4 Land Use Impact Considerations



Source: BIC (modified from Federal Transit Administration model, 1977)

Table 2.2 Benchmarks for Performance of Land Use Policies under New Starts Program

Performance of Land Use Policies		
Full Funding Grant Agreement	Score Ratings	Description
The adjacent Ratings are based on assessment of the following: • Demonstrated cases of development affected by transit-oriented policies • Station area development proposals and status	HIGH	A significant number of development proposals are being received for transit-supportive housing and employment in station areas. Significant amounts of transit-supportive development have occurred in other, existing transit corridors and station areas in the region.
	MEDIUM	Some development proposals are being received for transit-supportive housing and employment in station areas. Moderate amounts of transit-supportive development have occurred in other existing transit corridors and station areas in the region.
	LOW	A limited number of proposals for transit-supportive housing and employment development in the corridor are being received. Other existing transit corridors and station areas in the region lack significant examples of transit-supportive housing and employment development.
Engineering	HIGH	Transit-supportive housing and employment development is occurring in the corridor. Significant amounts of transit-supportive development have occurred in other, existing transit corridors and station areas in the region.
	MEDIUM	Station locations have not been established with finality, and therefore, development would not be expected. Moderate amounts of transit-supportive housing and employment development have occurred in other, existing transit corridors and station areas in the region.
	LOW	Other existing transit corridors and station areas in the region lack significant examples of transit-supportive housing and employment development.

Potential of Transit Project on Regional Land Use		
Engineering and Full Funding Grant Agreement	Score Ratings	Description
	HIGH	A significant amount of land in station areas is available for new development or redevelopment at transit-supportive densities. Local plans, policies, and development programs, as well as real estate market conditions, strongly support such development.
	MEDIUM	A moderate amount of land in station areas is available for new development or redevelopment at transit-supportive densities. Local plans, policies, and development programs, as well as real estate market conditions, moderately support such development.
	LOW	Only a modest amount of land in station areas is available for new development or redevelopment. Local plans, policies, and development programs, as well as real estate market conditions, provide marginal support for new development in station areas.




2.2.4 User Impacts

An assessment of user impacts would comprise 20 per cent of the Project Justification Rating and 8 per cent of the Final Project Rating.

The ARTAG model has already incorporated an assessment of the value of user impacts of a proposed project in the economic impacts measurements through:

- User Benefit (Economic Impacts)
- Social and Community Benefits (Economic Impacts)

These two elements brought together are factored into the economic impact component of the Project Justification Rating. The user impacts component would focus on a modified version of the two elements to place additional value on the end user impacts of a project. This overlap is intended to capture the crossover between economic value and end user value and from a policy making perspective encourage a focus on the end user impacts of Rapid Transit in project design. This focus on end user impacts is particularly important in the success of Rapid Transit projects attracting patronage.

There is a potential for a disconnect between the values identified as driving demand for Rapid Transit at a policy making level and the values that actually drive patronage from an end user perspective. In the Australian context there is a tendency for an overemphasis on the quantitative elements driving patronage, for example travel time savings, at the expense of elements which are valued far more highly by users of the system, for example station comfort and safety.

An incorporation of these more qualitative user impact considerations into ARTAG affords adaptability in the development of Rapid Transit projects to accommodate differences in public transport end user expectations based on a range of factors including the location of the proposed project. For example a Rapid Transit project designed for an area with low levels of frequency and low quality of existing public transport services might place an emphasis on frequency and ride comfort over travel time savings for users. A level of flexibility to adapt for different circumstances needs to be built into the assessment model.

The user impacts component will also incorporate an assessment of the value of a proposed project in serving the needs of users who are most reliant on public transport for mobility. In the proposed Federal Transit Administration model for assessment this falls under the "Mobility Improvements" criteria.

The final set of measurements for user impacts in ARTAG are outlined in Table 2.3, and as discussed previously the benchmarks and calculations for these measurements would need to be nationally agreed.

Process and Calculation

The funding applicant would address both the qualitative and quantitative parameters outlined in Table 2.3.

Note: The quantitative benchmarks ("transport measurements") for ARTAG could be identified within the eventual adoption of the updated National Guidelines for Transport System Management.

An applicant would have the option of providing their own set of calculations, but these would be subject to review by the body responsible for assessing project applications. Scoring would be conducted by the body responsible for assessing project applications.

Table 2.3 User Impacts Measurements for ARTAG

Measurement	Description
Travel Cost Savings Per User	Savings to end users in cost of transport and transport expenditure as a factor in household expenditure
Travel Time Savings Per User	Travel time savings to existing users, travel time savings to new users shifting to other modes, impacts (benefits and disbenefits) on other modes in area of operation
Improvements to Service	Improvements to reliability, quality and frequency of service, impact on user perceptions
Improvements to Public Health and Safety	Improvements to public health and safety from proposed project and impact on user perceptions.
Improvements to Mobility and Social Inclusion	Improvements to mobility and social inclusion from proposed project and impact on user perceptions.

Source: BIC, 2013

	Elements	Qualitative/Quantitative
	Savings from reduced car use	Quantitative
	Savings from elimination of car ownership	
	Savings from elimination of second car ownership	
	Difference between parking and public transport costs	
	Changes to transport as a percentage of household expenditure	
	Change in publicly owned on and off-street parking	
	Travel time by mode compared to pre existing travel times in area of operation	Quantitative
	Changes to frequency of service	Both
	Changes to average wait time for service	
	Change in customer expectations of quality	
	Change in customer expectations of reliability	
	Change in passenger capacity in area of operation	
	Connections to other modes of public transport	
	Transfer times between modes (if applicable)	
	Connection to pedestrian and bike facilities	
	Changes to perceived risk of property crime in station areas	Both
	Changes to perceived risk of violent crime in station areas	
	Changes to active travel (walking/cycling) intent in areas of operation	
	Reduction in traffic accidents in areas of operation	
	Decreased health care costs from reduced air pollution	
	Decreased health care costs from increased activity	
	Transit dependent persons in area of operation	Both
	Changes to perceived mobility/public transport accessibility in areas of operation	
	Changes to perceived accessibility to essential, commercial and cultural destinations in area of operation	
	Impact on indicators of social inclusion in areas of operation	

Case Study – New Start Assessment of the Euclid Corridor Transportation Project (ECTP)

The Euclid Corridor Transportation Project (ECTP) is an approximate 13 kilometre Bus Rapid Transit system visited by the BIC during the Rapid Transit Study Visit of North America.

The design for the project includes almost 4 kilometres of bus-oriented street improvements in a "transit zone" within downtown Cleveland.

The project was developed and is now operated by Greater Cleveland Regional Transit Authority (GCRTA).

The Bus Rapid Transit component of the project operates as the *HealthLine* after the purchase of naming rights by a consortium of the Cleveland Clinic and University Hospitals, two major health care institutions in the Euclid corridor.

The Bus Rapid Transit component of the project extends from Public Square in downtown Cleveland eastward on Euclid Avenue through the University Circle area to its terminus at the Stokes rapid transit station in East Cleveland.

The Bus Rapid Transit component provides exclusive mid-street lanes for Bus Rapid Transit vehicles and other transit buses. This segment includes 35 Bus Rapid Transit stations at 21 locations (28 stations are directional pairs at 14 cross-street locations). Stations have substantial structures with a distinctive design, off-board fare equipment, static schedule information, dedicated lighting, planters, and other amenities.

Bus Rapid Transit vehicles have signal priority at traffic intersections.

The design and construction of the Bus Rapid Transit component of the project resulted in the rebuild of the street and sidewalks in areas of operation.

Information gathered by the BIC during the Rapid Transit Study Visit of North America indicates the following special features on the system:

- A combined bus/rail patronage 200,000 per day
- A significant economic development benefit estimated at more than $4 billion.

The following is the assessment undertaken by the Federal Transit Administration US (FTA) of the project application under parameters for the New Starts Program at the time of application. A more detailed description of the "before and after" impacts of the project can be found in a case study in chapter 4 of this report.

Description

The GCRTA is proposing to design and construct a 9.8 mile transit corridor incorporating exclusive bus rapid transit lanes and related capital improvements on Euclid Avenue from Public Square in downtown Cleveland east to University Circle. The proposed project is known as the ECTP. The ECTP incorporates a series of transit improvements including an exclusive centre median busway along Euclid Avenue from Public Square to University Circle, improvements to East 17th/East 18th Streets, as well as a Transit Zone on St. Clair and Superior Avenues utilising exclusive transit lanes. The proposed busway will provide service to the University Circle area and continue into the City of East Cleveland, terminating at the Stokes/Windermere Rapid Transit Station. GCRTA proposes to operate sixty-foot articulated electric trolley buses (ETB) with both left and right-hand side doors for access and egress of patrons in the corridor. The ETBs will have access to the entire length of the Euclid corridor. However, conventional buses will not be able to access Euclid Avenue in the Central Business District (CBD). Total capital costs for the ECTP are estimated at $228.6 million (escalated dollars). GCRTA estimates that 29,500 average weekday boardings will use the ECTP in the forecast year (2025).

The proposed Transit Zone will be bounded by Superior Avenue, St. Clair Avenue, West 3rd Street and East 18th Street. The improvements to E. 17th/E. 18th Streets are anticipated to facilitate traffic flows into and out of the Transit Zone that will also function as north/south arterial roads connecting Euclid Avenue to St. Clair/Superior Avenues. E. 17th Street will be limited to transit and local auto traffic north of Euclid Avenue. E. 17th Street will also be extended from Prospect Avenue one block south for buses only. E. 18th Street will carry auto traffic only between the inner belt and the northern edge of the CBD.

FTA ASSESSMENT OF EUCLID CORRIDOR TRANSPORTATION PROJECT	
Proposed Project:	Bus Rapid Transit Lanes (7.34 miles – exclusive, 2.43 miles – mixed traffic) and related capital improvements
Total Capital Cost ($YOE):	$228.6 million
Section 5309 New Starts Share ($YOE):	$135.0 million
Annual Operating Cost ($YOE):	$1.3 million
Ridership Forecast (2025):	29,500 avg. weekday boardings 2,400 daily new riders
FY 2002 Financial Rating:	Medium-High
FY 2002 Project Justification Rating:	Medium
FY 2002 Overall Project Rating:	Recommended

The Recommended Rating is based on the project's strong transit supportive land use qualities and the strength of the project's capital and operating plans. The overall project rating applies to this Annual New Starts Report and reflects conditions as of November 2000. Project evaluation is an ongoing process. As New Starts projects proceed through development, the estimates of costs, benefits, and impacts are refined. The FTA ratings and recommendations will be updated annually to reflect new information, changing conditions, and refined financing plans.

Status

Section 3035 of Intermodal Surface Transport Efficiency Act (ISTEA) authorised FTA to enter into a multiyear grant agreement for development of the Dual Hub Corridor, originally considered as a rail link between downtown and University Circle. In November 1995, the GCRTA Board of Trustees selected the ECTP as the Locally Preferred Alternative (LPA), which included a busway and the rehabilitation and relocation of several existing rapid rail stations. In December 1995, the Northeast Ohio Areawide Coordinating Agency (local metropolitan planning organisation) adopted a resolution supporting the ECTP. In mid-1999, GCRTA reconfigured the scope of the ECTP to incorporate only the construction of a busway along Euclid Avenue. The rapid rail elements have been eliminated from the ECTP proposal for Section 5309 New Starts funding. The environmental review process for the ECTP is scheduled for completion in Summer 2001.

Section 3030(a)(17) of TEA-21 authorised the "Euclid Corridor Extension" for final design and construction. Through FY 2001, Congress has appropriated $13.44 million in Section 5309 New Starts funds for the ECTP. Of this amount, $4.72 million was rescinded or reprogrammed by Congress.

Evaluation

The following criteria have been estimated in conformance with FTA's *Technical Guidance on Section 5309 New Starts Criteria*. With concurrence from FTA, a comparison to a Transport Systems Management alternative was not completed. N/A indicates that data are not available for a specific measure. FTA has evaluated this project as being in preliminary engineering. The project will be re-evaluated when it is ready to advance to final design and for next year's Annual Report on New Starts.

Justification

The *Medium* project justification rating reflects the strength of the transit-supportive land use element and the anticipated travel time savings benefits associated with the project. The rating also acknowledges ECTP's relatively poor cost-effectiveness in terms of new riders.

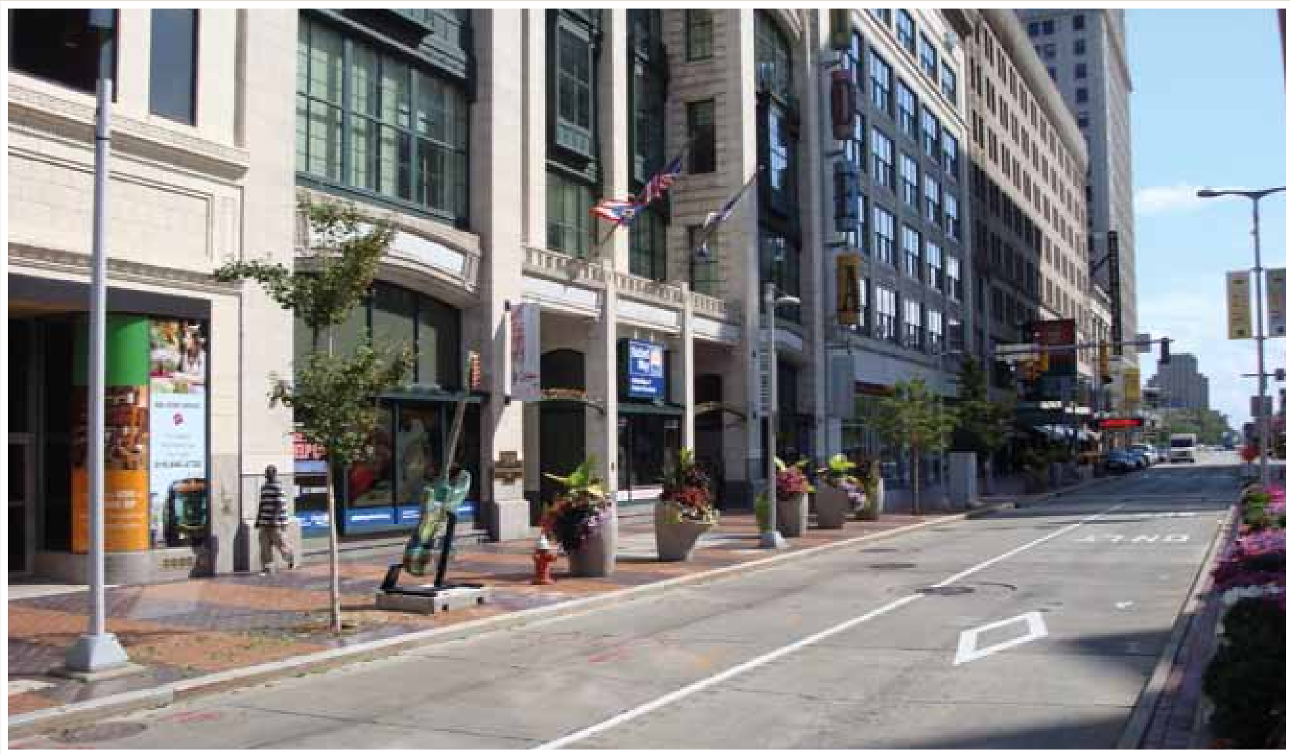
Mobility Improvements

Rating: Medium-High

GCRTA estimates 29,500 average weekday boardings, including 2,400 daily new riders, on the ECTP busway in 2025. GCRTA estimates the following annual travel time savings for the ECTP:

Mobility Improvements	New Start vs. No-Build	New Start vs. TSM
Annual Travel Time Savings (Hours)	1.0 million	N/A

Based on 1990 census data, there are an estimated 12,406 low-income households within a ½ mile radius of the 22 proposed stations. This represents 55 percent of the total households within a ½ mile radius of the proposed stations.



The Euclid Corridor Transportation Project in Cleveland

Rapid Transit Elements: rebuild of the street and pathways to be visually attractive with plants and street art (guitars)

The Cleveland Healthline Bus Rapid Transit

Rapid Transit Name: derived from a consortium of the Cleveland Clinic and University Hospitals located on the Euclid Corridor

Environmental Benefits

Rating: Medium

Cleveland is currently classified as a maintenance non-attainment area for ozone and a moderate non-attainment area for particulate matter (PM10). GCRTA estimates the following emission reductions for the ECTP as compared to the No-Build alternative.

Criteria Pollutant	New Start vs. No-Build	New Start vs. TSM
Carbon Monoxide (CO)	71	N/A
Nitrogen Oxide (NO_x)	23	N/A
Volatile Organic Compounds (VOC)	19	N/A
Particulate Matter (PM_{10})	1	N/A
Carbon Dioxide (CO_2)	8,481	N/A
Values reflect annual tons of emission reductions.		

GCRTA estimates that the ECTP will result in the following decrease in regional energy consumption (measured in British Thermal Units – BTUs) compared to the No-Build alternative.

Annual Energy Savings	New Start vs. No-Build	New Start vs. TSM
BTU (millions)	76,146	N/A

Operating Efficiencies

Rating: Medium

GCRTA estimates the following system wide operating costs per passenger mile in the year 2025 for the New Start compared to the No-Build alternative:

Annual Energy Savings	New Start vs. No-Build	New Start vs. TSM
BTU (millions)	76,146	N/A
Values reflect annual BTU reductions.		

Cost Effectiveness

Rating: Low

GCRTA estimates the following cost effectiveness index:

	New Start vs. No-Build	New Start vs. TSM
Incremental Cost per Incremental Passenger	$26.90	N/A
Values reflect 2025 ridership forecast and YOE dollars.		

Transit Supportive Existing Land Use and Future Patterns

Rating: Medium-High

The *Medium-High* land use rating reflects the strong existing land use and high trip generators in the Euclid Avenue Corridor, as well as transit-supportive policies within the Cleveland CBD and much of the remainder of the corridor.

Existing Conditions: The downtown area adjacent to Euclid Avenue includes high-density commercial uses (office and retail), a theatre district, the campus of Cleveland State University, and a professional sports complex. Several institutional and cultural uses are located in the University circle area, including Case Western Reserve University, the Cleveland Clinic Foundation, and four museums. MidTown, located between the CBD and University Circle, is characterised by underutilised commercial and industrial land. Multi-family and single-family housing – situated on a grid street pattern – is located one to two blocks away from Euclid Avenue throughout most of the corridor. In 1995, total employment in the Cleveland CBD was approximately 120,000, while total employment in the corridor as a whole (a one-half mile radius of the busway) was estimated at 207,000. Corridor population was estimated at 41,000. In addition, evidence of a reversal of previous downward population and employment trends is supported by recent increases in residential development in the Cleveland CBD and two corridor neighbourhoods, and by commercial redevelopment in the MidTown area.

Future Plans and Policies: A wide range of city, small area and institutional plans have been developed that focus on promoting redevelopment and on creating a more pedestrian-friendly, transit-oriented environment in the CBD and the Euclid Corridor. The city, including the MidTown area, also has a strong network of local development corporations and business organisations that act in partnership with the public sector in promoting redevelopment. Cleveland's 1990 comprehensive plan calls fore rezoning of the corridor to convert industrial areas to office uses and to allow mixed-use activities. Zoning will be revised following an update of the comprehensive plan, which is now underway. Conceptual plans have been developed for some neighbourhoods, with demonstrated examples of redevelopment activities that are consistent with these plans. Institutional plans also stress creating a more pedestrian-friendly environment and increasing institutional-related development in specific areas. Planning activities specific to the ECTP also been undertaken. These include an economic development plan for the corridor, street design guidelines, and *Transit-Supportive Principles and Development Guidelines* that specify guidelines for transit-supportive building design and placement. At a regional level, some recent efforts are being demonstrated that support reinvestment in fully developed communities and existing infrastructure.

Other Factors

The FTA Bus Rapid Transit Demonstration Program: In August 1999, the Cleveland ECTP was selected as one of FTA's ten Bus Rapid Transit Demonstration Projects. FTA's Bus Rapid Transit Demonstration Program is intended to foster the development of Bus Rapid Transit systems in the United States; address Bus Rapid Transit planning, implementation, and operational issues; and evaluate system performance in a wide range of operating environments.

Local Financial Commitment

> Proposed Non-Section 5309 Share of Total Project Costs: 41%

> The financial plan for the proposed ECTP includes

> $135 million (59 percent) in Section 5309 New Starts funds, $50 million (22 percent) in Flexible funds and $43.6 million (19 percent) in GCRTA and City of Cleveland funds.

Stability and Reliability of Capital Financing Plan

Rating: Medium-High

The *Medium-High* rating reflects the sound financial condition of GCRTA and the State of Ohio's financial commitment to the ECTP. The rating also acknowledges FTA's determination that GCRTA should re-evaluate the methodology that was used to develop the capital cost estimates for the project to ensure that adequate contingencies are in place to cover any unanticipated cost overruns associated with the project.

Agency Capital Financial Condition: The GCRTA is in good financial condition and is currently paying down debt incurred earlier in the 1990s to build the existing Waterfront Light Rail extension project. In addition, the agency's major funding source (sales tax revenues) continues to grow at a faster than estimated rate solidifying the agency's strong financial condition. GCRTA maintains a well-managed re-capitalisation program for the agency's bus fleet. According to GCRTA's bus fleet management plan, the average of the agency's buses is 7.9 years.

Capital Cost Estimates and Contingencies: Based upon FTA's review of the methodology that was used to develop the capital cost estimates for the ECTP, FTA has determined that GCRTA should re-evaluate the current capital cost estimate to ensure that adequate escalation rates and contingency factors are in place to account for any unanticipated cost overruns associated with the planned procurement of the dual-mode electric trolley vehicles.

Existing and Committed Funding: At this time, 100 percent ($93.6 million) of the non-Section 5309 New Starts share has been committed to the ECTP via the Ohio Department of Transportation's Transportation Review Advisory Commission, the City of Cleveland and GCRTA. The City and GCRTA have executed an interagency agreement that outlines the City's financial contribution ($17 million) to the ECTP.

New and Proposed Sources: Only existing sources are proposed for the construction of the ECTP.

Stability and Reliability of Operating Finance Plan

Rating: Medium-High

The *Medium-High* rating reflects the healthy operating condition of GCRTA. Revenues to operate the proposed ECTP are considered strong.

Agency Operating Condition: The GCRTA has managed to fully fund the operations of its existing system during a period of expansion. In 1997, ridership increased by four percent over 1996. Both bus and rail ridership increased for the first time since 1990. The increased ridership is attributed to special events in downtown Cleveland and a generally improved regional economy. Sales tax revenues rose by five percent on average per year between 1988 and 1997. GCRTA estimates annual increases of three percent beginning in the year 2000.

Operating Cost Estimates and Contingencies: Annual operating and maintenance costs - estimated at $1.3 million (escalated dollars) - are considered reasonable. However, it should be noted that while the proposed project replaces existing bus service along Euclid Avenue with ETB's, the increased operation and maintenance costs associated with the ETBs is anticipated to be covered by existing sources.

Existing and Committed Funding: All proposed operating revenues for the ECTP are existing and committed to the project. The operating plan for the ECTP projects an operating surplus of $12 million in the project's opening year (2004). Assumptions included in the 20-year cash flow analysis are based on historic funding levels and growth rates that appear to be reasonable. These funds are considered stable and reliable.

New and Proposed Sources: All proposed operating revenues currently exists. No new sources are needed.

LOCALLY PROPOSED FINANCING PLAN (Reported in $YOE)		
Proposed Source of Funds	Total Funding ($million)	Appropriations to Date
Federal:		
Section 5309 New Starts	$135.0	($13.44 million appropriated through FY 2001. $4.72 million rescinded or reprogrammed).
State:		
Flexible Funds	$50.0	
Local:		
GCRTA	$26.6	
City of Cleveland	$17.0	
TOTAL	$228.6	
NOTE: Funding proposal reflects assumptions made by project sponsors, and are not Department of Transportation (DOT) or FTA assumptions. Totals may not add due to rounding.		

three

Rapid Transit Demand Drivers and User Benefits

Chapter 3: Rapid Transit Demand Drivers and User Benefits

3.1 Introduction

This Chapter examines factors impacting on patronage of rapid transit systems and the benefits to public transport users from the development of Rapid Transit and presents a case study from the Metro Los Angeles Rapid Transit system, which was visited during the BIC's Rapid Transit Study Visit of North America.

3.2 Patronage Impacts of Rapid Transit

3.2.1 Literature in This Area

There is a wealth of data available on the factors influencing the patronage of public transport systems and specifically Rapid Transit systems. This section explores the literature regarding patronage of Rapid Transit, and summarises the available research of these factors into their core principles.

There are a number of studies, both international and Australian, which have examined the drivers of patronage on public transport systems. In their review of the literature, across a range of studies, on the factors affecting public transport patronage UCLA researchers Taylor and Fink (2002) identify the factors influencing patronage on public transport broadly into internal and external factors.[49]

According to Taylor and Fink external factors can be broadly categorised as:

> **Socio economic factors** relate to variables such as:

- Employment levels in the area of study
- Income levels in the area of study
- The cost of parking and pricing strategies to limit demand for parking
- Car ownership levels in the area of study.

> **Spatial factors** relate to the relationship between public transport, the existing urban form and land use planning in the areas of study. Key spatial elements in public transport patronage identified across the studies include:

- The availability of parking in the area of study
- Residential density in the area of study
- Employment density in the area of study.

> **Public finance** factors are identified as the level of subsidy provided to the users of the system. This was found across a number of studies to have an impact on the patronage of public transport, with a feedback loop being created where increased patronage attracted increased subsidies.[50]

External factors identified in the study as influencing public transport patronage were:

- Pricing factors
- Service quantity factors
- Service quality factors.

Pricing factors related to the cost of using and operating public transport include:

- Fares
- Revenue vehicle hours
- Discounting/concession fares available.

Service quantity factors relate to the frequency and availability of services include:

- Geographic coverage of services
- Frequency of services
- Span of hours of operation of services.

Service quality factors include:

- Customer service
- Station safety
- On-board safety
- Information available to users.

In their analysis of the Ottawa Transpo system, a Rapid Transit system visited on the BIC's Rapid Transit Study Visit of North America, Syed and Khan (2000) found the following factors affected ridership in order of importance, one being the most important:[51]

49 Taylor, B, and Fink, C, 2002, *"The Factors Influencing Transit Ridership: A Review and Analysis of the Ridership Literature"*, UCLA Department of Urban Planning Working Paper, UCLA Institute of Transportation Studies.

50 Ibid.,^

51 Syed, S and Khan, A, 2000, *"Factor Analysis for the Determinants of Public Transit Ridership", Journal of Public Transportation 3(3), 1-17.*

1. Bus information
2. On-street service
3. Station safety
4. Customer service
5. Safety en-route
6. Reductions in fare
7. Cleanliness
8. General attitudes towards transit.

In *Understanding Ridership Drivers for Bus Rapid Transit Systems in Australia*, Currie and Delbosc (2010) examine the patronage effects of constructing and operating Bus Rapid Transit in Australian environments.

This research examined the design features of Bus Rapid Transit that might influence patronage on Rapid Transit; it is one of the few available studies which look specifically at the patronage drivers of Rapid Transit as opposed to public transport.

In the literature review the key drivers of public transport patronage across a range of sources were found to be:

> High service levels
> High density residential development
> Low car ownership
> Low fares
> Modal integration
> Ticket integration
> Reliable service.

Table 3.1 outlines the research demonstrating the relationship between these factors and public transport patronage.

In total the study looked at 33 conventional bus routes and 44 Bus Rapid Transit routes in Brisbane, Sydney, Melbourne and Adelaide.

The researchers concluded that:[52]

> *"…the quantity of service supplied is the most important driver of ridership regardless of the quality of the BRT (or conventional bus) infrastructure… The implication of the above factors is that bus services should operate at high frequency and with lots of service quantity, using modern low floor accessible vehicles in areas of high population density to achieve higher ridership."*

While the study stopped short of implying that patronage benefits could be achieved without the large scale infrastructure investment required for Rapid Transit, this was a significant point for consideration raised by the results.

This conclusion supports the Rapid Transit Study Visit of North America that across the range of Road Based Rapid Transit solutions available, there is scope to deliver improved ridership without the large scale investment required from full Bus Rapid Transit or Light Rail systems. This is reflected in the findings and recommendations in this report.

A recent study from the University of Sydney *Drivers of Bus Rapid Transit Systems – Influences on Ridership and Service Frequency* (Hensher, et al. 2012) brought together the results of three studies into the patronage drivers of Bus Rapid Transit across 12 countries and 121 systems.[53] This study is also included in a full presentation from Professor Hensher in 2013 which is included as Appendix E in this report. The researchers identified some core variables across the three studies as influencing patronage on Rapid Transit systems, specifically Bus Rapid Transit. The research identified consistently important influences on patronage across all three studies, these were:[54]

> The average fare
> Service frequency
> Station spacing
> Pre-board fare collection
> Location of doors.

There was also study-specific evidence supporting a number of other features such as:[55]

> Vehicle capacity
> Modal integration
> Network integration
> Corridor length.

Table 3.2 maps the similarities and differences in findings across the three studies. These findings correspond

52 Currie, G, and Delbosc, A, 2010, *"Understanding Ridership Drivers for Bus Rapid Transit Systems in Australia"*, Institute of Transport, Monash University, Victoria, Australia.

53 Hensher, D, Mulley, C and Li, Z, 2012, *"Drivers of Bus Rapid Transit Systems – Influences on Ridership and Service Frequency"*, Institute of Transport and Logistics Studies, University of Sydney, Australia.
54 Ibid., ^
55 Ibid., ^

approximately with other research into the drivers of patronage on Rapid Transit systems and the findings of the Rapid Transit Study Visit of North America. It is useful to note that throughout the review of literature there were similarities between the principles underlying the drivers of patronage on existing public transport systems and Rapid Transit systems. A set of core elements underlying patronage growth on Rapid Transit systems has been identified; these are discussed in section 3.2.2 of this report.

3.2.2 Core Elements Underlying Patronage on Rapid Transit

Based on a review of aggregate studies investigating the drivers of patronage on both conventional public transport systems and Rapid Transit systems, a set of core elements and the scale of their impact in driving patronage on Rapid Transit are mapped in Table 3.3.

It is important to note that a diminishing returns principle does apply to individual elements in terms of driving patronage. The value of a single element diminishes in relative terms as it becomes more prevalent. If, for example, a service is run at low frequencies, it is likely that service frequency will be placed at a higher value than other elements; once a service is delivered in high frequencies coverage may become the number one priority for improvement.

Table 3.1 Previously Identified Route Level Public Transport Drivers

Identified Driver	Research Source
High service levels	(Stopher 1992) (Fitzroy and Smith 1998) (Currie and Wallis 2008) (Mackett and Babalik-Sutcliffe 2003) (Kain and Liu 1999)
High density residential development	(Johnson 2003) (Seskin and Cervero 1996b) (Babalik-Sutcliffe 2002) (Kain and Liu 1999) (Kain et al. 2004)
Low car ownership	(Babalik-Sutcliffe 2002) (Mackett and Babalik-Sutcliffe 2003)
Low fares	(Mackett and Babalik-Sutcliffe 2003) (Kain and Liu 1999)
Modal integration	(Mackett and Babalik-Sutcliffe 2003) (Kain et al. 2004)
Ticket integration	(Mackett and Babalik-Sutcliffe 2003)
Reliable service	(Mackett and Babalik-Sutcliffe 2003)

Source: Currie and Delbosc, 2010

Table 3.2 Accumulated Evidence on Key Drivers of Bus Rapid Transit Patronage

Hensher, Li and Mulley (2012)	Hensher and Golob (2008)	Hensher and Li (2012)
Maximum fare	Average fare trip	Average fare trip
Service frequency	Peak headway	Headway
Car mode share	Trunk vehicle capacity	Average distance between stations divided by population density
Number of Bus Rapid Transit stations interacted with extension of segregated flow lanes	Number of stations	Number of trunk corridors
Pre-board fare collection		Pre-board fare collection and fare verification
Doorways for passengers on left and right hand side of the bus		Doorways located on median and curbside
Longitudinal location of with-flow bus lanes on sides		Existence of an integrated network of routes and corridors
		Modal and integration at stations
		Total length of Bus Rapid Transit corridors
		Opening year relative to 2011
		Quality control/oversight from an independent entity/agency
		Location of Bus Rapid Transit

Source: Hensher, Mulley and Li (2012)

Table 3.3.Core Elements Underlying Patronage on Rapid Transit

Element	Description	Impact
Service Frequency	Scheduled frequency of service along routes of operation. At optimal levels during peak this means an effective "timetable free" frequency, for example a bus every five minutes on a Bus Rapid Transit system. This creates an intuitive understanding amongst users of the availability of transport and can feed into perceptions of service convenience and quality.	HIGH
Service Coverage	Geographical coverage of the service and span of hours of operation. Span of hours in particular can influence user perceptions of service quality.	HIGH
Service Quality	Customer service levels, user perceptions of safety on board vehicles and user perceptions of safety and amenity while waiting at stations influence the ability of Rapid Transit systems to attract new passengers. Ride comfort can relate to the use of new vehicles with modern design and engineering for improved comfort on Rapid Transit systems.	HIGH to MEDIUM
Service Information	The availability of information on services and timetables to users also plays a role in perception of service quality and the ability of this element to influence patronage. As highlighted previously, the adoption of a timetable free system on Rapid Transit systems will improve the perception of service quality.	HIGH TO MEDIUM
Residential Density	Residential densities and population in the areas of operation. Indicative densities required before the construction of Rapid Transit systems are encompassed in the ARTAG model.	MEDIUM
Employment Density	Prevalence of commercial property in the areas of operation. Indicative densities required before the construction of Rapid Transit systems are encompassed in the ARTAG model.	MEDIUM
Service Cost	Fares, relative cost of service to other modes.	MEDIUM TO LOW
Travel Time Savings	Door to door ride time for passengers and improvements relative to pre-existing forms of public transport and competing modes of transport including walking, cycling and cars.	MEDIUM TO LOW

Source: BIC, 2013, aggregated from literature

Case Study Metro Los Angeles – Factors Influencing Ridership and User Perceptions of Rapid Transit

Introduction

The Metro Los Angeles Rapid Transit system integrates a number of Rapid Transit modes into a network.

The BIC visited the Metro Los Angeles Rapid Transit network in its Rapid Transit Study Visit of North America. The integrated nature of the Metro Los Angeles Rapid Transit network along with a similarly integrated network in Cleveland strongly indicated that Rapid Transit can operate in a metropolitan area and that there is a need for an integrative rather than competitive approach between Rapid Transit modes.

This integrated Rapid Transit network also presents an opportunity to identify the differences between the performance of various Rapid Transit modes within an integrated network and the user experience of these modes. In its project evaluation of the Metro Orange Line Bus Rapid Transit component of the Metro Los Angeles Rapid Transit, the Federal Transit Administration (FTA) identifies the following components as integral to the network:[56]

- Metro Local is the conventional bus service that operates throughout the city. Buses are distinguished by their bright orange color or an orange stripe. Weekday boardings in 2008 averaged 1,153,758
- Metro Rapid (Bus Rapid Transit-Lite) represents the lower-investment approach to Bus Rapid Transit that typically runs in mixed traffic, using relatively low-cost applications such as traffic signalling priority, intersection queue jumps, headway-based schedules, and far-side stops to provide improved commercial speeds and reliability. The Metro Rapid consists of a 450 mile network of routes throughout the city, has a unified brand identity and enhanced stops with lighting, canopies, and real-time information. In 2008, average weekday boardings for the 25 Rapid lines operated by Metro were estimated at 242,000
- Metro Orange Line (Full Bus Rapid Transit) operates on an exclusive busway, representing the high end of the Bus Rapid Transit investment and performance spectrum. The Orange Line averaged 23,352 weekday boardings in 2008
- Metro Silver Line is a new element of the Metro Los Angeles Rapid Transit network. The Silver Line, a Bus Rapid Transit system, began operation in 2009 and runs on High Occupancy Vehicle Lanes on two highways totalling 26.8 miles (approximately 43 kilometres) The Silver Line operates on a single flat fare of US$2.45 and has experienced a 70 per cent patronage increase from 2009 to 2012 with average weekday boardings at 11,000.
- Metro Blue Line (Light Rail) serves 22 stations and traverses much of the densely populated area through South Los Angeles, Watts, Willowbrook, Compton, and Long Beach, which includes some of the most economically-deprived areas of the city. The average weekday boardings for 2008 was 75,564
- Metro Gold Line (Light Rail) spans 13.7 miles from downtown Los Angeles to eastern Pasadena, adjacent to the heavily-congested Pasadena and Foothill freeways. Weekday boardings in 2008 averaged 20,514
- Metro Red Line (Heavy Rail) operates solely underground and provides high-speed service to the city's most densely populated areas. Weekday boardings in 2008 averaged 134,665, making it the busiest rail line in Los Angeles.

Factors Influencing Ridership and Perceptions

In 2007/08 the National Bus Rapid Transit Institute (NRBTI) conducted a series of focus group studies in to the Metro Los Angeles Rapid Transit network with an attitudinal survey of 2,400 transit users and non-users.[57] Research was undertaken in Los Angeles due to the range of different Rapid Transit modes in the area.

Approximately 400 respondents from each of the six identified transit modes were sampled for the attitudinal survey, as were 400 non-transit users. Due to the geographically disparate nature of the greater Los Angeles area, and as a consequence the latent need for different types of Rapid Transit service amongst the survey group, a rating of each service from 1 (very poor) to 5 (very good) was used as a proxy measurement for ridership attraction rather than direct usage data.

56 Flynn, J et al, 2011, *"Metro Orange Line Project Evaluation"*, National Bus Rapid Transit Institute," Centre for Urban Transportation Research, University of South Florida, United States.

57 Ibid.,^

Following the conduct of the focus groups, user perceptions were separated into tangible and intangible variable groups and then synthesised into 14 core variables that were incorporated into the attitudinal survey.

These variables were then given scores from 1 (very poor) to 5 (very good) and ratings developed from the results. On the basis of this data Table 3.4 shows the variables, their ratings out of a possible total of five and their rankings relative to other variables.

The rankings of variables are roughly concordant with other research in the area as outlined in section 3.1. The five most important factors in ridership as identified in this study were:

- Reliability of service
- Frequency of service
- Safety while riding the system
- Hours of service (span of hours)
- Safety at the station.

In presenting their findings the NBRTI established four tiers of user perceptions of different services in the Metro Los Angeles network. These were:

- Tier 1: Local bus service (mean overall rating of 3.70)
- Tier 2: Metro Rapid Bus Rapid Transit and Blue Line Light Rail (mean overall ratings of 4.01 and 3.98, respectively)
- Tier 3: Orange Line Bus Rapid Transit and Gold Line Light Rail (mean overall ratings of 4.08 and 4.06, respectively)
- Tier 4: Red Line Heavy Rail (mean overall rating of 4.18)

While these ratings demonstrated a difference in user perceptions of different services in the Metro Los Angeles network, the disparity in ratings was not necessarily modally based. For example the Orange Line Bus Rapid Transit systems scored higher than the Blue and Gold Line Light Rail systems.[58] The ratings attributed to the individual systems within the Metro Los Angeles network were averaged across the variables and then juxtaposed against the capital costs of building the systems, see Figure 3.1.

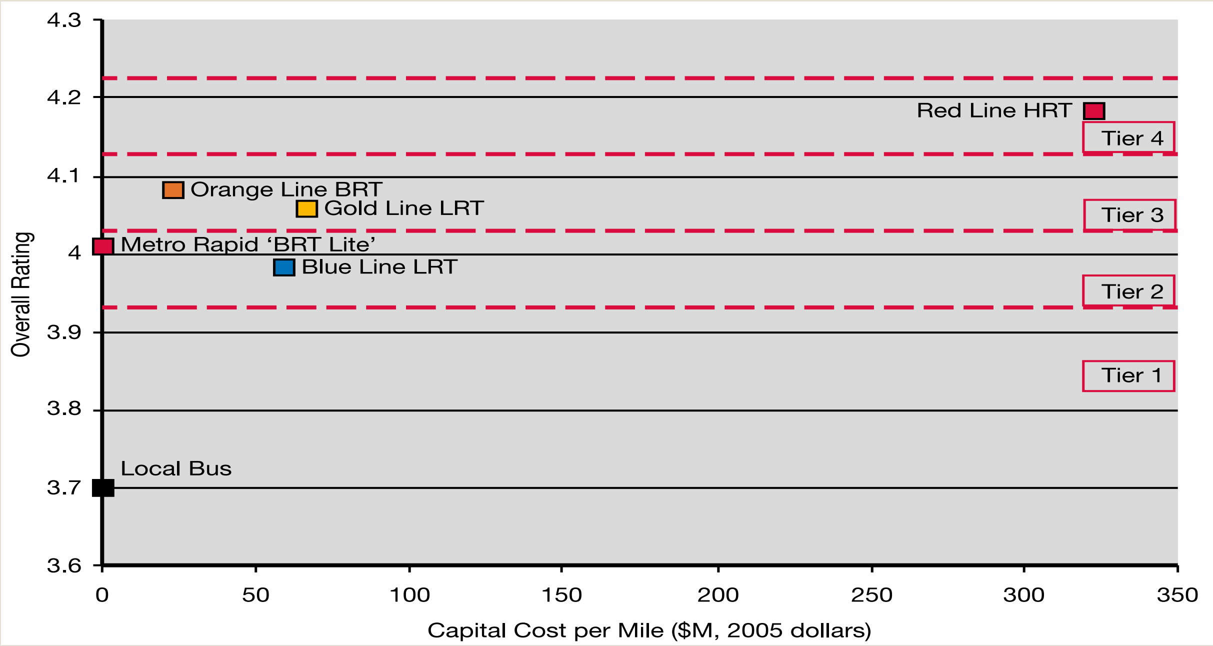
58 Flynn, J et al, 2011, *"Metro Orange Line Project Evaluation"*, National Bus Rapid Transit Institute, Centre for Urban Transportation Research, University of South Florida, United States.

Table 3.4 Tangible and Intangible Variables Affecting User Perceptions of Rapid Transit

Tangible Variables	Rating	Ranking	Intangible Variables	Rating	Ranking
Travel cost – transit fares, plus related costs like parking	4.25	9	Safety while riding the service – safety from accidents and/or crime.	4.50	3
Door to door travel time	4.21	10	Comfort while riding – seats available, temperature, smooth ride, cleanliness, etc.	4.21	10
Frequency of service	4.51	2	Safety at the station/stop – safety from accidents and crime.	4.42	5
Convenience of service	4.41	6	Customer service – provided by drivers and other transit service staff.	4.14	11
Reliability of service	4.53	1	Ease of service – clear service info, routes are legible, timetables easy to understand etc.	4.39	7
Hours of Service (Span of Hours)	4.44	4	Other riders – feeling secure/at ease/ compatible with other riders on the service.	3.96	13
			Avoidance of stress/cost of car use – traffic, parking, accidents, tickets etc.	4.27	8
			Stop comfort – Station amenities and comfort of waiting facilities.	4.05	12

Source: NBRTI, 2009, modified by the BIC

Figure 3.1 User Rating of Metro Los Angeles Rapid Transit Systems against Capital Costs



Source: NBRTI, 2009

Cost versus Quality

What Figure 3.1 and the findings of this study demonstrated is that the ratings achieved by different Rapid Transit services within the Metro Los Angeles Rapid Transit network did not directly correspond to investment levels.

For Tiers 2 and 3, both the Metro Rapid "Bus Rapid Transit Lite" and Orange Line "Full Bus Rapid Transit" achieved higher ratings than the Light Rail systems within the same tier. The study found the Metro Rapid achieved a rating equivalent to the Blue Line Light Rail for a fraction of the investment cost per mile ($0.355 million versus $59.1 million per mile).

The Orange Line Bus Rapid Transit achieved an overall rating that was equivalent to the Gold Line Light Rail and significantly higher than the Blue Line Light Rail, for approximately one-third the capital investment. This indicates that the Orange Line also performs well in terms of overall rating achieved per dollar of investment, although not to the dramatic level associated with the Metro Rapid. The findings showed that within the Metro Los Angeles Rapid Transit network full Bus Rapid Transit can replicate both the functionality standards (tangible attributes) and image qualities (intangible attributes) normally associated with the higher-investment Light Rail systems.

The findings also demonstrated that a lower-investment Bus Rapid Transit-Lite service such as the Metro Rapid performed remarkably well in terms of overall rating achieved per investment dollar even in comparison to a Full-Service Bus Rapid Transit system. While the Orange Line Full-Service Bus Rapid Transit scored higher than the Metro Rapid across all measurements (tangible and intangible variables), the key difference between user perceptions of the two services was in the "Station Comfort" variable.[59]

A combined analysis of the findings of this study and the existing literature on factors affecting ridership of Rapid Transit provides a "take home" message for Rapid Transit decision making that end user perceptions of Rapid Transit are less related to modal choice and more related to a set of core principles for providing good public transport services.

In value for money terms a well designed Rapid Transit system which meets user requirements of frequency, reliability, and high quality of service (stations, ride comfort, safety) will attract ridership irrespective of the modal choice and level of investment required to deliver it.

59 Flynn, J et al, 2011, *"Metro Orange Line Project Evaluation"*, National Bus Rapid Transit Institute, Centre for Urban Transportation Research, University of South Florida, United States.

3.3 User Benefits of Rapid Transit

While there is a significant body of research concerning the economic, patronage and mode shift impacts of Rapid Transit systems, the discussion about the user benefits of Rapid Transit specifically is relatively limited. The focus on mode shift impacts in assessing the relationship between Rapid Transit and users presumes that a modal shift to Rapid Transit within a transport network indicates user benefits, such as travel time and travel cost savings, are being derived by users of the Rapid Transit system.

This is undoubtedly the case in systems where there is a significant and sustained growth in patronage and modal shift along the corridor of operation over time, but there are other elements underlying modal shift to Rapid Transit. This section aims to identify the explicit end user benefits of Rapid Transit to assist in the assessment of these benefits where and when Rapid Transit projects are proposed.

The identifiable end user benefits of Rapid Transit as they explored here are:

> Travel time savings to users

> Travel cost savings to users

> Health benefits to users

> Social inclusion benefits to users.

3.3.1 Travel Time Savings from Rapid Transit

Rapid Transit has the potential to significantly reduce door to door travel times for users. The travel time savings from Rapid Transit have an important value as a driver of patronage, but this value at times can be overemphasised because travel time reductions are an easily quantifiable comparative measure between a new Rapid Transit system and pre-existing public transport systems along corridors of operation.

Most importantly data on the value of travel time savings informs the economic benefit and productivity benefit assumptions surrounding Rapid Transit systems, which are crucial to assessing the value of proposed Rapid Transit projects.

3.3.2 Travel Time Savings in Australia

In developing a new model for assessing the secondary benefits of Bus Rapid Transit, Currie and Sarvi (2011) explored a relationship between travel time savings from Rapid Transit systems and modal shift to the Rapid Transit system along the corridors of operation. The data from this study has been extrapolated to produce Table 3.5 which maps the travel time savings achieved on Rapid Transit systems in operation in Australia. The table also includes travel time savings from the Euclid Corridor Transportation Project, which features in this report, as an international comparison.

Table 3.5 Travel Time Savings on Rapid Transit Systems

System	Travel Time (Before)	Travel Time (After)	Travel Time Savings
Adelaide North East Busway	40 minutes	25 minutes	15 minutes saved Saving of 38%
Sydney Liverpool Parramatta Transitway	N/A	N/A	Up to 60 minutes saved Implies a 51% notional saving in run time
Brisbane South East Busway	60 minutes	18 minutes	42 minutes saved Saving of 70%
SmartBus Route 901 Melbourne	57 minutes	43 minutes	14 minutes saved Saving of 25%
SmartBus Route 902 Melbourne	87 minutes	68 minutes	19 minutes saved Saving of 22%
SmartBus Route 903 Melbourne	98 minutes	74 minutes	24 minutes saved Saving of 23%
Transit Link 2 West Lakes Adelaide	47 minutes	38.5 minutes	8.5 minutes saved Saving of 18%
Transit Link 3 Elizabeth Adelaide	71 minutes	62 minutes	9 minutes saved Saving of 12.67%
Transit Link 4 Port Road Adelaide	45 minutes	39.5 minutes	5.5 minutes saved Saving of 12%
Transit Link 5 Grange Adelaide	43 minutes	39.5 minutes	3.5 minutes saved Saving of 8%
Euclid Avenue Cleveland	41 minutes	33 minutes	8 minutes saved Saving of 19.5%

Source: Modified from Currie and Sarvi, 2011

The design and route of operation for Rapid Transit can impact on the travel time savings from the system. In a recent pre-feasibility study into a proposed Northern Beaches Bus Rapid Transit system in Sydney, Transport for NSW identified a set of potential travel time savings based on various designs and routes. These are outlined in Table 3.6. The benefits of achieving travel time savings from Rapid Transit must be weighed against the additional cost of design elements that bring about these savings. The monetised value of travel time savings are explored in the following sections of this report.

Table 3.6 Estimated Travel Time Savings from Northern Beaches Bus Rapid Transit

Route Type	Route Section	Travel Time				
		Without Project	Kerb Median/ Bus Rapid Transit		Bus Tunnel	
		Time	Time	Saving	Time	Saving
All stops	Spit Junction to Wynyard	26	23	-3	23	-3
	Spit Junction to Wynyard (via North Sydney interchange)		27	+1	27	+1
Limited-stops	Mona Vale to Wynyard	74	61	-13	57	-17
	Mona Vale to Wynyard (via North Sydney interchange		67	-7	63	-11
Express	Mona Vale to Wynyard	66	53	-13	49	-17
	Mona Vale to Wynyard (via North Sydney Interchange		59	-7	55	-11
Warringah Road	Narraweena to Skyline	11	8	-3		
	Frenchs Forest to Chatswood East	19	14	-5		

Source: Transport for NSW 2013

3.3.3 The Value of Travel Time Savings

The monetised Value of Travel Time Savings is incorporated into the ARTAG assessment criteria for Rapid Transit projects. This section explores Australian analyses of the Value of Travel Time Savings and its relevance as a factor in economic impact evaluation of infrastructure projects. Value of Travel Time Savings is a major factor in existing project evaluations, particularly road project evaluations with estimates in the region of 70 per cent of overall benefits.[60] The National Guidelines for Transport System Management in Australia (Australian Transport Council, 2006) outlines a set of values for travel time relating to urban transport including Bus and Light Rail services. The Guidelines prescribe a set of values for in-vehicle time for public transport modes which define the ratio between generalised costs and generalised times. A monetised Value of Travel Time Savings can be inferred from these default in-vehicle time values. The methodology is outlined in the Guidelines. The values are summarised in Table 3.7.

Table 3.7 Standard Value Travel Time Saving for Public Transport Users by Mode (per hour in 2006 dollar terms)

	All ($/hr)	Peak ($/hr)	Off-Peak ($/hr)
Bus	8.80	9.35	8.25
Rail/Light Rail	10.25	11.20	9.30
Ferry	11.80	12.90	10.70

Source: Australian Transport Council, 2006

3.3.4 Future Research into Rapid Transit Travel Time Savings

There is no definitive data on the Value of Travel Time Savings of constructing Rapid Transit as either a new public transport system on a corridor or on an improvement to an existing one. There exists an opportunity for research to be undertaken into this area with the following parameters considered:

- Comparative Value of Travel Time Savings of Rapid Transit versus pre-existing forms of public transport in corridors and areas of

60 Roberts, L et al., 1997,*"The Value of Travel Time Savings"*, Austroads, Sydney, Australia.

operation

- Value of Travel Time Savings of modal shift to Rapid Transit from other modes to the end user
- Value of Travel Time Savings of modal shift to Rapid Transit from other modes to other road users and public transport system users.

The data from this research could form a valuable element of an assessment model for Rapid Transit projects.

3.3.5 Travel Cost Savings from Rapid Transit

Travel cost savings from public transport use relate specifically to the savings to commuters from reductions in Vehicle Kilometres Travelled (VKT) by car and from reductions in the ancillary costs of driving such as parking fees, driving fines and accident costs.

In its assessment of the benefits of using public transport for work related travel, the Western Australian Government identified travel cost savings across a range of assumptions including vehicle size, distance travelled, fuel costs and parking costs.

Table 3.8 outlines travel cost savings for work trips from using public transport by distance travelled. The assumptions used in the cost model are shown.

Table 3.8 Travel to Work Savings from Public Transport*

Distance Travelled to Work	Savings from Commuting by Public Transport
25km	$1,409 - $4,574
20km	$1,280 - $4,444
15km	$1,155 - $4,320
10km	$716 - $3,881
5km	$693 - $3,858

Source: Modified from Transperth, 2011

*Calculated using Transperth Savings and Emissions Calculator and Royal Automobile Club Vehicle Running Costs Guide 2011. Based on medium sized car, fuel at $1.40/L, car parking at $5/day or $18.70/day (average commuter parking in Perth CBD) for 231 working days/ year and Transperth SmartRider Autoload fares.

Transperth produces a cost savings calculator for commuters which provides sensitivities to a range of variables. This is available online at the link provided in the footnote below.[61]

The specific travel cost savings benefit from modal shift to Rapid Transit are harder to quantify and less explored in the available literature than the overall benefit to users and non-users of public transport. In their research into the *Cost/Benefit Analysis of Converting a Lane for Bus Rapid Transit-Phase II Evaluation and Methodology* (2011) Ang-Olson et al examined the benefits and losses that accrued to users and non-users from the conversion of an arterial lane of traffic into a Bus Rapid Transit system with a 40,000 daily person throughput.

Under their model the benefits to users of the Bus Rapid Transit system outweighed the losses to car users by a factor of 3.5. The research did not, however, attribute a specific value to travel cost savings from modal shift to the Bus Rapid Transit though the accident cost savings identified from such a measure were estimated at US $425,733 in 2009 dollar terms.[62]

61 http://www.transperth.wa.gov.au/TicketsandFares/SavingsandCarbonEmissionsCalculator/tabid/114/Default.aspx
62 Ang-Olsen, J, and Mahendra, A, 2011, *"Cost/Benefit Analysis of Converting a Lane for Bus Rapid Transit-Phase II Evaluation and Methodology"*, Transportation Research Board, Washington DC.

3.3.6 Future Research into Rapid Transit Travel Cost Savings

The paucity of data into the specific travel cost savings from Rapid Transit presents an opportunity for future research in the area with a focus on the following parameters:

- Travel cost savings to existing users of the public transport system
- Travel cost savings to users of other modes who shift onto the Rapid Transit system
- Travel cost savings or increases to users of other modes in the corridors or areas of operation of the Rapid Transit system.

3.3.7 Health Benefits from Public Transport

The available data on the health benefits of public and active travel have been explored in a range of Australian and international studies.

This section will explore the available research on the health benefits of Rapid Transit where possible and in lieu of significant research in this area will also highlight the identified benefits of public transport in general.

A very comprehensive analysis of the health benefits of public transport was undertaken by Todd Litman of the Victoria Policy Institute in *Evaluating Public Transportation Health Benefits* (2010) a research paper undertaken for the American Public Transportation Association. Litman identifies the following factors interrelating public transport and public health benefits:[63]

- Reductions in traffic accidents and casualties
- Reductions in emissions and pollutions related health costs
- Changes to urban design encouraging mode active travel (walking and cycling) producing health benefits from increased activity
- Increased mobility and access to opportunity
- Increased affordability.

The analysis of these health benefits against their impacts on public transport are presented in Table 3.8 which has been extrapolated from Litman's work.

63 Litman, T, 2010, *"Evaluating Public Transportation Health Benefits"*, Victoria Policy Institute for the American Public Transportation Association.

Table 3.8 Health Benefits and Impacts on Public Transport

Health Benefit	Description	Public Transport Impact
Traffic safety	Reduced traffic crash injuries, disabilities and deaths	Significant reductions in per capita injuries and deaths, particularly if total vehicle travel is reduced
Pollution Reduction	Reduced exposure to harmful air, water and noise pollution	Generally reduces emissions per passenger-mile and per capita, particularly if public transport uses alternative fuels or state-of-the-art emission controls
Physical fitness	Increased physical activity by walking and cycling	Since most transit trips involve walking or cycling links, and transit oriented development improves non motorised conditions, improvements to public transport tend to increase fitness.
Mental health	Reduced emotional stress	High quality public transport and transit oriented development can reduce emotional stresses and improve access to economic, social and recreational opportunities
Affordability	Reduced financial burdens, particularly for lower income households	Public transit and transit-oriented development can reduce transportation costs, which leaves money to purchase housing, healthy food and medical care
Basic mobility	Ability for people to access essential goods and services	Public transit and transit-oriented development provide basic mobility and accessibility

Source: BIC, 2013, modified from Litman, 2010

Crucially Litman identifies "high quality" public transport and the transit oriented development that comes with it as key factors in the modal shift to public transport required to maximise the health benefits from public transport.

> *"As service quality improves and communities become more transit oriented, residents tend to own fewer vehicles, drive less and rely more on alternative modes (walking, cycling and public transit) than they otherwise would."*[64]

In the context of Rapid Transit this corroborates the idea that there is a virtuous circle created by the service quality and end user perception improvements generated by Rapid Transit which in turn lead to greater benefits derived from the system due to patronage growth.

The ARTAG model captures the need for integration between a proposed Rapid Transit project and the development and improvement of land surrounding the area of operation through the "economic impacts" and "land use impacts" measurements. The ARTAG model aims to shift the causality of land development, land improvement and strategic land use planning towards being a pre-condition of Rapid Transit construction rather than an outcome of it.

3.3.8 Health Benefits from Rapid Transit

Litman (2010) also identifies a monetised value for the health benefits produced by high quality public transport systems (see Table 3.9) this data reiterates the need for Rapid Transit infrastructure development to be accompanied, or predated by, improvements to land use and to be integrated with the development surrounding its area of operation.

There is a quantifiable difference between "Good Transit" constituting Rail Based Rapid Transit and Road Based Rapid Transit projects and "Transit Oriented Development" which incorporates land improvement and development considerations into project planning. Litman demonstrates that Transit Oriented Development provides a higher return of benefits than Rapid Transit alone. This difference is only quantified in the context of the health benefits produced by Rapid Transit.

Further research is required into the monetised value of social benefits such as improvements to public health and safety and social inclusion, produced by Rapid Transit systems, which are included in the "user impacts" assessment of the ARTAG model.

In estimating the impact of Light Rail on health care costs Stokes et al. (2008) confirmed Litman's analysis and found that:

> *"…When people choose Rapid Transit over the use of single occupancy vehicles, they walk an average of 30 min more a day than those who drive their car."*[65]

An explanation offered for this outcome is a slightly larger distance between stops, which encouraged more walking and the connectivity of the system which encouraged a higher modal shift to Rapid Transit.[66]

64 Litman, T, 2010, *"Evaluating Public Transportation Health Benefits"*, Victoria Policy Institute for the American Public Transportation Association.

65 Stokes, J, et al, 2008, *"Estimating the Effects of Light Rail Transit on Health Care Costs"*, Health and Place, 14, 45–58.

66 Ibid.,^

Table 3.9 Comparison of Estimated Health Benefits from Rapid Transit and Rapid Transit Integrated with Land Use

	Base Case Typical North American public transport service quality	Good Transit High quality Rail Based Rapid Transit and Road Based Rapid Transit systems	Transit Oriented Development Rapid Transit, with walkable mixed use development around stations
Per Capita Annual Mileage	Annual Miles Per Capita		
Automobile travel	7953	4847	3577
Travel on public transport	100	658	958
Walking	100	249	443
Cycling	35	61	83
Change from Base Case	Annual Miles Per Capita		
Automobile travel	Base case	-2,485	-3,501
Travel on public transport	Base case	447	687
Walking	Base case	119	274
Cycling	Base case	21	39
Annual Monetised benefits	Annual Dollars ($US) Per Capita		
Crash reduction	Base case	$276.89	$378.30
Emission reduction	Base case	$16.70	$23.49
Walking health benefit	Base case	$57.29	$131.57
Cycling health benefit	Base case	$3.99	$7.32
Total health benefits		$354.86	$540.68

Source: Modified from Litman, 2010

3.3.9 Social Inclusion Benefits to Users

Social inclusion often features as a benefit in applications for investment into Rapid Transit projects. A recent example comes through the ACT Government's (2008) proposal to Infrastructure Australia for funding a Light Rail corridor of 12kms, which is branded as the Capital Metro Project.

> *"Light rail would provide better transport accessibility for Canberrans, particularly those who currently have poor transport access. Transport plays a key role in keeping communities connected, in ensuring that people have access to employment, education and cultural facilities. Conversely poor transport links can result in isolation, unemployment, poor quality of life and increasing inequality."*[67]

The Capital Metro Light Rail is predicted to service 7,500 commuters during the morning peak by 2031.[68] Based on these figures the attribution of social inclusion benefits of the Capital Metro to the entire population of the ACT may be unwarranted. There is little explanation or quantification of the specific social inclusion benefits that a Rapid Transit system might provide ahead of a significant improvement in the span and frequency of existing public transport (particularly bus) services.

A more considered examination of the social inclusion impacts of various modes of Rapid Transit suggests that Rail Based Rapid Transit in particular can elicit perverse social inclusion outcomes. A "First Principles" assessment of Light Rail conducted for the University of Leeds suggests that a high cost Light Rail system

67 Territory and Municipal Services, 2008, *"ACT Light Rail: Proposal to Infrastructure Australia"*, ACT Government, Canberra Australia.

68 Minister for the Environment and Sustainable Development for the Australian Capital Territory, 2013, *"Notice Paper of Thursday February 2013: Legislative Assembly Question", Act Government Hansard.*

servicing a specific area could produce "losers" across a network:

> *"They [people with poor access to public transport] will win if they live in an area served by light rail, but if they do not and there is less funding for other alternatives to the car, they are likely to lose."*[69]

In addition there are equity concerns produced by Light Rail which might negate transport accessibility benefits, particularly relating to low income travellers. These relate particularly to the gentrification of housing in the areas that surround the routes of operation and stations in a Light Rail development.

A comparison of 1981 to 2006 census areas where Vancouver SkyTrain stations are located found "a rising disparity of income levels between wealthier and poorer residents [and] ... an increasing level of high educational achievement of residents and a relative decline of less-educated residents in comparison to Vancouver CMA's trends." The research showed that over time, wealthier residents moved to areas once home to lower-earning, less-educated occupants. The construction of relatively high cost new housing near transit stations resulted in the displacement of the working poor, students, and low income seniors and likely reduced their ability to access public transport.[70]

The inclusion of low income housing development in the "Mobility Improvements" measurement developed by the Federal Transit Administration for New Starts funding aims to counteract this natural tendency of Rail Based Rapid Transit to gentrify areas that it is developed in.

Road Based Rapid Transit due to its wider range of service types and flexibility of operation can uplift the community and social inclusion value of an entire public transport network.

An Australian example of a bus service that can enhance social inclusion is the Smart Bus network in Melbourne which features in this report. While no explicit research has been undertaken into the social inclusion benefits of the Smart Bus network the growth in patronage coupled with the routes of operation, connecting outer suburbs in orbital and radial routes suggests this type of Road Based Rapid Transit system could enhance accessibility to employment opportunities and social activities and enhance social inclusion across the entire network.

Examples of Bus Rapid Transit systems delivering positive social inclusion outcomes are found primarily where they are built in developing countries.

The International Association for Public Transport (UITP) identifies the Curitiba system in Brazil as an example of Bus Rapid Transit enhancing social inclusion:

> *"The Bus Rapid Transit system of Curitiba (Brazil) has received international recognition and is often considered as a leading example worldwide. The metropolitan area of Curitiba has 2.95 million inhabitants and a transport system based on bus services. It has a single fare for the entire metropolitan area. This type of integrated planning has been the main success factor in the development of a transport network which takes social inclusion into account."*[71]

3.3.10 Future Research into the Social Benefits of Rapid Transit

Future research in this area might focus on the value of Rapid Transit trips using a model outlined by Stanley et al. (2011) in *Social Exclusion and the Value of Mobility*. The model factors in variables and data items such as wellbeing measures, sense of community and contact with members of family to assess the risk of individuals being socially excluded, and as a corollary the social inclusion value of higher levels of mobility.

The research found a lowered risk of social exclusion was related to higher rates of connection with community, household income, realised mobility and personal growth. The value of additional trips, for an individual with two or more social exclusion risk factors, was found to be AUS$20 using this model.[72]

It would be valuable in the context of assessing applications for Rapid Transit investment to determine whether this value is less, equal or greater for Rapid Transit systems due to the different nature of design, mode and location generally found in Rapid Transit projects. An evaluation of the social inclusion benefits of the Smart Bus network in Victoria would be a useful case study.

69 Wayland, S, 2011, *"The Impact of Light Rail Transit on Low Income Households"*, Accessible online at: http://www.raisethehammer.org/article/1479/

70 Ibid., ^

71 Wright, L, and Hook, W, 2007, *"Bus Rapid Transit Planning Guide", Institute for Transportation Development and Policy, New York.*

72 Stanley, J, Hensher, D.A, Stanley, Janet, Currie, G, Greene, W.H. and Vella-Brodrick, D, 2011, *"Social Exclusion and the Value of Mobility"*, Journal of Transport Economics and Policy, 45 (2), 197-222

3.4 Mode Shift Impacts from Rapid Transit

3.4.1 Introduction

While earlier sections of this report have explored the relationship between Rapid Transit and drivers of public transport patronage, this section looks specifically at evidence of modal shift from other modes of transport to Rapid Transit generated by the construction of Rapid Transit systems. There is a significant amount of research demonstrating the modal shift impacts of both Bus Rapid Transit and Light Rail systems. This section looks at Australian and international examples across both Road and Rail Based Rapid Transit modes.

3.4.2 Mode Shift Impacts of Rail and Road Based Rapid Transit

The relative scale of modal shift from Rail Based Rapid Transit is often cited as a key difference between the Light Rail and Bus Rapid Transit as a modal choice.

There are, however, elements that impact on the initial phase of operation for Rapid Transit systems that produce an initial uplift in patronage and mode share, which can create a false impression that a Rail Based Rapid Transit system is producing end user benefits that Road Based Rapid Transit cannot.

3.4.3 Transport Demand Elasticity

The elasticity of transport demand is an important factor in identifying the drivers of mode shift from cars to public transport services. While there is no similar mapping of Rapid Transit specifically, it can serve a similar function in identifying the drivers of modal shift to Rapid Transit from cars and pre-existing forms of public transport.

The most comprehensive analysis of transport demand elasticity available in the literature was produced by Litman (2013) in *Understanding Transport Demand and Elasticities.* The study summarises factors affecting transport demand in to six core areas:[73]

> Demographics

> Commercial Activity

> Transport Options

> Land Use

> Demand Management

> Prices

These factors and their constituent elements are outlined in Table 3.10.

73 Litman, T, 2013, *"Understanding Transport Demand and Elasticities"*, Victoria Transport Institute, Canada.

Table 3.10 Factors that Affect Transport Demand

Demographics	Commercial Activity	Transport Options	Land Use	Demand Management	Prices
Number of people (residents, employers and visitors)	Number of jobs	Walking	Density	Road use prioritisation	Fuel prices and taxes
Employment rate	Business activity	Cycling	Mix	Pricing reforms	Vehicle taxes and fees
Wealth/Incomes	Freight transport	Public transit	Walkability	Parking management	Road tolls
Age/lifestyle	Tourist activity	Ridesharing	Connectivity	User information	Parking fees
Lifestyles		Automobile	Transit service proximity	Promotion campaigns	Vehicle insurance
Preferences		Taxi services	Roadway design		Transit fares
		Telework			
		Delivery services			

Source: Litman, 2013

A key focus in the research into transport demand elasticities is the impact of pricing including fuel prices, fares for public transport and road taxes. Currie and Phung (2008) undertook research into the fuel price elasticities of public transport modes in the Australian environment, in particular in the city of Melbourne. The research found the values for the fuel price elasticity of demand for bus system services in Melbourne was not statistically significant. This was due primarily to the high rate of non car ownership amongst users of both forms of transport.

In considering these factors and how they feed into demand for Rapid Transit services the land use factors identified by Litman can be considered the most significant, particularly land use in the areas of operation of a Rapid Transit service. This concurs with the observations of delegates on the Rapid Transit Study Visit of North America and other research into the patronage drivers of Rapid Transit presented in this report. While the fuel price elasticity of demand for trams was identified by Currie and Phung to be negligible, the high rate of passengers who previously drove cars on Bus Rapid Transit systems (see Table 3.11) indicates that these systems may possibly be exposed to a higher rate of fuel and price elasticity. This would need to be confirmed by future research.

3.4.4 The Sparks Effect

If other indicators are not measured, The "Sparks Effect" phenomenon can lead to a false impression that increased patronage and mode shift equals end user benefits.

The ARTAG model aims to ensure end user benefits are attributed a distinct set of measurements and a value in scoring project applications. The "Sparks Effect" in its initial usage signified the patronage impact of moving from diesel rail to electrified rail systems. Newman and Kenworthy (1999) identified the "Sparks Effect" as being *"so consistently found that it is frequently built into passenger estimates at about 20 percent over other transit patronage."*[74]

The "Sparks Effect" has been used to argue the patronage and modal shift impacts of Light Rail systems over other modes and is factored into the benefits of Rapid Transit systems; often without full consideration of all modal shift and patronage factors and automatic acceptance of the "Sparks Effect" as a static element. This requires greater analysis when used as a justification to proceed with a Light Rail project. In a recent business case for the Northern Suburbs Light Rail system in Hobart Tasmania, ACIL Tasman calibrated its demand model and the subsequent analysis of benefits flowing from the construction of the Light Rail to include gradations of the "Sparks Effect."

An over-reliance on modal shift and patronage growth data can cloud a genuine assessment of the end user and community benefits produced by a proposed Rapid Transit project.

74 Newman, P, and Kenworthy, J, 1999, *"Sustainability and Cities: Overcoming Automobile Dependence"*, page 158, Island Press.

Evidence from the UK suggests tramways have a modal shift impact from cars of 16% to 20%.[75] This figure is corroborated by the Passenger Transport Executive Group in their analysis on the performance of Light Rail in the UK. The Passenger Transport Executive Group found:[76]

- About 20% of peak hour passengers on UK tram schemes previously travelled by car
- At weekends, up to 50% of tram passengers previously travelled by car
- UK schemes were better at attracting passengers from cars than schemes in other countries, despite operators having less control over other factors, such as competition from buses and traffic management
- Investment in quality bus services in the UK was shown to deliver much lower levels of mode-shift from the car.

In comparison, the Passenger Transport Executive Group report quotes an LEK Consulting report of "Quality Bus" schemes in the UK as engendering only between 4.1-6.1% modal shift from car users.[77] There is, however, data from Bus Rapid Transit systems operating in Australia, Europe, the UK and the US that demonstrates similar mode shift impacts for Light Rail and Bus Rapid Transit systems.

In identifying *A New Model for the Secondary Benefits of Transit Priority,* Currie and Sarvi (2012) analysed the relationship between travel time impacts and mode shift impacts for Bus Rapid Transit systems across continents, with a primary focus on Australian systems in operation.[78] Table 3.11 has been produced from this analysis outlining the mode shift impacts of Bus Rapid Transit in Australia, which includes the percentage of new passengers shifted from car use.

This data demonstrates a similarity between the modal shift impacts of Bus Rapid Transit and the figures produced for the UK Light Rail. The US General Accountability Office in its assessment of the potential modal shift impacts of Bus Rapid Transit, in comparison with Light Rail, found:

> *"…ridership on Bus Rapid Transit and Light Rail systems varies widely and depends, in part, on frequency of service, number of stops, hours of operation, and customer demand."*[79]

This corresponds with the idea that the drivers of patronage on Rapid Transit, regardless of modal consideration are more related to the frequency, coverage, quality and reliability of services than the time travel benefits or speed of travel in areas of operation.

Research indicates that both Light Rail and Bus Rapid Transit can have similar modal shift impacts.

The Euclid Corridor Transportation Project – before and after case study, provides an analysis of the costs and benefits of a Rapid Transit system.

3.4.5 Future Research in Rapid Transit Demand Elasticity

It is proposed that research is undertaken to identify the key factors affecting demand for Rapid Transit in Australian cities. This could be combined with research in to the patronage drivers of Rapid Transit.

75 House of Commons Transport Committee, 2005, *"Integrated Transport: the Future of Light Rail and Modern Trams in the United Kingdom: Government response to the Committee's 10th Report of Session 2004-05"*, UK Government.
76 PTEG, 2005, *"What Light Rail can do for Cities: A Review of the Evidence"*, Passenger Transport Executive Group, Leeds, United Kingdom.
77 Ibid.,^
78 Currie, G, and Sarvi, M, 2012, *"A New Model for the Secondary Benefits of Transit Priority"*, Paper Number 12-0720, submitted for publication and presentation, Transport Research Record.
79 US General Accounting Office, 2001, *"Mass Transit: Bus Rapid Transit Shows Promise"*, Report to Congressional Requesters, Washington DC.

Table 3.11 Bus Rapid Transit Mode Shift Impact Evidence in Australia

System	Mode Shift Impact
Adelaide North East Busway	Ridership Growth = 24% % Passengers that previously drove = 40%
Sydney Liverpool Parramatta Transitway	Ridership Growth = 56% 47% of growth new journeys % Passengers that previously drove = 26%
Brisbane SE Busway Brisbane	Ridership Growth = 56% 17% new journeys % Passengers who previously drove = 26%
SmartBus Route 901 Melbourne	Ridership growth = 42% % Passengers who previously drove = 34%
SmartBus Route 902 Melbourne	Ridership Growth = 47% % Passengers who previously drove 29%
SmartBus Route 903 Melbourne	Ridership Growth = 26% %Passengers who previously drove 21%

Source: Modified from Currie and Sarvi, 2012

Case Study Euclid Corridor Transportation Project: Cleveland, Ohio – Before and After Assessment [80]

Introduction

The Euclid Corridor Transportation Project (ECTP) formed a key element of the BIC's Rapid Transit Study Visit of North America. This case study of the Cleveland *HealthLine* system provided the clearest data on the benefits that accrued to Bus Rapid Transit and highlighted to participants that Bus Rapid Transit can deliver similar benefits to Light Rail.

The Federal Transit Administration (FTA) assessment measures differences between elements in the application for funding by the Greater Cleveland Regional Transit Authority (GCRTA) and the actual outcomes following the delivery of the project. These elements include:

- Capital cost
- Service levels (Transit Service)
- Patronage impacts on the corridor of operation
- Patronage impacts across the network
- Economic development impacts.

Capital Cost

The actual cost of the Euclid Corridor project was $197.2 million in year-of-expenditure (YOE) dollars, including a Full Funding Grant Agreement (FFGA) baseline cost estimate of $168.4 million and $28.8 million in streetscaping elements funded separately as a non-transit project. Aggregate unit cost of the transit project was $17.9 million per mile ($14.9 million per mile without the cost of Bus Rapid Transit vehicles). Within this average, unit costs vary from $24 to $27 million per mile for intensive street reconstruction to $2 to $3 million per mile for station-only upgrades.

Predictions of project costs were reasonably accurate throughout project development. Differences from the actual cost were caused largely by changes in project scope, plus a very optimistic construction schedule assumed for the cost prediction. *Predicted costs* at entry were high by 10 percent in constant dollars (no YOE was prepared). *Real costs* at entry were high by 15 percent in YOE dollars and high by 28 percent in constant dollars, reflecting the ambitious design standards applied to the entire project. The FFGA cost prediction was 0.2 percent lower than the actual outcome in YOE dollars, but 1.8 percent higher than the outcome in constant 2008 dollars, reflecting the project revision and down-sizing made during procurement and construction.

Transit Service

With the opening of the project in 2008, the *HealthLine* Bus Rapid Transit service replaced the #6 local bus route and four other local bus routes were able to use the Bus Rapid Transit lanes for parts of their itineraries. *HealthLine* provided 5-minute headways in the peak periods compared to 6-minute headways on Route #6 and the same 10-minute headway in off-peak periods. Headways on the other corridor routes were unchanged. In aggregate terms, Route #6 previously had provided 75 percent of the service on Euclid Avenue; the more frequent peak-period service on *HealthLine* increased this share to 82 percent from when service began.

End-to-end run-time for the Bus Rapid Transit bus service averages 36 minutes compared to (previously) 46 minutes for the #6 buses. Run-time savings occur throughout the Bus Rapid Transit facility because of longer stop-spacing and off-board fare collection. However, 80 percent of the run-time savings occurs within the 4.5 mile segment where the Bus Rapid Transit also has exclusive lanes and traffic-signal priority. Overall, changes associated with the opening of *HealthLine* increased service in the corridor by 22 percent and reduced run-times by 21 percent.

In April 2010, in response to a drop in operating revenues caused by contraction of the national and regional economies, GCRTA's system-wide reductions in service included significant changes in the Euclid Corridor. Service on *HealthLine* remained unchanged. Local bus service on the Bus Rapid Transit facility was effectively eliminated as these routes were truncated at rail and Bus Rapid Transit stations in the corridor. As a result, *HealthLine* provided 98 percent of all service on Euclid Avenue.

The net effect of the 2008 the *HealthLine* opening and the 2010 service adjustments has been a 2 percent increase in aggregate service levels and a 21 percent reduction in bus run-times on Euclid Avenue.

Throughout project development, service plans for the Euclid Corridor accurately anticipated the levels of

80 Office of Planning and Environment, Federal Transit Administration, U.S. Department of Transportation, 2012, "*Before and After Studies of New Starts Programs: Report to Congress*", US Department of Transportation, Washington DC.
The case study is a before and after assessment of the project conducted by the FTA following on from the funding of the project under the New Starts Program.

service provided after the project opened. Early plans did not fully anticipate the significant improvements in run-times because of the reserved lanes and other elements of the project. None of the service plans anticipated the 2010 reductions in local bus services in the Euclid corridor caused by contraction of the national and regional economies.

Operating and Maintenance Costs

Operation and maintenance (O&M) costs for the *HealthLine* service itself are $8.2 million annually compared to $7 million for the Route #6 service that it replaced, an increase of 17 percent. This net increase in cost reflects the maintenance of the physical facilities added by the project. However, the 37 percent increase in the number of bus trips provided by *HealthLine* compared to Route #6 results in a reduction in cost per bus-trip caused by the 21 percent faster bus run-time.

During project development, GCRTA accurately anticipated an increase in the *HealthLine* O&M costs of approximately $1 million annually.

Ridership

HealthLine carries 14,300 trips on the average weekday compared to 8,900 weekday trips on the Route 6 that it replaced. This increase reflects:

- Faster travel times and moderately more-frequent peak-period service
- Increased customer satisfaction with the *HealthLine* service
- The elimination of local bus routes on Euclid Avenue.

Total ridership in the Euclid Corridor increased from 16,200 to 21,200 trips per average weekday; a gain of 31 percent. This ridership gain in Euclid Corridor occurred over a 3-year period in which the metro-area bus system lost 30 percent of its ridership because of the economic contraction and consequent declines in travel needs and reductions in bus service. Total transit ridership in the metro area (including rail and para-transit services) dropped by 22 percent over this interval.

Given that overall service in the corridor returned to pre-*HealthLine* levels because of the service reductions in 2010, ridership gains in the Euclid Corridor are a response to faster travel times and the "fixed-guideway" effects of the Bus Rapid Transit facility. Surveys of riders before and after project opening indicate substantial increases in rider satisfaction with passenger facilities at stations, on-time performance, comfort on the Bus Rapid Transit vehicles, and the overall transit-riding experience.

Early ridership forecasts anticipated volumes of 21,100 trips per average weekday. Later refinements to local travel-forecasting procedures produced a revised forecast of 13,500 weekday trips documented in the FFGA. Neither of these forecasts anticipated the substantial contraction of the regional economy in the late 2000's or the consequent drop in area-wide transit ridership.

Economic development

The Euclid Corridor project has both contributed to and benefited from ongoing development and redevelopment in the corridor. A 2009 article by The Plain Dealer of Cleveland catalogued some $4.3 billion in investments that were recently completed, underway, or planned proximate to *HealthLine*. These investments have included residential transit-oriented-development, the continued growth of many major institutions (particularly universities and hospitals), and greater business expansion. This record comes at a time of significant contraction in the regional economy and stands in significant contrast to conditions elsewhere in the metropolitan area.

As with most major transit investments, efforts to determine causality are obscured by changing market conditions, subsidies and other governmental incentives for investment, and the varying situations faced by individual developers, institutions, and businesses.

Nevertheless, the stated goals of the Euclid Corridor Transportation Project included the support of reinvestment in a corridor that has both major assets and major liabilities. The project has improved transit accessibility within the corridor with visible and permanent transit facilities. It has further upgraded the physical appeal of streets, sidewalks, and other public spaces. And it has attracted the sponsorship of two major institutions in the corridor. The contribution of the project to economic development in the corridor is evident from the examples cited, however, the precise impact of the project is difficult to quantify.

Rebirth on Euclid Avenue

Steven Litt | The Plain Dealer

Over the past century, Euclid Avenue has gone from being Cleveland's most prestigious address to a Main Street riddled by blight. Now, thanks in part to the Greater Cleveland Regional Transit Authority's Euclid Corridor bus rapid transit project, the avenue is rebounding as the backbone of the city's new economy. But while a transformation is in the works, nothing is guaranteed. The national economy, the location of the much-discussed Medical Mart and disruptive highway work by the Ohio Department of Transportation could blunt the multibillion-dollar reinvestment now gathering momentum. Shown below is an overview — by no means exhaustive — of construction projects in the Euclid Corridor zone.

What's driving the development?

Observers say Euclid Avenue and adjacent blocks are benefiting from a "perfect storm" of positive factors including:

- The rising price of gasoline, which is encouraging dense, pedestrian-oriented development around the RTA bus line.
- Federal and state historic-preservation tax credits have made it viable for developers to renovate dozens of early 20th-century buildings downtown.
- Continued growth at the city's big medical centers and at Cleveland State and Case Western Reserve universities.
- The bottoming-out of local real estate prices, now viewed by lenders and developers as a bargain in comparison with prices in more expensive cities.
- Demand for new, in-town housing, driven by the steady influx of hospital employees and spin-off industries, plus the growing back-to-the-city movement among retirees and empty-nesters.

What are the possible roadblocks?

Despite the proven investments under way, the rebirth of Euclid Avenue could be hampered by other factors:

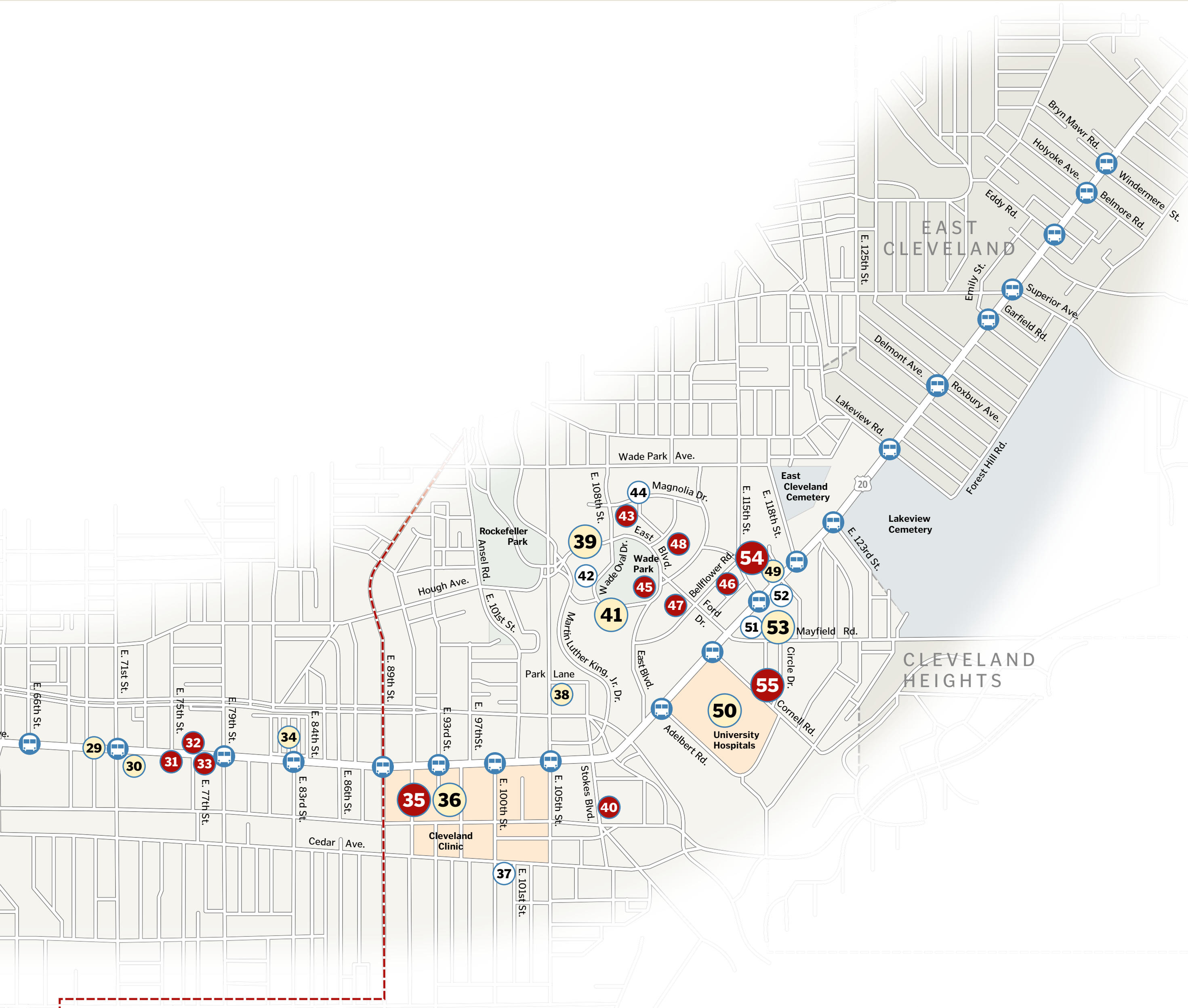
- A looming recession and tightening of credit among lenders could slow the recovery along Euclid, but won't stop it, developers say. Housing developers say they're optimistic they will find the capital they need.
- The Ohio Department of Transportation's $1.5 billion reconstruction of the downtown Inner Belt could impose a 15-year tourniquet on the city's main traffic artery and strangle property values. Developers say there's a critical need to maintain the flow of traffic. "Our politicians have to be all over this," said Doug Price III, chief executive of the K&D Group.
- The proposed Medical Mart and new convention center could damage the city for decades if located in Midtown near the Cleveland Clinic. The projects would bleed energy from the existing business district and undercut decades of investment there, developers and planners say.

Public Square to Inner belt ($1.3 billion)

	Project	Cost of project
1	Arcade/Hyatt Regency hotel	$60 million
2	515 Euclid Ave. garage	$22 million
3	East 4th Street	$110 million
4	Colonial Arcade Renovation	$30 million
5	668 Euclid Avenue	$65 million
6	Ameritrust complex	$200 million
7	Cleveland Athletic Building, 1001-1021 and 1101 Euclid Avenue	$70 million
8	Avenue District	$300 million
9	Carter Manor	$27.8 million
10	Idea Center	$42 million
11	Hanna Theatre	$19.2million
12	CSU law school renovation	$8.8 million
13	CSU arts complex	$50 million
14	Collegetown development	$18 million
15	CSU student center	$50 million
16	CSU garage and RTA transit center	$19 million
17	CSU main classroom building	$27 million
18	Trinity Cathedral annex	$9.8 million
19	CSU administrative complex	$16 million
20	CSU recreation center	$29.5 million
21	CSU Fenn Tower renovation	$30 million
22	CSU new student housing	$45 million
23	CSU College of Education building	$36 million

Midtown ($87.3 million)

	Project	Cost of project
24	Myers University Club	$10 million
25	Northeast Ohio Regional Sewer District headquarters	$22.1 million
26	Centers for Families and Children	$1.7 million
27	Cleveland Midtown Innovation Center	$5 million
28	4600 Euclid Avenue	$5 million
29	Victory Lofts building	$10 million
30	Baker Motor Car building	$7 million
31	Aldi supermarket	$1.5 million
32	Erie Square apartments	$3.8 million
33	Church of Latter day Saints	$1.2 million
34	Woodhaven townhouses	$20 million



University Circle ($3 billion)

	Project	Cost of project
35	Cleveland Clinic, various projects	$419 million
36	Cleveland Clinic, various projects	$868 million
37	Global Cardiovascular Innovation Center	$28 million
38	Park Lane apartments	$30 million
39	Stokes VA hospital	$183 million
40	John Jay High School	$36.7 million
41	Cleveland Museum of Art	$258 million
42	Cleveland Museum of Natural History	30 to $50 million
43	Shafran Planetarium	$6.9 million
44	Hawken School	$3.5 million
45	Cleveland Botanical Garden	$47 million
46	Mandel Center for Nonprofit Organizations	$11 million
47	Peter B. Lewis Building	$61.7 million
48	Cleveland Institute of Music	$32 million
49	Cleveland Hearing and Speech Center	$11.8 million
50	University Hospitals	$326 million
51	Museum of Contemporary Art Cleveland	No cost or date set
52	Cleveland Institute of Art	$53 million
53	University Arts and Retail District	$300 million
54	Village at 115	$126 million
55	Wolstein Research Center	$110 million

SOURCES: Historic Gateway Neighborhood; Cleveland State University; Midtown Cleveland Inc.; Cleveland Clinic; University Circle institutions

MAP BY REID BROWN | THE PLAIN DEALER

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Benefits of Investment in Rapid Transit

Chapter 4. Benefits of Investment in Rapid Transit

4.1 Introduction

This chapter of the report explores the benefits of investment in Rapid Transit systems that go beyond the user benefits of Rapid Transit covered in Chapter 3. These benefits, in the context of a quantified and objective assessment of the value of proposed Rapid Transit projects, are most prevalent in the economic impacts measurements of the Australian Rapid Transit Assessment Guidelines (ARTAG) model proposed in Chapter 2. This Chapter discusses the following key elements of benefits from the Rapid Transit investment:

> Economic and land value benefits

> Environmental benefits

> Employment impacts of Rapid Transit.

4.2 Economic and Land Value Benefits

4.2.1 Introduction

As highlighted in the ARTAG model, the economic benefits of Rapid Transit encompass a range of measures. These include:

> Direct financial and economic benefits

> Land value benefits

> Economic elements of user benefits

> Economic elements of environmental benefits

> Economic elements of social and community benefits.

The economic elements of user benefits and social and community benefits were explored in Chapter 2. Further into this chapter the environmental and secondary benefits of Rapid Transit are explored. Due to their linked nature this section focuses on the economic and land value benefits from Rapid Transit systems. The economic benefits of Rapid Transit are primarily assessed in terms of land value impacts arising from the construction of the system. This is relevant for both Road and Rail Based forms of Rapid Transit.

A review of recent research[81] in economic and land value benefits from Rapid Transit produced three non-mode specific factors identified as significant in producing variations across a range of studies.

The three factors identified in the review of research were:[82]

> **Local value of accessibility**

Both push and pull elements mediate the attractiveness of transit. The frequency, reliability, and coverage of the transit system, compared to the intensity of traffic congestion, result in different values being placed on accessibility in different locations. Accessibility by car and accessibility to employment have also been found to be influential on the property land value uplift (Mulley, 2013).[83]

> **Travel characteristics of area residents**

The impact of Rapid Transit on land value has been shown to vary over geographical space (Mulley, 2013). This impact is associated with the socio-demographics of the neighbourhoods and requirements of households for travel. For example, smaller households with relatively simple travel needs (such as working couples with no children and two full time jobs) are likely to be better served by transit than families with children, who are more likely to have complex daily travel patterns to a wider variety of locations (Duncan 2008). Thus, residents of denser housing types (such as townhouses and apartments) may be more likely to value accessibility than residents of lower density single detached homes (Cervero et al 2004). There are divergent findings about the value of transit accessibility to lower versus higher income.

> **Design characteristics of the station area**

The design of the surrounding area, including pedestrian walkability and safety, the mix of uses clustered around the train station, and the contrast between walk-and ride and park-and-ride stations all affect whether accessibility benefits outweigh dis-amenities (Bartholomew and Ewing 2011). Wardrip (2011) suggests that the regional economy, and in particular the strength of the local housing market, is a key element mediating whether transit investments have positive impacts on property prices. He argues that additional incentives are needed to attract housing development growth, but that parallel strategies are also needed to protect

81 Ge, X, et al., 2012, *"Assessing the Impact of Rail Investment in Housing Prices in North West Sydney"*, 18th Annual Pacific Rim Real Estate Conference Adelaide 15-18 January 2012.

82 Ibid.,^

83 Mulley, C. 2013, *"Accessibility and Residential Land Value Uplift: Identifying Spatial Variations in the Accessibility Impacts of a Bus Transitway"*, Urban Studies

housing affordability when new transit investments redistribute growth and housing demand to some locations.

What needs to be emphasised in the context of developing Rapid Transit projects for funding is that while economic benefits, particularly land value benefits, flow from the construction of Rapid Transit, the pre-conditions that warrant the development of Rapid Transit can produce land value uplift.

Although this concept is not explored thoroughly in this report Figure 4.2, while demonstrating that Bus Rapid Transit in Beijing produced slightly higher land value uplift in catchment areas, also demonstrates that land value uplift took place in non catchment areas.

As discussed throughout this report Rapid Transit should be an outcome of factors related to land use management and land value growth rather than seek to engender it.

4.2.2 Economic and Land Value Benefits from Rail Based Rapid Transit

The available literature suggests a strong link between Rail Based Rapid Transit systems, in particular Light Rail and increases to property values in areas adjacent to the route of operation.

There is a strong link between Rapid Transit , regardless of the mode, and increases to property values and economic development in areas along, and adjacent to the corridor of operation.

Where Rapid Transit is used to increase capacity feeding into Central Business Districts both Rail and Road Based Rapid Transit will deliver significant agglomeration benefits.

A recent study into the housing value impacts of the Epping-Chatswood Rail Link on properties near the Macquarie University Rail Station, *Assessing the Impact of Rail Investment in Housing Prices in North West Sydney* (2012) provides valuable data on the impact of Rail Based Rapid Transit on land values in an Australian environment.[84] While this study was focused on a Heavy Rail system the methodology is applicable to Light Rail and the findings are instructive for Rapid Transit regardless of the mode.

The study found dwelling prices appreciated more before the commencement of construction and after the opening of rail service than they did after starting the construction and before the opening. The findings showed houses within one kilometre of the station were priced $80,833 higher than those further away during the period before construction commenced, but this dropped to $64,523 over the period after commencement of construction.

The most comprehensive research regarding the land value impacts of Light Rail have been produced in the US. In *Transportation, Social and Economic Impacts of Light and Commuter Rail* (2009) Clower and Weinstein undertook a review of literature relating to the economic and development value of Light Rail and Commuter (Heavy) Rail across US Cities.[85] The review identified the systems in terms of operation value impacts, and identified the measurements used in the analysis of systems. Table 4.1 presents an abridged version focused on Light Rail.

84 Ge, X, et al., 2012, *"Assessing the Impact of Rail Investment in Housing Prices in North West Sydney", 18th Annual Pacific Rim Real Estate Conference Adelaide 15-18 January 2012.*

85 Clower, T, and Weinstein, B, et al, 2009, "*Transportation, Social and Economic Impacts of Light Rail"*, Texas Transportation Institute, Texas Department of Transportation, Research and Technology Implementation Office.

Table 4.1 Review of Literature into Land Value Impacts of Light Rail (US)

System	Measure	Value	Impact Type	Source
Sacramento	Impact of Light Rail on property values	The presence of a nearby light rail station or line does not have a significant measurable impact on the value of nearby properties.	Economic	Jaiyeoba and Quinn (2005)
Santa Clara	Impact of TOD on commercial values	Land values up 23% in commercial business district, up 120% near Caltrans stations	Economic	Cervero and Duncan (2002a)
Santa Clara	Impact of TOD on residential values	In terms of commuter rail transit stations, within a 1/4 mile radius, ALL residential parcel values increased, however land value premiums (20%+) were significantly lower than when compared to light rail stations. For light rail stations, values ONLY increased for 5+ unit apartment buildings in the same radius. Land value premium effects for large apartment properties were 45% within the 1/4 mile radius of a light rail station. Within a 4 mile radius, effects for all properties were 28%.	Economic	Weinberger (2001)
Portland (Westside Max)	Tax values	31% higher value within 1/2 mile of announced station and 10% higher within mile	Economic	Knaap, Ding, Hopkins (2001)
Portland (Eastside Max)	Residential Property Value	10.6% greater within 500 meters of the transit	Economic	Al-Mosaind (1993)
Texas (Dallas Art Rapid Transit	Value of TOD developments completed, underway, or planned; Taxable property values (both real and potential); Potential sales tax revenues	Total value for all current and projected developments near DART rail stations is $4.9 billion. Value of taxable real and business personal property associated with these projects exceeds $2.84 billion. The retail component of TOD projects will generate over $660 billion in annual taxable retail sales.	Economic	Weinstein, Clower and Seman (2007)
Portland	Impact of Light Rail on residential property values	Light Rail in Portland contributes up to 10.5% on residential property value.	Economic	Chen et al. (1997)[86]
Miami	Impact of Light Rail and Commuter (Heavy) Rail on residential property values	Residential land value is only marginally benefited from Miami Metrorail by up to 5% of price premium.	Economic	Gatzlaff and Smith (1993)[87]
Washington DC; Atlanta	Impact of Light Rail and Commuter (Heavy) Rail on commercial property and rent	Office buildings at some of the metro station areas studied had a slight rent premium over their freeway-oriented areas.	Economic	Cervero and Landis (1993)[88]

Source: Weinstein and Clower et al. 2009; Du and Mulley (2006)[89]

86 Chen, H., A. Rufolo, and K. J. Dueker, 1997, *"Measuring the Impact of Light Rail Systems on Single Family Home Values: A Hedonic Approach with GIS Application"*, Centre for Urban Studies, College of Urban and Public Affairs, Portland State University, Oregon.

87 Gatzlaff, D. H., and M. T. Smith, 1993, *"The Impact of the Miami Metrorail on the Value of Residences near Station Locations"*, Land Economics, Vol. 69, pp. 54–66.

88 Cervero, R., and J. Landis. "*Assessing the Impacts of Urban Rail Transit on Local Real Estate Markets Using Quasi-Experimental Comparisons"*, Transportation Research Part A: Policy and Practice, Vol. 27, 1993, pp. 13–22.

89 Du, H. and Mulley, C, 2006, *"Relationship between Transport Accessibility and Land Value: a local model approach with Geographically Weighted Regression"*, Transportation Research Record: Journal of the Transportation Research Board, vol.301

Case Study Effects of bus rapid transit on housing price: evidence from Sydney, Australia[90]

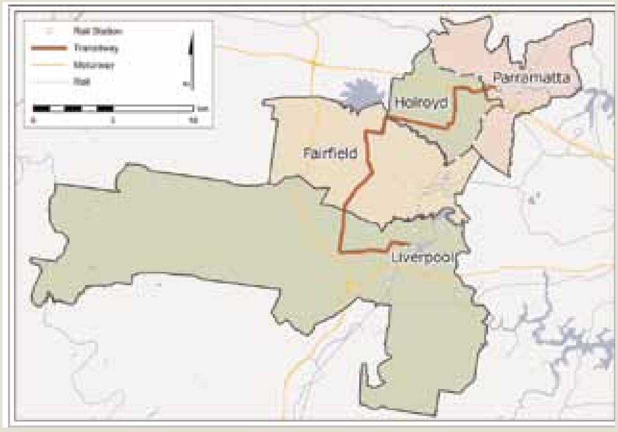
Introduction

Bus modes are important in the Australian lower density city environment and transitways are increasingly being considered as a way to provide cost-efficient, flexible public transport. However, the impact of bus based Rapid Transit on land value is still under-researched in the context of Australian capital cities. This case study presents a recent study conducted by Mulley and Tsai (2013) which investigates the influence of a Bus Rapid Transit system on residential housing prices in Sydney.

The Liverpool Parramatta Transitway

The Liverpool-Parramatta Transitway (LPT) is the first Bus Rapid Transit system which connects the major centres of Liverpool and Parramatta in the South-West of Sydney, Australia. The termini are in Liverpool Local Government Area (LGA) and Parramatta LGA respectively. The Transitway route traverses the two further LGAs of Fairfield and Holyroyd. The 31 km route with 33 stations includes 20 km of new dedicated bus-only infrastructure and 10 km of on-road bus priority. Figure 4.1 shows the route of the LPT. The LPT offers the opportunity to examine land value uplift consequent on bus infrastructure investment in a relatively self-contained spatial area.

Figure 4.1 The Liverpool-Parramatta Transitway



Source: GIS layers Hedonic Model

The focus of this analysis is not only the identification of the effect of transport intervention on property price but also an understanding when this effect occurs whether the land value has increased since the project announcement (1998) or the start of construction (2002), or the opening in February 2003. A hedonic model is employed in this analysis as defined in equation (1).

Equation (1)

$$Y_i = constant + \sum_j \alpha_j P_{ij} + \sum_j \beta_j N_{ij} + \theta_2 \cdot Phase2 + \theta_3 \cdot Phase3 + \gamma_1 \cdot C \cdot Phase1 + \gamma_2 \cdot C \cdot Phase2 + \gamma_3 \cdot C \cdot Phase3 + \varepsilon_i$$

where Y_i is predicted by a number of property attributes (P_{ij}) and neighbourhood attributes (N_{ij}). $Phase2$ (construction) and $Phase3$ (opening) are the dummy variables of time which represent the time period where the property was sold and are designed to capture price changes over time using $Phase1$ (announcement) as a reference point. C is the dummy variable capturing the sold properties located in the catchment area, so C takes the value of zero in the control areas and a value of one if in the catchment areas. Details of the catchment and control area identification are available in the full paper. [91] The interaction terms of C and the time dummies examine the price difference between catchment and control areas in each phase.

90 Mulley, C. and Tsai, C, 2013 *"How Much Does New Transport Infrastructure Add to Land Values? Evidence from the Bus Rapid Transit System in Sydney Australia"*, Working paper, Institute of Transport and Logistics Studies, University of Sydney.

91 Mulley, C. and Tsai, C, 2013 *"How Much Does New Transport Infrastructure Add to Land Values? Evidence from the Bus Rapid Transit System in Sydney Australia"*, Working Paper, Institute of Transport and Logistics Studies, University of Sydney.

Land Value Uplift

The findings of this study are summarised as follows:

1. The opening of the LPT led to 3.6 percent price uplift in the LPT catchment areas, relative to the control areas, after controlling for property and neighbourhood attributes.
2. Overall housing market grew from the announcement year (1998) to construction year (2002) and then remained stable afterwards.
3. Properties located within 50 metres of the LPT stations have lower prices than properties outside of the buffer, most likely because they experience noise and other negative externalities.
4. Neighbourhood and property attributes are significant drivers of property values.
5. It is possible that the benefits of the LPT, as the first Bus Rapid Transit system in Sydney, might be under-estimated before its opening because of uncertainty perceived by the residents in Sydney.
6. The land value uplift values for a transitway in suburbs away from the CBD may be lower than what might be experienced with a high volume, high frequency, city centre transitway route.

4.2.3 Economic and Land Value Benefits from Road Based Rapid Transit

There is a considerable field of research examining the impact of Bus Rapid Transit systems implementation and operation on land use, land value, public transport accessibility and modal shift.

In a study into the land value impacts of the Beijing Southern Axis Bus Rapid Transit system Deng and Nelson (2011) presented a "literature review" in to the land development and value impacts related to Bus Rapid Transit systems across the world.[92] The available literature demonstrated comparable economic and land value benefits between Road and Rail Based Rapid Transit. Table 4.2 presents Deng and Nelson "literature review" which includes systems visited on the BIC's Rapid Transit Study Visit of North America and systems in operation in Australia.

As outlined in an earlier case study, the Euclid Corridor Transport Project has both contributed to and benefited from ongoing development and redevelopment in the corridor. The BIC's primary research during the Rapid Transit Study Visit indicates that this economic development figure is now estimated by the Greater Cleveland Regional Transit Authority to be approximately US$4.3 billion.

Deng and Nelson's (2013) analysis of the Beijing Southern Axis Bus Rapid Transit line demonstrates locations near Bus Rapid Transit projects have increased development, particularly in high-density residential construction. The Bus Rapid Transit line has significantly improved public transport accessibility for communities along its route and this accessibility has been capitalised into higher real estate prices.[93]

Figure 4.2 provides a comparison of property prices which fell into the catchment areas for the Beijing Southern Axis Bus Rapid Transit line against control areas not serviced by the Bus Rapid Transit. While both areas grew rapidly the growth in property prices in the Bus Rapid Transit catchment area was higher. Of note, also, was the growth in property prices in the catchment area began at construction phase.

The primary use of Rapid Transit should be to provide increased capacity in corridors within a transport network.

Economic and urban development benefits from Rapid Transit should be viewed as a flow on effect of an integrated approach to land use and transport planning.

From 2003 to 2009, the average price of apartments adjacent to a Bus Rapid Transit station gained a relatively faster increase (4.61% annually) than those not served by the Bus Rapid Transit system: an annual increase of 59.04% in catchment areas and 54.43% in control areas. The asking prices of apartments in Bus Rapid Transit catchment areas (500 metres radius of a Bus Rapid Transit station) was 1.67%, 0.96% and 10.27% higher than those in control areas in 2003 (planning phase), 2004 (construction phase) and 2009 (5 years after the Bus Rapid Transit operation) respectively. [94]

The asking price of properties (single-family and units in multi-family apartments) in the catchment area was between 13% and 14% higher than those in the control area, using price changes of residential properties between 2001 and 2006.[95]

Data from quantitative modelling for the US urban environment indicates that a property 1,000 feet away from a Bus Rapid Transit station is valued approximately $9,745 less than a property 100 feet away which is a relatively high figure in comparison to Light Rail systems.[96]

92 Deng, T and Nelson, D, 2011, *"Recent Developments in Bus Rapid Transit: A Review of the Literature"*, Transport Reviews, 31: 1, 69 — 96, First published on: 10 November 2010 (iFirst)

93 Deng, T, and Nelson, J, 2013, *"Bus Rapid Transit Implementation in Beijing: An evaluation of Performance and Impacts"*, Research in Transportation Economics 39(1): 108–113.

94 Deng, T, and Nelson, J, 2013, *"Bus Rapid Transit Implementation in Beijing: An evaluation of Performance and Impacts"*, Research in Transportation Economics 39(1): 108–113.

95 Ibid., ^

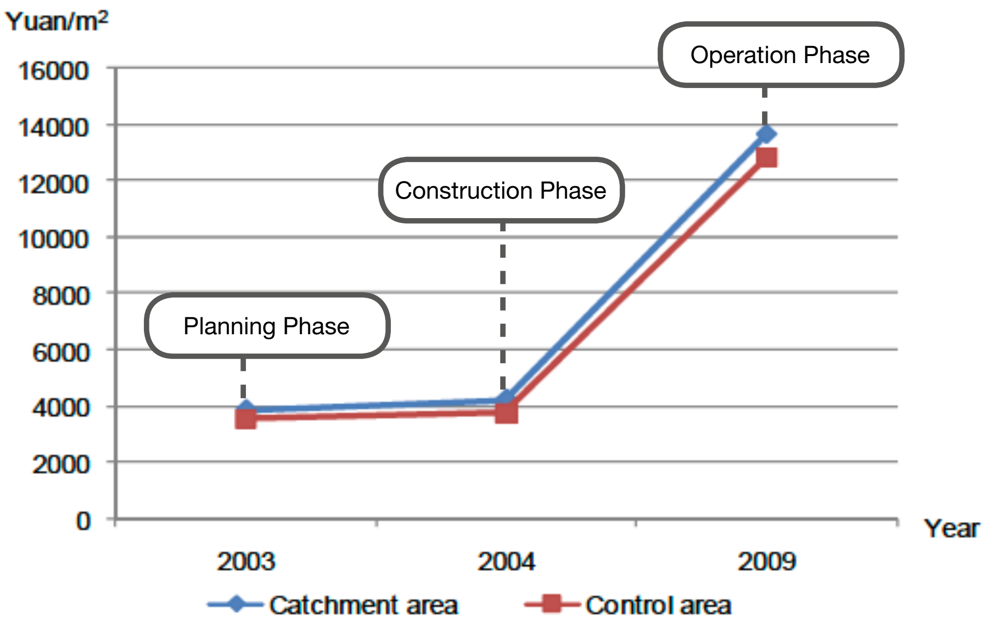
96 Perk, V, 2012, *"Land Use and Property Impact Values of Bus Rapid Transit"*, Presentation to the 5th National Bus Rapid Transit Conference, National Bus Rapid Transit Institute, Centre for Urban Transport Research, University of Florida.

Table 4.2 Literature Review of Land Development Impacts Related to Bus Rapid Transit

City	Authors	Year Opened	BRT System	Land Development Impact
Curitiba	Rabinovitch and Hoehn (1995)	1974	Surface Metro	High density residential and commercial development occurred along Bus Rapid Transit corridors
Bogota	Rodriguez and Targa (2004)	2000	TransMilenio	After only 2-years of operation of Bus Rapid Transit residential rental costs increased between 6.8% and 9.3% for every 5 minutes walking time to Bus Rapid Transit stations
Bogata	Rodriguez and Mojica	2000	TransMilenio	Network effects were found from the extension of the Bus Rapid Transit. The asking price of properties in the Bus Rapid Transit catchment area was found to be between 13% and 14% higher than in the control area
Bogota	Munoz-Raskin	2000	TransMilenio	Within a 10 minute walking distance to the Autopista Norte trunk corridor and to the Portal Norte feeder lines, the average annual property value increased 2.2% and 2.9% respectively
Boston	Diaz et al. (2009)	2002	Silver Line	Development has accelerated along the Washington Street corridor. Silver Line Phase 1 has generated at least US $93 in new development, involving a mix of retail, housing and institutional uses
Las Vegas		2002	MAX	One casino operator has invested in pedestrian facilities and an additional station
Orlando		1997	LYMMO	The local authority has used the Bus Rapid Transit as a tool to promote development. 5 new office buildings with about 1 million square feet per building and 6 new apartment communities have been developed in the downtown area, possibly resulting from the Bus Rapid Transit
Pittsburgh	Levinson, Zimmerman, Clinger, Rutherford et al. (2003) and Levinson, Zimmerman, Clinger, Gast et al. (2003)	1983	East Busway	59 developments within a 1500 foot radius of station. $302 million in land development benefits, pf which $275 million was new construction
Ottawa		1987	Transitway	The construction of the Transitway has led up to US$675 million in construction around stations
Adelaide		1986	O-Bahn	Tea Tree Gully is becoming an urban village
Brisbane		2001	South East Busway	Property value near Bus Rapid Transit stations grew to 2 to 3 times faster than those located in the non-busway suburbs
Kent	DFT (2008)	2006	Fastrack	The second route was fully funded by the developers as part of the first mixed-use regeneration project in the Thames Gateway
Seoul	Cervero and Kan (2009)	2004	Bus Rapid Transit	Land use along Bus Rapid Transit corridors was intensified. Within 300 metres of Bus Rapid Transit stations, residential values gained premiums ranging from 5% to 10%; within 150 metres of Bus Rapid Transit stations, non-residential land values gained premiums varying between 3% and 26%
Sydney	Mulley and Tsai (2013)	2003	Liverpool Parramatta BRT	The Bus Rapid Transit system contributes around 3.6% of price premium on residential properties near Bus Rapid Transit stations after the opening.

Source: Deng and Nelson, 2011; Mulley and Tsai, 2013

Figure 4.2 Comparison of Property Prices in Catchment and Control Areas



Source: Deng and Nelson, 2013

4.2.4 Future Research in this Area

There is potential to update and expand on existing research into the direct financial, land value and socio-economic (employment, tax revenue) benefits of Rapid Transit systems in Australia.

The hedonic pricing models proposed in Ge et al. (2012) and in Mulley and Tsai (2013) could be applied to existing and proposed Rapid Transit projects to assess their land value benefits. Parameters for research would include:

- Land value effects of Rapid Transit on private housing and rental prices
- Land value effects for commercial property rentals and sales
- Changes to land use reflected in density of residential and commercial space
- Changes to land use reflected in the collection of rates by local councils
- Demographic shifts in areas of operation.

Case Study Institute of Transportation Development and Policy: More development for your transit dollar

Systems visited on the BIC's Rapid Transit Study Visit of North America were among those assessed in a 2013 study of 21 mass transit surface corridors (Rapid Transit systems) across 13 US and Canadian cities undertaken by the Institute for Transportation Development and Policy.[97]

> Per dollar of transit investment, and under similar conditions, Bus Rapid Transit leverages more transit-oriented development investment than Light Rail or streetcars.

Cleveland's *HealthLine* Bus Rapid Transit and Portland's *MAX Blue Line* Light Rail leveraged the most overall Transit Oriented Development investment of all the corridors we studied — $5.8 billion and $6.6 billion, respectively. Yet, because the *HealthLine* Bus Rapid Transit cost significantly less to build than the *MAX Blue Line* Light Rail, Cleveland's *HealthLine* Bus Rapid Transit leveraged approximately 31 times more Transit Oriented Development investment per dollar spent on transit than Portland's *MAX Blue Line* Light Rail.

> Both Bus Rapid Transit and Light Rail can leverage many times more Transit Oriented Development investment than they cost.

Of the 21 corridors we studied, 14 leveraged greater than $1 of Transit Oriented Development investment per $1 of transit spent. Five of them were Bus Rapid Transit, four of them were Light Rail, two were streetcars, and three were improved bus (non-Bus Rapid Transit) corridors.

> Government support for Transit Oriented Development is the strongest predictor of success.

> A government that sees potential in a site for development can provide a range of support from regulatory changes to financing to marketing of the area. There is nearly a direct correlation between the level of Transit Oriented Development investment and the strength of government support. If a government does nothing to support Transit Oriented Development along the transit corridor, there will be no Transit Oriented Development impact.

> The strength of the land market around the transit corridor is the secondary indicator of success.

> Where governments provide moderate support for Transit Oriented Development, the existing market strength of the land determines the level of Transit Oriented Development investment. Today, downtowns tend to be strong land markets, so having the transit investment pass through downtown leads to better Transit Oriented Development impacts.

97 Hook, W, and Lotshaw, S and Weinstock, A, 2013, *"More Development for your Transit Dollar: An Analysis of 21 North American Corridors"*, Institute for Transportation Development and Policy, New York.

4.3 Environmental Benefits

The environmental benefits associated with Rapid Transit systems relate primarily to the reductions in greenhouse gas emissions, pollution and energy use associated with the modal shift to public transport from cars that a Rapid Transit system, if delivered correctly, can generate.

The ARTAG model recognises the interrelationship between modal shift impacts and environmental benefits from Rapid Transit by factoring environmental benefits measurements in to the economic impacts component of the criteria. While there is a significant body of research into the environmental benefits of modal shift to public transport, there is less evidence about the specific benefits of Rapid Transit. There are, however, some instances of comparison between modes of Rapid Transit in environmental performance.

In its information brief on Light Rail the Sunshine Coast identified the following modal distinction between Light Rail and Buses:

> *"Light rail uses less energy than buses and with 3.6 times the capacity of a bus, can carry more people. A modern light rail vehicle also creates less pollution with approximately seven times less emissions per passenger kilometre than a bus."*[98]

This assumption about the comparative emissions reduction benefits of Light Rail over Bus need to be prefaced by a consideration of the energy source used to power the Light Rail system in a whole of life analysis of the environmental benefits. For example, it is a reasonable assumption to draw that a Light Rail system powered completely by renewable energy sources is likely to produce significantly more environmental benefits than a Light Rail system powered by electricity produced from brown coal. It is also a reasonable assumption to make that a Bus Rapid Transit system operating at full capacity will produce more emissions reductions benefits than a Light Rail system that runs empty during off-peak times.

A life cycle analysis of the carbon emissions output of different modes of transport including Light Rail and Buses was undertaken by Chester and Horvath (2008). The results across vehicle classes, applications and locations for the United States are outlined in Figure 4.3.[99]

Figure 4.3 compares the energy consumption rates, including fuel used in their operation, and energy embodied in vehicle and facility construction and maintenance. According to Chester and Horvath:

> *"Transit policies that reduce average load factors by increasing transit service to times and locations when demand is low (such as increasing fares or expanding service to suburban areas or late nights) reduces efficiency while policies that increase load factors (such as reducing fares, improving rider comfort, transit encouragement programs, and transit oriented development) tend to increase efficiency…"*

While the results on the whole indicate that Light Rail produces a lower carbon emissions output over its lifecycle, certain applications such as urban diesel buses during peak, school buses and urban electric buses produce low carbon emissions over their lifespan. Regardless of the mode of Rapid Transit the implication from Chester and Horvath is that high patronage on systems is crucial to the energy efficiency and environmental benefits derived from public transport and by association Rapid Transit systems.[100]

Vehicles on Bus Rapid Transit systems observed during the BIC's Rapid Transit Study Visit of North America were broadly trending towards newer engines and emissions technologies including diesel electric hybrids and CNG buses. In their analysis of emissions reductions from specific modes of Rapid Transit in US cities Vincent and Jerram (2006) find that the right combinations of vehicle capacity and fuel technology on Bus Rapid Transit systems produce less carbon emissions per passenger mile and can achieve significantly higher reductions in emissions than Light Rail systems over a 20 year life of the project (see Figures 4.4 and 4.5).[101]

The authors cite reasons for this outcome as twofold:[102]

> *"The generation mix of electricity used to power LRT. Electricity generated from fossil fuels produces a large amount of CO2…BRT costs significantly less to build than LRT, and thus more can be deployed for a given budget. However, even without this additional benefit, the per passenger mile CO2 emissions for a BRT system are likely to be significantly lower than those of an LRT system almost anywhere in the country."*

98 Sunshine Coast Council, 2013, *"Sunshine Coast Light Rail 2020: FAQs", Accessible online at:* http://sunshinecoastlightrail2020.com.au/faq/index/3

99 Chester, M, and Horvarth, A, 2008, *"Life-cycle Energy and Emissions, Inventories for Motorcycles, Diesel Automobiles, Electric Buses, Chicago Rail and New York City Rail*", Working Paper UCB-ITS-VWP–2009–2, UC Berkley Centre for Future Transport, University of California, Berkley.

100 Chester, M, and Horvarth, A, 2008, *"Life-cycle Energy and Emissions, Inventories for Motorcycles, Diesel Automobiles, Electric Buses, Chicago Rail and New York City Rail*", Working Paper UCB-ITS-VWP–2009–2, UC Berkley Centre for Future Transport, University of California, Berkley.

101 Vincent, W., and Jerram, L, 2006, *"The Potential for Bus Rapid Transit to Reduce Transport Related C02 Emissions"*, Journal of Public Transportation 2006, Special BRT Edition, pp 219-237.

102 Ibid.,^

While Light Rail may operate on a significantly different generation mix in future, current electricity generation mix suggests that better environmental dividends can be achieved by operating Bus Rapid Transit with low emissions technology and the whole of network coverage possible with Bus Rapid Transit, and therefore emissions reduction from reduced car use, is difficult to match with Light Rail.

In their research Hook et al (2010) identified the TransMilenio II system in Bogota as the first bus rapid transit system that secured credits for CO2 reduction through the UNFCC Clean Development Mechanism (CDM).

Under their methodology the projected savings of CO2 from 2006 to 2012 on this system were calculated at 1.7M tonnes. The actual reduction of CO2 emissions was in 2006 - 60%, in 2007 - 52% and in 2008 - 30% of the estimated reduction. The yearly average reduction was 68,000 tonnes.[103] This is the most comprehensive analysis of the methodologies available for assessing the emissions reduction impact of Bus Rapid Transit systems and could serve as a useful tool in assessing the emissions reduction benefits from proposed Bus Rapid Transit projects.

4.3.1 Federal Transit Administration Model for Assessing Environmental Benefits

In developing a proposed set of calculations for assessing the environmental benefits of applications for Rapid Transit project funding under the New Starts Program the Federal Transit Administration bases their model on the following elements:

- Indirect benefits to human health
- Safety, energy
- Air quality environment.

The potential changes to these elements identified in project applications are then compared to either the existing environment with the transit system in the year of application or both the existing environment with the transit system and the no-build environment and transit system in a horizon year.

The estimated benefits are then monetised and compared to the annualised capital and operating cost of the proposed project.

The Federal Transit Administration model uses the following criteria for assessment:

- Change in air quality criteria pollutants
- Change in energy use
- Change in greenhouse gas emissions
- Change in safety.

Importantly all of these measures, which stem from the primary source of data, change in Vehicle Kilometres Travelled (VKT), are converted to their specific measurements through a national standard for converting VKT into specific outcomes.

A nationally agreed framework for calculating "transport measures" as benchmarks should include a national standard for converting VKT into specific outcomes.

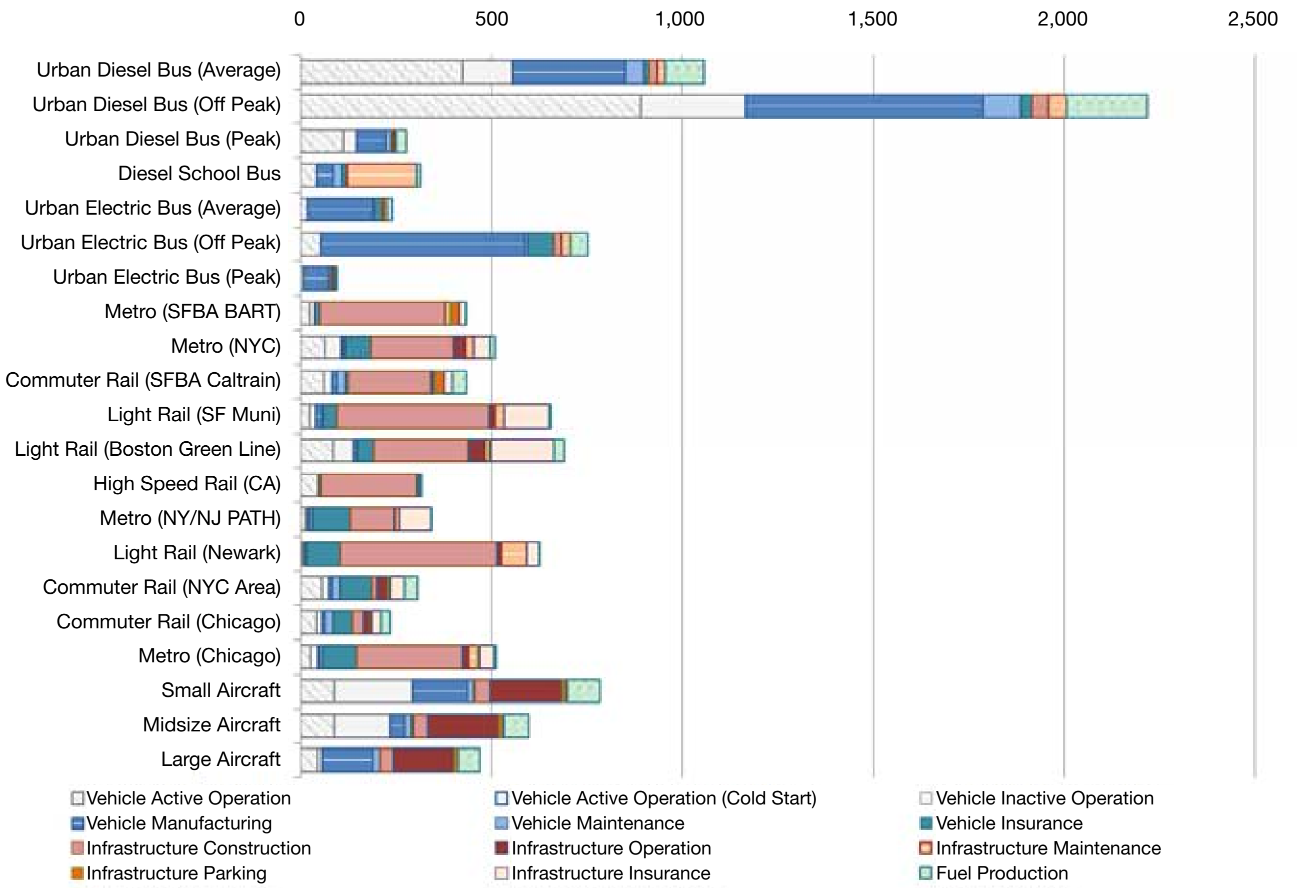
4.3.2 Best Practice for Assessing Environmental Benefits

American Public Transportation Association (2009) provides guidance to transit agencies for quantifying their greenhouse gas emissions, including both emissions generated by transit and the potential reduction of emissions through efficiency and reductions in automobile travel.

A nationally agreed framework for calculating "transport measures" as benchmarks should adopt the American Public Transportation Association version if it is not addressed in the revised version of the National Guidelines for Transport System Management.

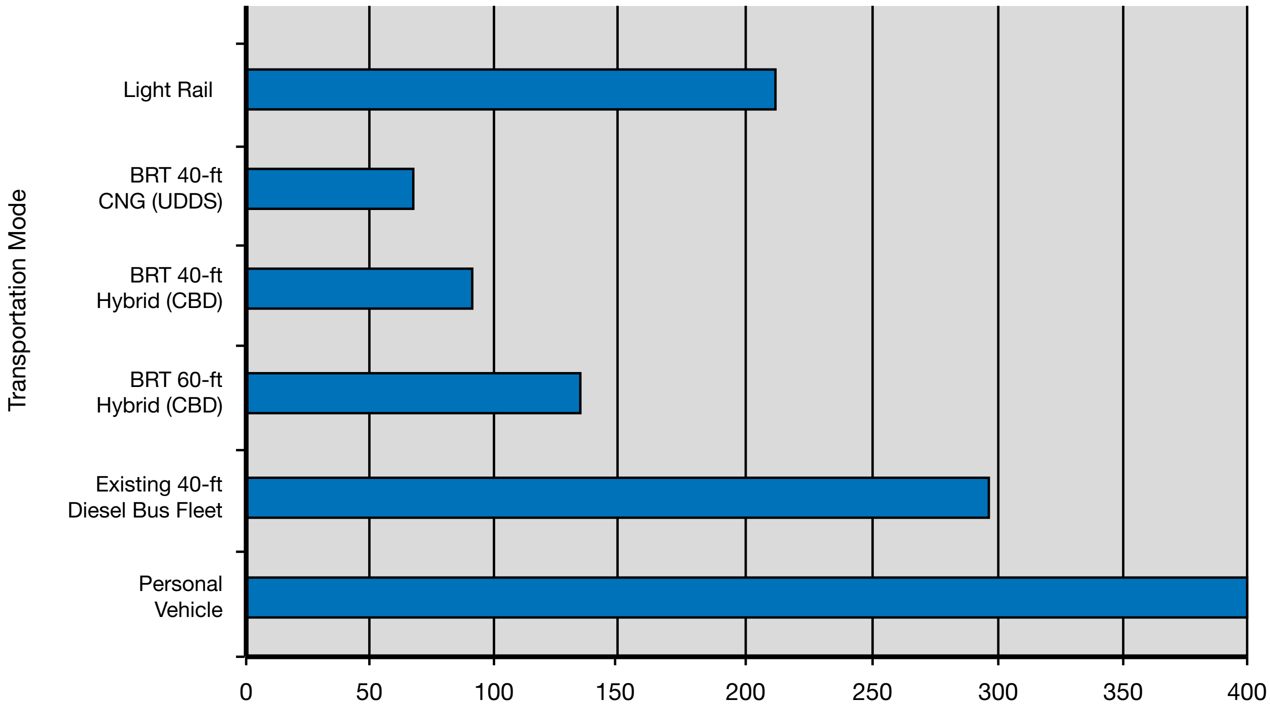
103 Hook, W et al, 2010, *"Carbon Dioxide Reduction Benefits of Bus Rapid Transit Systems Learning from Bogotá, Colombia; Mexico City, Mexico; and Jakarta, Indonesia",* Accessible online at: http://www.academia.edu/719566/Carbon_Dioxide_Reduction_Benefits_of_Bus_Rapid_Transit_Systems_Learning_from_Bogota_Colombia_Mexico_City_Mexico_and_Jakarta_Indonesia

Figure 4.3 Bus, Rail and Aircraft CO2 Emissions in mg/PMT



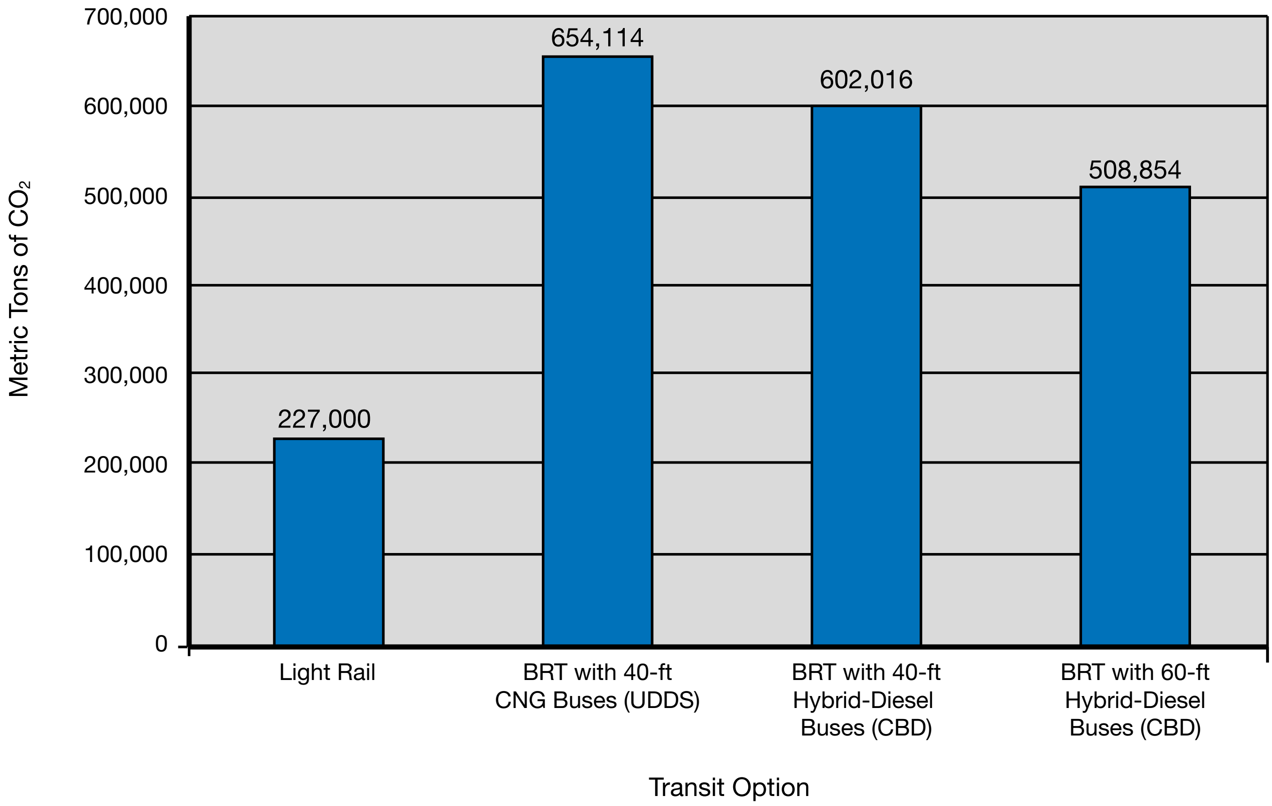
Source: Chester and Horvath, 2009

Figure 4.4 Carbon Emissions per Passenger Mile for all Transportation



Source: Vincent and Gerram, 2006

Figure 4.5 Carbon Emissions Saved Over 20 Year Life of Project



Source: Vincent and Gerram, 2006

4.4 Employment Impacts of Rapid Transit

4.4.1 Introduction

A challenge in identifying the secondary impacts generated by Rapid Transit comes in separating them from primary impacts such as economic, environmental and social benefits addressed throughout this report. Available literature on the secondary impacts of Rapid Transit relates primarily to the employment impacts of systems during their construction. This section presents information on the employment impacts of Rapid Transit systems.

4.4.2 Employment Impacts

The employment growth impacts of Bus Rapid Transit are anecdotally recognised, but remain largely unquantified or relate specifically to the employment generated by the project itself, rather than by any stimulus to business along the route of operation.

Due to the emphasis on high-quality infrastructure and services, employment related to the development of a Rapid Transit project can range from artisan work on stations to the direct labour applied to road work.

According to Wright and Hook (2007) Bus Rapid Transit systems bring significant improvements in the quality of the employment, particularly in developing countries.[104]

> *"The improved efficiency and lower operating costs in the new system will improve overall profitability. A primary difference between the BRT and non-BRT scenario in congested corridors would be that for the non-BRT scenario, after a certain number of years, population and employment growth in the corridor would stop, whereas in the BRT corridor it would continue at historical growth rates."*[105]

In a broader sense the employment generation impacts of Rapid Transit relate to the relationship between urban form, transport and accessibility to employment. Improved public transport services and transformation of the urban form into higher density, centralised areas of housing serviced by good transport, regardless of mode or design, can produce positive employment impacts, particularly in nodes serviced by major stations and along routes of operation.

An analysis of the Hiawatha Light Rail in Minnesota, across low, medium and high wage levels found the system has:[106]

> *"…Generated significant job accessibility benefits for all workers.. In areas near downtown and north LRT stations, the magnitude of accessibility increases among low-wage workers is larger than that of medium- and high-wage workers who live in the areas. Yet, in other LRT station areas as well as in areas served with bus routes connecting LRT, low-wage workers benefited less than their high-wage counterparts."*

In *Moving People*: *Solutions for a Liveable Australia* Stanley (2012) cites SGS Planning (2012) research which found a strong connection between employment accessibility and higher density housing.[107]

While there is some evidence that Rapid Transit can produce employment in its area of operation, this relates primarily to the development and operation of the system. Research related to the specific impacts of Rapid Transit systems on employment generation along corridors of operation i.e. through the development of business and commercial enterprise along corridors is limited. Future research relating to the economic impacts of Rapid Transit should include the employment generation impacts of projects once they are operational.

104 Wright, L, and Hook, W, 2007, *"Bus Rapid Transit Planning Guide"*, Institute for Transportation Development and Policy, New York.
105 Ibid.,^

106 Fan, Y., et al, 2012, *"Impact of Light Rail Implementation on Labor Market Accessibility: A Transportation Equity Perspective"*, The Journal of Transport and Land Use, Volume 5, Number 3, pp 28-39.
107 Stanley, J, 2012, *"Moving People: Solutions for a Liveable Australia"*, Bus Industry Confederation, Canberra.


HealthLine
Public Square
Points of Interest
Cleveland Clinic
RTA
University Hospitals

Appendices

Appendix A: Systems Visited on Rapid Transit Study Visit (Operational Information)

<table>
<tr><th>Location</th><th>Bus Rapid Transit Travel</th><th>Distance</th><th>Cost Level</th><th>Patronage Growth/Fares</th><th>Bus Rapid Transit Attributes</th><th>Other</th></tr>
<tr><td>Los Angeles Metro Rapid</td><td>Low</td><td>300 miles
33 cities
20 lines</td><td>Low</td><td>10,000 boardings per day in first year of operation</td><td>Branded buses and stops
Signal priority
Fewer stops</td><td>Major arterials in mixed traffic</td></tr>
<tr><td>Los Angeles Silver Line (Opened December 2009)</td><td>Medium – High Occupancy Vehicle Lanes</td><td>26.8 miles
2 corridors</td><td>Medium</td><td>70 per cent in 3 years
$2.45 US flat fare</td><td>N/A</td><td>Distinctive livery
Low floor articulated buses</td></tr>
<tr><td>Los Angeles Orange Line (October 2005)</td><td>High – Exclusively bus
Pedestrian crossings and traffic lights at cross roads</td><td>18 miles
18 stations
8 park and rides</td><td>High</td><td>25,000 boardings per day</td><td>Pre paid all door boarding
Signal priority
Bus exclusivity</td><td>Distinctive livery
Low floor artic buses
12 miles of bikeways
77 acres of landscaping</td></tr>
<tr><td>Las Vegas</td><td>High – Bus only portion
Low – Mixed traffic elements</td><td>12.5 miles
22 stations</td><td>Medium</td><td>Significant patronage growth
$1.75 flat fare
$4 all day tickets</td><td>12 minute frequency 5am to
20 minute frequency 7pm to 10pm
Signal priority
Off bus fare collection</td><td>Inner city mixed traffic element detracts from overall benefit
Passenger counters installed</td></tr>
<tr><td>Washington</td><td colspan="6">Washington is the home of the Federal Transit Administration. 2.8 cents of the gasoline tax of 18.4 cents per gallon is dedicated to public transport projects.
Washington has seen $1.9B investment per year for two years.
24 Bus Rapid Transit projects have been funded in the past two years.</td></tr>
</table>

Location	Bus Rapid Transit Travel	Distance	Cost Level	Patronage Growth/Fares	Bus Rapid Transit Attributes	Other
New York	Low - Some dedicated lanes in mixed traffic. Lanes painted for bus stops and policed.	Road network Basic road markings increased average speed of travel by 28 per cent	Very Low	Flat fare via Metrocard (mag stripe – not a smartcard	Very little Bus Rapid Transit attributes Basically a train subway city Subway patronage 5.5 million passenger trips per day and buses 2.8 million passenger trips per day	The Busway is simply a 2nd lane from the kerb. Public transport funding is provided 50-50 via fare box collection and real estate tax, phone bills and payroll tax
Cleveland	High Exclusive Busway "Healthline" with hospital sponsorship over 25 years	13 kilometres	High	48 per cent growth in year 1 60 per cent increase over three years $2.25 flat fare	108 stops reduced to 36 high quality articulated buses Doors on both sides for kerb/ median strip boarding	Standout from economic development perspective with $4.3 billion investment outcome "The Rebirth of Euclid Avenue" see case studies in this report
Ottawa	Mixed – High to medium	N/A mixture of regular buses, Bus Rapid Transit, and Light Rail.	Medium	560,000 boardings per day across various modes	Grade separation plus inside lane on highways Significant distance between stops Non specialist buses provide flexibility to operate both on and off the busways	Have effectively linked grade separation busway with HOV lanes on highway. Buses can be used on busway as well as on normal roads Plenty of layover areas

Location	Bus Rapid Transit Travel	Distance	Cost Level	Patronage Growth/Fares	Bus Rapid Transit Attributes	Other
Toronto	Medium (Provinces moved to owning infrastructure to write off over longer period)	N/A	Medium	ZUM – 23 per cent growth in 18 months Average fare $6 for an average travelling distance of 35kms	Branded bus stops and buses High frequency ZUM run by Brampton Transit Viva run by York County	"The Big Move" policy document contained 100 actions for all modes plus freight Light rail focused on corridor development Bus Rapid Transit focused on moving people
Brisbane Busway Network	High, however buses run on and off busway with passing lanes at bus stations	29 kilometres	Very High	Exceptional Fares high increased 68 per cent in 3 and 1/2 years	Grade separation Stops up to 2 ½ kms apart Non specialist buses provide flexibility to operate both on and off the busways	Inner Sth East Busway (opened in 2000) has subsequently been extended to the south, north and east as well as to University of Qld over subsequent years (UQ link has resulted in patronage growing from 3,600/day to over 30,000

Appendix B: Summary of Bus Rapid Transit Study Visit Undertaken by the BIC

Date	Activity	Location	System/Service	Description
17 August 2012	Meeting with Regulators	Los Angeles - Los Angeles County Metropolitan Transportation Authority Headquarters	Los Angeles County Metropolitan Transportation Authority – Los Angeles Metro Rapid Transit system	Delegates were introduced to and welcomed to the Los Angeles Country Metropolitan Transportation Authority by Paul, Deputy Chief Executive Officer
17 August 2012	Learning and Research	Los Angeles - Los Angeles County Metropolitan Transportation Authority Headquarters	Los Angeles County Metropolitan Transportation Authority – Los Angeles Metro Rapid Transit system	Delegates were presented an overview of the planning and implementation of Rapid transit in Los Angeles County by the following representatives: - Metro Rapid Project Martha Butler (Director, Countywide Planning & Development) - Metro Silver Line Conan Cheung (Deputy Executive Officer, Operations) - Metro Orange Line Hitesh Patel (Deputy Executive Officer, Project Management)
17 August 2012	Site Visit	Metro Red Line to North Hollywood	Los Angeles County Metropolitan Transportation Authority – Los Angeles Metro Rapid Transit system	Delegates travelled on the Metro Red Line, a Heavy Rail system connecting the Los Angeles downtown area with suburbs including Hollywood. The Red Line connects with the Metro Orange Line Bus Rapid Transit system at North Hollywood
17 August 2012	Site Visit	Metro Orange Line from North Hollywood to Chatsworth	Los Angeles County Metropolitan Transportation Authority – Los Angeles Metro Rapid Transit system	Delegates took a round trip of Metro's Bus Rapid Transit system the Orange Line from North Hollywood to Chatsworth. The Metro Orange Line runs on dedicated right of way lanes and features in case studies later in the report. Delegates were led by Hitesh Patel, Deputy Executive Office, Project Management, at Metro

Date	Activity	Location	System/Service	Description
20 August – 22 August 2012	Learning and Research	Las Vegas - US Transportation Research Board – National Bus Rapid Transit Conference	Regional Transportation Commission of South Nevada	The Transportation Research Board (TRB) and the National Bus Rapid Transit Institute (NBRTI), hosted the TRB Fifth National Bus Rapid Transit Conference. The Conference attracted more than 150 US and international attendees representing transit and consulting agencies, vehicle manufacturers and researcher centres. Industry information was shared among attendees, with more than 20 presentations, a technical tour of the Las Vegas Bus Rapid Transit services, and a poster session as part of the three day conference. The BIC representatives delivered a presentation on the Brisbane Busways Bus Rapid Transit system Themes explored during the Conference included: - Bus Rapid Transit around the world - Bus Rapid Transit Research and Innovation - Moving Bus Rapid Transit Forward in Your Community - Bus Rapid Transit technology and enhancements - Bus Rapid Transit and Land Use - Bus Rapid Transit Vehicles
24 August 2012	Meeting with Industry	American Public Transportation Association headquarters, Washington DC	N/A	Delegates met with representatives of the American Public Transportation Association. American Public Transportation Association is the peak representative body for public transport in the United States. American Public Transportation Association represents the interests of its members who include public transport operators and regulators
24 August 2012	Meeting with Regulators	United States Department of Transportation – Federal Transit Administration headquarters, Washington DC	N/A	Delegates met with Walter Kulyk, Director, Office of Mobility Innovation and Rita Daguillard, Director, Office of Research Management and staff of the Federal Transit Administration

Date	Activity	Location	System/Service	Description
27 August 2012	Meeting with Regulators and Site Visit	Metropolitan Transportation Authority, New York City Transit, and New York City Department of Transportation headquarters, New York	Select Bus Service	Delegates met with Ted Orosz, Director of Long Range Bus Planning, Darnell Tyson, Manager of Long Range Bus Planning, and Eric Beaton Director of Transit Planning. Delegates discussed the Select Bus Service Bus Rapid Transit and took a short ride on the service.
28 August 2012	Meeting with Regulators and Site Visit	Greater Cleveland Regional Transit Authority Main Offices and HealthLine Vehicle at Public Square (NW Quadrant HL Station)	Greater Cleveland Regional Transit Authority Rapid Transit system.	Delegates received a presentation on the Euclid Corridor Transportation Project by Greater Cleveland Regional Transit Authority staff. This was followed by a site visit of the Cleveland HealthLine Bus Rapid Transit system which features in this report as a case study. Presenters and site visit guides were Joseph Calabrese Chief Executive Officer/ General Manager of the Regional Transit Authority, Michael Schipper Director General Management of Engineering and Project Management, Regional Transit Authority, Tom Yablonsky, Executive Vice President, Downtown Cleveland Alliance, Jim Haviland, Executive Director, Midtown Corridor.
29 August 2012	Meeting with Regulators and Site Visit	City of Ottawa Transit Services Department and Ottowa OC Transpo Rapid Transit system	OC Transpo	Delegates visited the Transitway platform on Slater Street at Metcalfe Street. Delegates rode the OC Transpo system through Train Station, St. Laurent Station, Blair Station (future terminal of light rail line), Road 174 (bus lanes on shoulder of highway, and Place d'Orleans Station The host for the site visit was Pat Scrimgeour, Manager, Transit Service and Planning and OC Transpo.
30 August 2012	Meeting with Regulators and Industry, Site Visit	Toronto, Metrolinx system	Metrolinx System and Canadian Urban Transit Association	Delegates met with representatives of the Metrolinx Authority. Delegates received a presentation from the Canadian Urban Transit Association. This was followed by a tour of the Metrolinx System.

Date	Activity	Location	System/Service	Description
30 August 2012	Meeting with Regulators, Learning and Research, Site Visit	Toronto	Brampton Transit	Delegates met with representatives of Brampton Transit and received a presentation from them. Delegates took a tour of the Brampton Transit system. The Brampton Transit system features the Brampton ZUM Rapid Transit. The Brampton ZUM Rapid Transit is a Bus Rapid Transit system featuring express services with a strong branding ethic to distinguish it from pre-existing services.
30 August 2012	Meeting with Regulators, Site Visit	Toronto	York Region Transit	Delegates met with representatives of York Region Transit and toured the York Region Transit system. The York Region Transit system includes the Viva Bus Rapid Transit system.

Appendix C: Major Elements of Bus Rapid Transit (United States and International Examples)

Bus Rapid Transit Element	Experience in the United States	International Examples
Running Way > Running way segregation > Running way marking > Guidance lateral	• Bus Rapid Transit systems in the U.S. have incorporated all types of running ways, mixed flow arterial (Los Angeles, Oakland, Kansas City), mixed flow freeway (Phoenix), dedicated arterial lanes (Boston, Orlando), at-grade transitways (Miami, Eugene), and fully grade-separated surface transitways (Pittsburgh), and subways (Seattle, Boston). • Mechanical guidance features have been incorporated into a few Bus Rapid Transit systems (Eugene, Cleveland). The only application of non-mechanical running way guidance was the precision docking for Las Vegas MAX (visited on the Rapid Transit Study Visit of North America) with optical guidance, which has since been deactivated. • Use of running way markings to differentiate Bus Rapid Transit running ways and articulated brand identity is rare.	• Use of exclusive running ways, both arterial bus lanes in transitways is widespread cross new Bus Rapid Transit applications in Europe, Asia, Australia and the Americas. • Use of running way guidance is evident with mostly mechanical guidance applications. • Physical barriers such as curbs and raised markers are evident in some especially – congested corridors in Latin America and Asia. Coloured lane markings are used in a few cases (e.g. Auckland, London, Nagoya, Sydney, and Utrecht.
Stations > Station type > Platform Height > Passing capability > Station Access	• The level of station design correlates strongly with higher sophistication and more amenities. • The use of level boarding has grown in the US following the example of the Las Vegas MAX (visited on the Rapid Transit Study Visit of North America), new applications of raised curbs in Eugene and near-level boarding in Cleveland (visited on the Rapid Transit Study Visit of North America). No uniform approach has emerged. • Real time schedule and/or vehicle arrival information and communications infrastructure such as public telephones and emergency telephones are starting to be installed in systems.	• As the use of exclusive running ways is more common among international Bus Rapid Transit systems more elaborate station types are used. • Enclosed stations are more common among Latin American Bus Rapid Transit systems.

Bus Rapid Transit Element	Experience in the United States	International Examples
Vehicles > Vehicle configuration > Aesthetic enhancement > Passenger circulation enhancement > Propulsion	• Early Bus Rapid Transit systems used standard vehicles that were often identical to the rest of a particular agency's fleet. Systems such as the Los Angeles Metro Rapid (visited on the Rapid Transit Study Visit of North America), AC Transit's Rapid Bus, and Boston's Silver Line are phasing in operation of 60 foot articulated buses as demand grows. • The use of vehicle configurations or aesthetic enhancements to differentiate Bus Rapid Transit is gaining momentum. In addition to differentiated liveries and logos, agencies are procuring stylised and specialised Bus Rapid Transit vehicles. • Las Vegas (visited on the Rapid Transit Study Visit of North America) represents the first use of a specialised Bus Rapid Transit vehicle in the US. • A key feature of the vehicles on this system was doors on both sides of the bus enabling stops to be located on the kerbisde or on purpose built median strips. • Other systems including systems visited on the Rapid Transit Study Visit of North America (Cleveland, Eugene, Los Angeles Orange Line, Oakland) are implementing stylised vehicles in both articulated and standard sizes.	• Use of stylised vehicles is widespread in European and Latin American Bus Rapid Transit systems although conventional bus configurations are still the norm worldwide. • A few systems use bi-articulated buses on trunk lines in Latin America (Curitiba and Bogota) and Europe (Eindhoven, Utrecht and Caen). • High floor vehicles are common among Latin American systems. Low-floor vehicles are becoming widely applied throughout the world.
Fare Collection	• Alternate fare collection processes are rare in the United States, use of proof of payment features in three systems visited on the Rapid Transit Study Visit of North America (Las Vegas MAX system, Los Angeles Orange Line, Cleveland Health Line). Variations on proof-of-payment such as free downtown zones and pay-on-exit are used in Orland, Seattle and Pittsburgh. • Electronic fare collection using magnetic-stripe cards or smart cars is slowly being incorporated into Bus Rapid Transit systems, but as part of agency-wide implementation rather than Bus Rapid Transit specific implementation. Smart cards are more common than other forms of electronic fare collection.	• Pre-paid fare collection is the norm amongst Bus Rapid Transit systems in Latin America (Bogota, Curitiba, Quito and Guayaquil) and new systems in China (Beijing and Hangzhou). • Some proof-of-payment

Bus Rapid Transit Element	Experience in the United States	International Examples
Intelligent Transportation Systems	• The most common ITS applications include Transit Signal Priority, Automatic Vehicle Location Systems, Automated Scheduling and Dispatch Systems, and Real-Time Traveller Information at Stations and on Vehicles. • Installation of security systems such as emergency telephones at stations and closed circuit video monitoring is rare, but increasing as newer, more comprehensive systems are implemented.	• As in the U.S., Automatic Vehicle Location and Transit Signal Priority and Real-Time Traveler Information are the most commonly implemented ITS systems. • Electronic guidance systems have been implemented in only a few cases (Rouen, Eindhoven).
Branding Elements	• Most newly-launched Bus Rapid Transit systems have been consciously marketed as distinct from local transit services with distinct Bus Rapid Transit brands. • Use of brand names, logos, and colors is widespread.	• Especially in the context of developing countries, implementation of Bus Rapid Transit as a distinct brand has been used as a tool to reform and regulate the bus industries and simplify the service offerings perceived by the public (many cases in Brazil, Colombia, and China). • Use of brand names, logos, and colors is widespread. Use of differentiated colors for other types of bus service is common in Latin America. • In some cases, it is common for the running way facility and stations to be branded, while some routes that serve them are designated like other routes in the system (Brisbane and Ottawa)

Source: US Department of Transportation, 2009

Appendix D: Benchmarks for Transit Supportive Plans and Policies and Performance (New Starts)

Growth Management		
Engineering and Full Funding Grant Agreement The adjacent Ratings are based on assessment of the following: • Concentration of development around established activity centers and regional transit • Land conservation and management.	**Ratings**	**Description**
	HIGH	Adopted and enforceable growth management and land conservation policies are in place throughout the region. Existing and planned densities, along with market trends in the region and corridor are strongly compatible with transit
	MEDIUM	Significant progress has been made toward implementing growth management and land conservation policies. Strong policies may be adopted in some jurisdictions but not others, or only moderately enforceable policies (e.g., incentive-based) may be adopted region wide. Existing and/or planned densities and market trends are moderately compatible with transit
	LOW	Limited consideration has been given to implementing growth management and land conservation policies; adopted policies may be weak and apply to only a limited area. Existing and/or planned densities and market trends are minimally or not supportive of transit.

Transport Supportive Corridor Policies		
Full Funding Grant Agreement The adjacent Ratings are based on assessment of the following: • Plans and policies to increase corridor and station area development • Plans and policies to enhance transit-friendly character of corridor and station area development • Plans to improve pedestrian facilities, including facilities for persons with disabilities • Parking policies.	**Ratings**	**Description**
	HIGH	Conceptual plans for the corridor and station areas have been developed. Local jurisdictions have adopted or drafted revisions to comprehensive and/or small area plans in most or all station areas. Land use patterns proposed in conceptual plans and local and institutional plan revisions are strongly supportive of a major transit investment.
	MEDIUM	Conceptual plans for the corridor and station areas have been developed. Local jurisdictions have initiated the process of revising comprehensive and/or small area plans. Land use patterns proposed in conceptual plans and local and institutional plan revisions are at least moderately supportive of a major transit investment.
	LOW	Limited progress, to date, has been made toward developing station area conceptual plans or revising local comprehensive or small area plans. Existing station area land uses identified in local comprehensive plans are marginally or not transit-supportive.

Transport Supportive Corridor Policies		
Engineering	**Ratings**	**Description**
The adjacent Ratings are based on assessment of the following: • Plans and policies to increase corridor and station area development • Plans and policies to enhance transit-friendly character of corridor and station area development • Plans to improve pedestrian facilities, including facilities for persons with disabilities • Parking policies.	HIGH	Conceptual plans for the corridor and station areas have been developed. Discussions have been undertaken with local jurisdictions about revising comprehensive plans. Land use patterns proposed in conceptual plans for station areas (or in existing comprehensive plans and institutional master plans throughout the corridor) are strongly supportive of a major transit investment
	MEDIUM	Conceptual plans for the corridor and station areas are being developed. Discussions have been undertaken with local jurisdictions about revising comprehensive plans. Land use patterns proposed in conceptual plans for station areas (or existing in local comprehensive plans and institutional master plans) are at least moderately supportive of a major transit investment.
	LOW	Limited progress, to date, has been made toward developing station area conceptual plans or working with local jurisdictions to revise comprehensive plans. Existing station area land uses identified in local comprehensive plans are marginally or not transit-supportive.

Tools to Implement Land Use Policies		
Full Funding Grant Agreement	Ratings	Description
The adjacent Ratings are based on assessment of the following: • Outreach to government agencies and the community in support of land use planning • Regulatory and financial incentives to promote transit-supportive development • Efforts to engage the development community in station area planning and transit-supportive development.	HIGH	Transit agencies and/or regional agencies are working proactively with local jurisdictions, developers, and the public to promote transit-supportive land use planning and station area development. The transit agency has established a joint development program and identified development opportunities. Agencies have adopted effective regulatory and financial incentives to promote transit-oriented development. Public and private capital improvements are being programmed in the corridor and station areas which implement the local land use policies and which leverage the Federal investment in the proposed corridor.
	MEDIUM	Transit agencies and/or regional agencies have conducted some outreach to promote transit-supportive land use planning and station area development. Regulatory and financial incentives to promote transit-oriented development are being developed, or have been adopted but are only moderately effective. Capital improvements are being identified that support station area land use plans and leverage the Federal investment in the proposed major transit corridor.
	LOW	Limited effort has been made to reach out to jurisdictions, developers, or the public to promote transit-supportive land use planning; to identify regulatory and financial incentives to promote development; or to identify capital improvements.

Tools to Implement Land Use Policies		
Engineering	Ratings	Description
The adjacent Ratings are based on assessment of the following: • Outreach to government agencies and the community in support of land use planning • Regulatory and financial incentives to promote transit-supportive development • Efforts to engage the development community in station area planning and transit-supportive development.	HIGH	Transit agencies and/or regional agencies are working proactively with local jurisdictions, developers, and the public to promote transit-supportive land use planning and station area development. Local agencies are making recommendations for effective regulatory and financial incentives to promote transit-oriented development. Capital improvement programs are being developed that support station area land use plans and leverage the Federal investment in the proposed major transit corridor.
	MEDIUM	Transit agencies and/or regional agencies have conducted some outreach to promote transit-supportive land use planning and station area development. Agencies are investigating regulatory and financial incentives to promote transit-oriented development. Capital improvements are being identified that support station area land use plans and leverage the Federal investment in the proposed major transit corridor.
	LOW	Limited effort has been made to reach out to jurisdictions, developers, or the public to promote transit-supportive land use planning; to identify regulatory and financial incentives to promote development; or to identify capital improvements.
Performance of Land Use Policies		
Full Funding Grant Agreement	Ratings	Description
The adjacent Ratings are based on assessment of the following: • Demonstrated cases of development affected by transit-oriented policies • Station area development proposals and status.	HIGH	A significant number of development proposals are being received for transit-supportive housing and employment in station areas. Significant amounts of transit-supportive development have occurred in other, existing transit corridors and station areas in the region.
	MEDIUM	Some development proposals are being received for transit-supportive housing and employment in station areas. Moderate amounts of transit-supportive development have occurred in other existing transit corridors and station areas in the region.
	LOW	A limited number of proposals for transit-supportive housing and employment development in the corridor are being received. Other existing transit corridors and station areas in the region lack significant examples of transit-supportive housing and employment development.
Engineering	HIGH	Transit-supportive housing and employment development is occurring in the corridor. Significant amounts of transit-supportive development have occurred in other, existing transit corridors and station areas in the region.
	MEDIUM	Station locations have not been established with finality, and therefore, development would not be expected. Moderate amounts of transit-supportive housing and employment development have occurred in other, existing transit corridors and station areas in the region.
	LOW	Other existing transit corridors and station areas in the region lack significant examples of transit-supportive housing and employment development.

<table>
<tr><th colspan="3">Potential of Transit Project on Regional Land Use</th></tr>
<tr><td rowspan="4">Engineering and Full Funding Granting Agreement

The adjacent Ratings are based on assessment of the following:
• Adaptability of station area land for development
• Corridor economic environment</td><td>Ratings</td><td>Description</td></tr>
<tr><td>HIGH</td><td>A significant amount of land in station areas is available for new development or redevelopment at transit-supportive densities. Local plans, policies, and development programs, as well as real estate market conditions, strongly support such development.</td></tr>
<tr><td>MEDIUM</td><td>A moderate amount of land in station areas is available for new development or redevelopment at transit-supportive densities. Local plans, policies, and development programs, as well as real estate market conditions, moderately support such development.</td></tr>
<tr><td>LOW</td><td>Only a modest amount of land in station areas is available for new development or redevelopment. Local plans, policies, and development programs, as well as real estate market conditions, provide marginal support for new development in station areas.</td></tr>
<tr><th colspan="3">Plans and Policies to Maintain or Increase Affordable Housing in the Corridor</th></tr>
<tr><td rowspan="4">Full Funding Grant Agreement

The adjacent Ratings are based on assessment of the following:
• Plans and policies to preserve or increase affordable housing in region and/or corridor
• Adopted financing tools and strategies targeted to preserving or increasing affordable housing in the region and/or corridor
• Documented evaluation of corridor-specific affordable housing needs and supply
• Corridor-specific plans and policies to preserve or increase affordable housing in corridor
• Evidence of developer activity to preserve or increase affordable housing in the corridor.</td><td>Ratings</td><td>Description</td></tr>
<tr><td>HIGH</td><td>Comprehensive affordable housing plans, policies are in place and robust financial incentives are available at the regional level and along the proposed corridor to support affordable housing development. Land use policies and zoning codes support and encourage affordable housing development in transit corridors.</td></tr>
<tr><td>MEDIUM</td><td>Some affordable housing plans and policies are in place on a regional and/or local level, and some financial incentives are available along the proposed corridor to support affordable housing development. Land use policies and zoning codes support affordable housing development in and near transit corridors to a moderate extent.</td></tr>
<tr><td>LOW</td><td>Affordable housing plans and policies are in development or non-existent. Little or no financial incentives are available to support affordable housing development. Land use policies and zoning codes support affordable housing development in and near transit corridors to a lesser extent.</td></tr>
</table>

Plans and Policies to Maintain or Increase Affordable Housing in the Corridor		
Engineering	Ratings	Description
The adjacent Ratings are based on assessment of the following: • Plans and policies to preserve or increase affordable housing in region and/or corridor • Adopted financing tools and strategies targeted to preserving or increasing affordable housing in the region and/or corridor • Documented evaluation of corridor-specific affordable housing needs and supply • Corridor-specific plans and policies to preserve or increase affordable housing in corridor Evidence of developer activity to preserve or increase affordable housing in the corridor.	HIGH	Plans and policies are in place that identify and address the specific housing affordability needs along the corridor, including income target levels, tenure, and unit types. Financing commitments and/or sources of funding are identified and secured to preserve and/or build new affordable housing consistent with adopted plans. Developers are actively working in the corridor to secure priority development sites and/or maintain affordability levels in existing housing units.
	MEDIUM	Plans and policies are being prepared that identify and address the specific housing affordability needs along the corridor, including income target levels, tenure, and unit types. Some financing commitments and/or sources of funding have been identified and secured to preserve and/or build new affordable housing consistent with adopted plans. Developers are starting to work in the corridor to secure priority development sites and/or maintain affordability levels in existing housing units.
	LOW	Plans and policies are not in place that identify and address the specific housing affordability needs along the corridor. Financing commitments and/or sources of funding have not been identified and secured to preserve and/or build new affordable housing consistent with adopted plans. There is little or no affordable housing development activity in the corridor.

Source: Federal Transit Administration, 2013

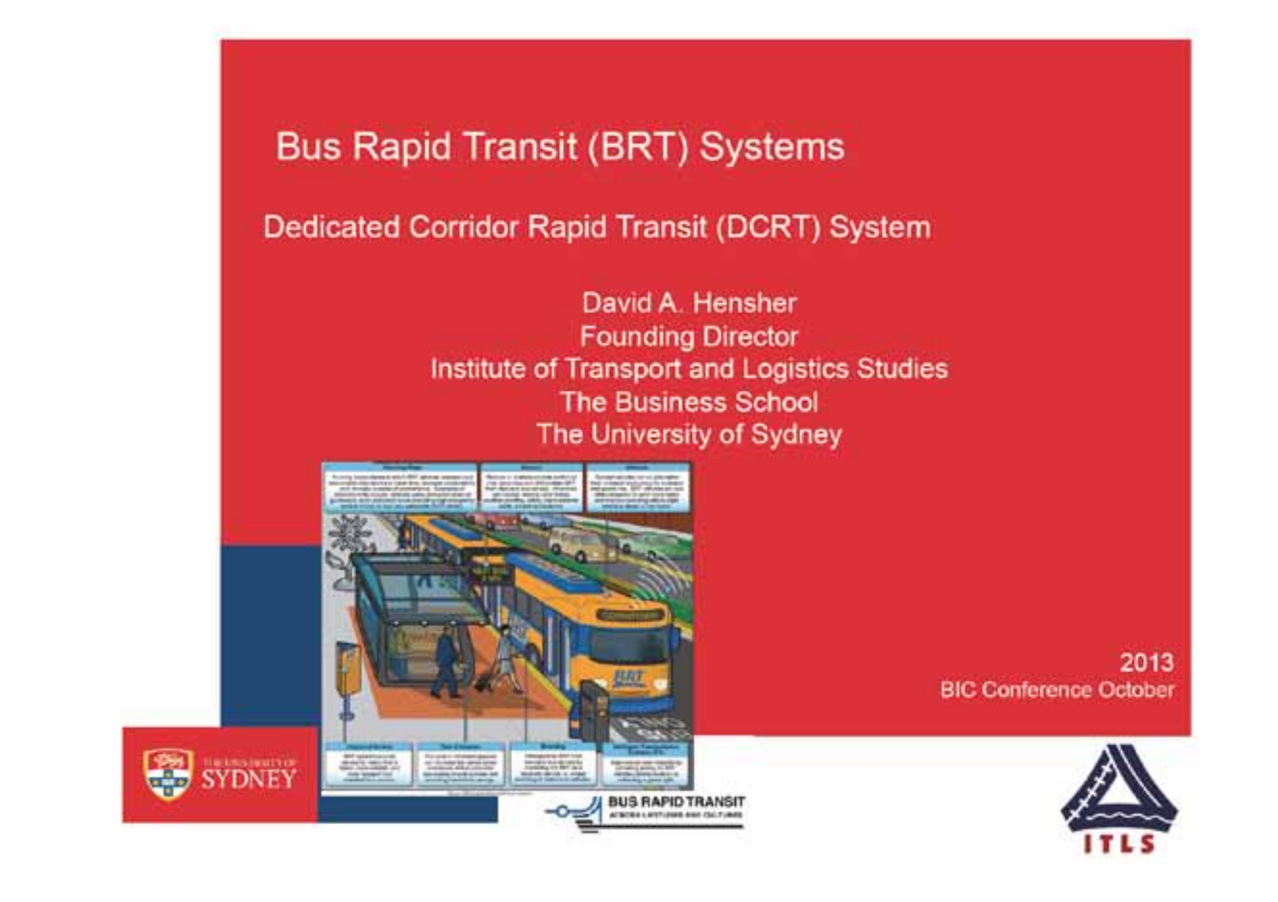
* The Full Funding Grant Agreement (FFGA) is the final step of the New Starts planning and project development process.
The Federal Transit Administration and the agencies responsible for the project enter into this multi-year contractual agreement that formally establishes the maximum level of Federal financial assistance and outlines the terms and conditions of Federal participation. For projects requiring $75 million or more of New Starts funding, the requisite agreement is the FFGA.
The FFGA defines the project, including cost, scope, and schedule; commits to a maximum level of New Starts financial assistance, establishes the terms and conditions of Federal financial participation, defines the period of time for completion of the project and helps Federal Transit Administration and the agency responsible for the project manage the project in accordance with Federal law.
The FFGA assures the grantee of predictable Federal financial support for the project, while placing a limitation on the amount of this support.
An FFGA limits the exposure of the Federal Government if the project experiences any cost increases during construction, as it is the responsibility of agency responsible for the project to properly manage, design, and construct the project.
The Federal Transit Administration uses a Project Management Oversight Program to obtain independent feedback on project status and progress, including the establishment of scope, budget, and schedule, as well as to provide guidance on management, construction, and quality assurance practices.
The Federal Transit Administration typically considers an FFGA for a New Starts project shortly after it has been approved to enter the final design phase of the New Starts project development process (for Small Starts projects, a PCGA is contemplated late in project development).
By the time of the execution of the agreement, the grantee has developed a final project scope, schedule, budget, and financial plan to build and operate the project.
Reflecting the intense Federal interest in the project, the FFGA is subject to a Congressional 60-day review period before Federal Transit Administration may execute it.

Appendix E: Presentation From David Hensher To The Bic National Conference

The following presentation was given by Professor David Hensher, Founding Director of the Institute of Transport and Logistics Studies at the Business School University of Sydney at the University of Sydney to the 2013 Bus Industry Confederation National Conference in Adelaide.

It has been included in here because it touches on a number of key areas addressed in this report including the definition of Rapid Transit (in particular Bus Rapid Transit and Buses with Higher Levels of Service), patronage drivers for Rapid Transit, the marketing of Rapid Transit and the possibility of defining a new nomenclature for Rapid Transit that bypasses traditional stereotypes.

The BIC thanks Professor Hensher for his contribution to the field of knowledge on Rapid Transit and for allowing us to use this presentation in this report.



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What is a Bus Rapid Transit System?

"Is a flexible, rubber-tired form of rapid transit that combines stations, vehicles, services, running ways and ITS elements into an integrated system with strong identity"
TCRP Report 90 – Bus Rapid Transit – Volume 2: Implementation Guidelines 2003

"It is a high quality public transport system, oriented to the user that offers fast, comfortable and low cost urban mobility"
BRT Planning Guide – ITDP, 2007

Photo: Karl Fjelstrom - ITDP

ITLS

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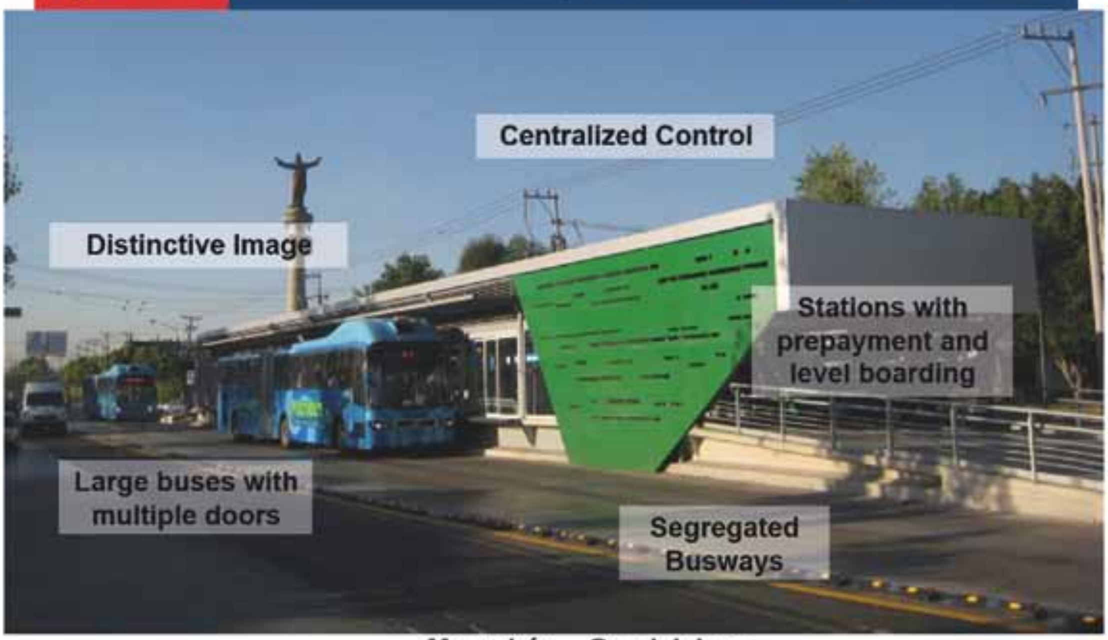
Key BRT Components



Macrobús – Guadalajara

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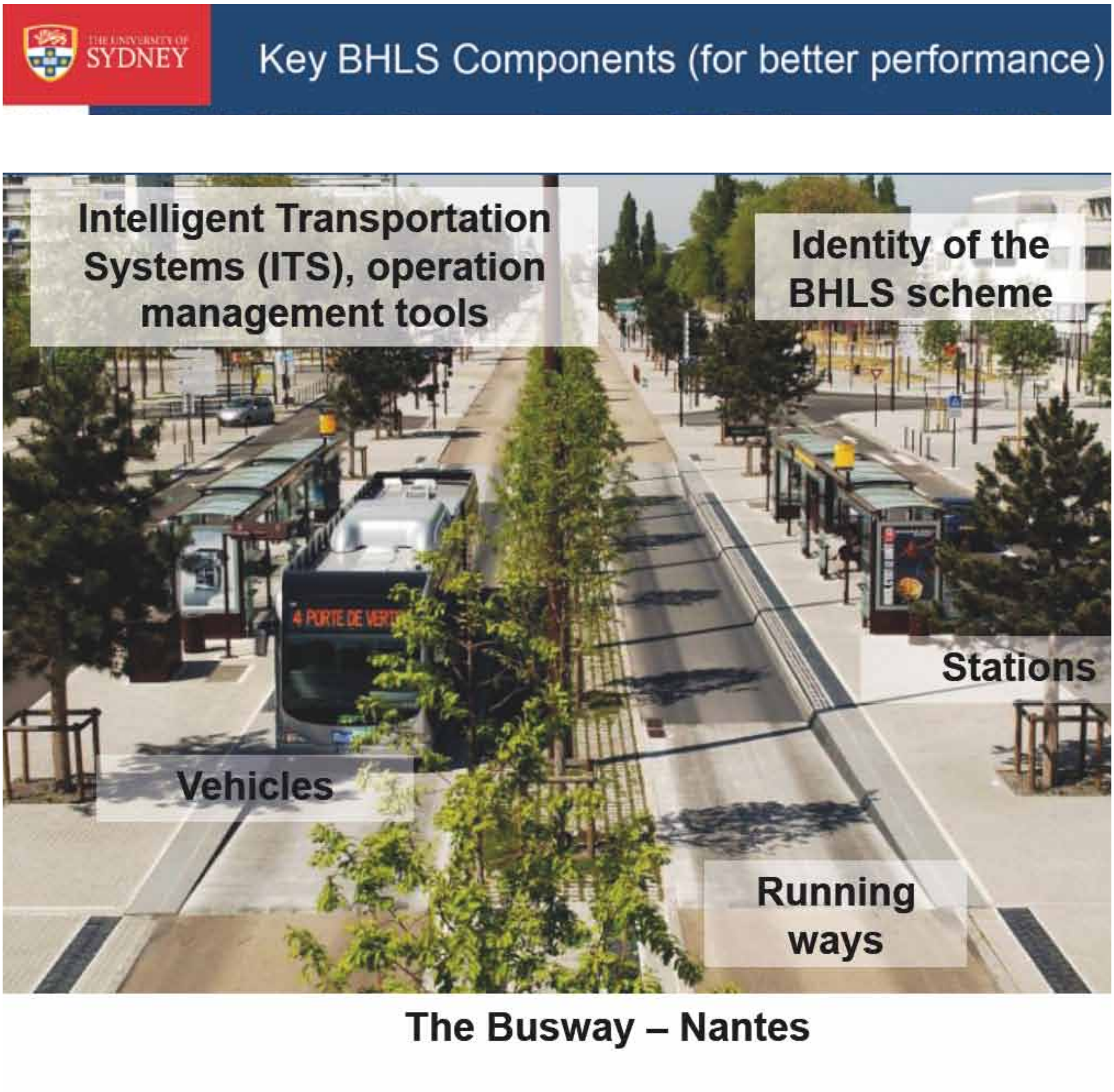
Buses with a High Level of Service (BHLS)

Cambridge, UK

"is an urban transport system integrating a bus, but within new conditions providing an increase in performance thanks to a triple optimization of:

- *The internal characteristics of the technical and commercial offer.*
- *The integration of this offer into the whole public transport network.*
- *The integration of this network into the urban area"*

(Finn et al. 2011)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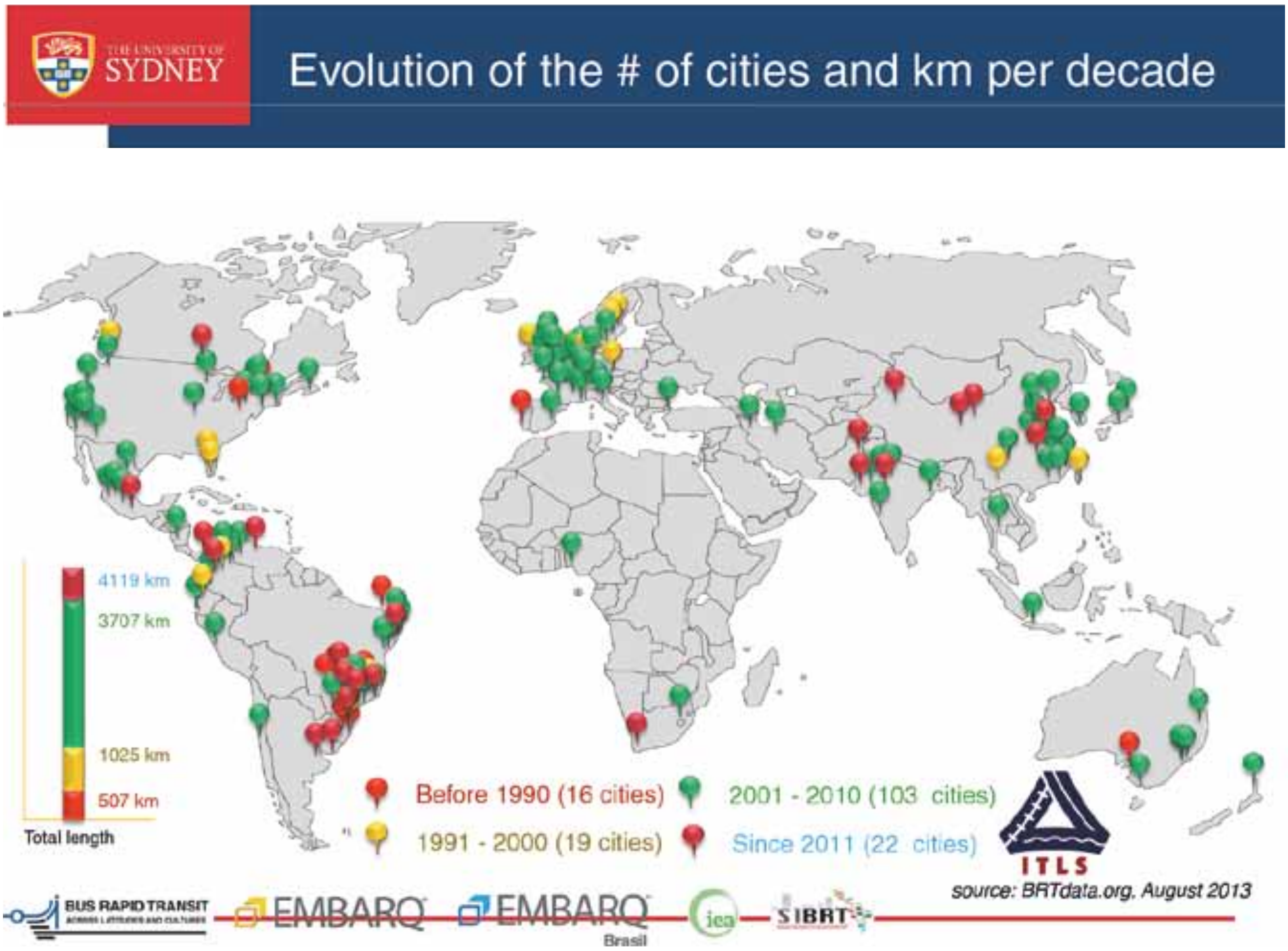
Key BHLS Components (for better performance)
Intelligent Transportation Systems (ITS), operation management tools
Identity of the BHLS scheme
Stations
Vehicles
Running ways
The Busway – Nantes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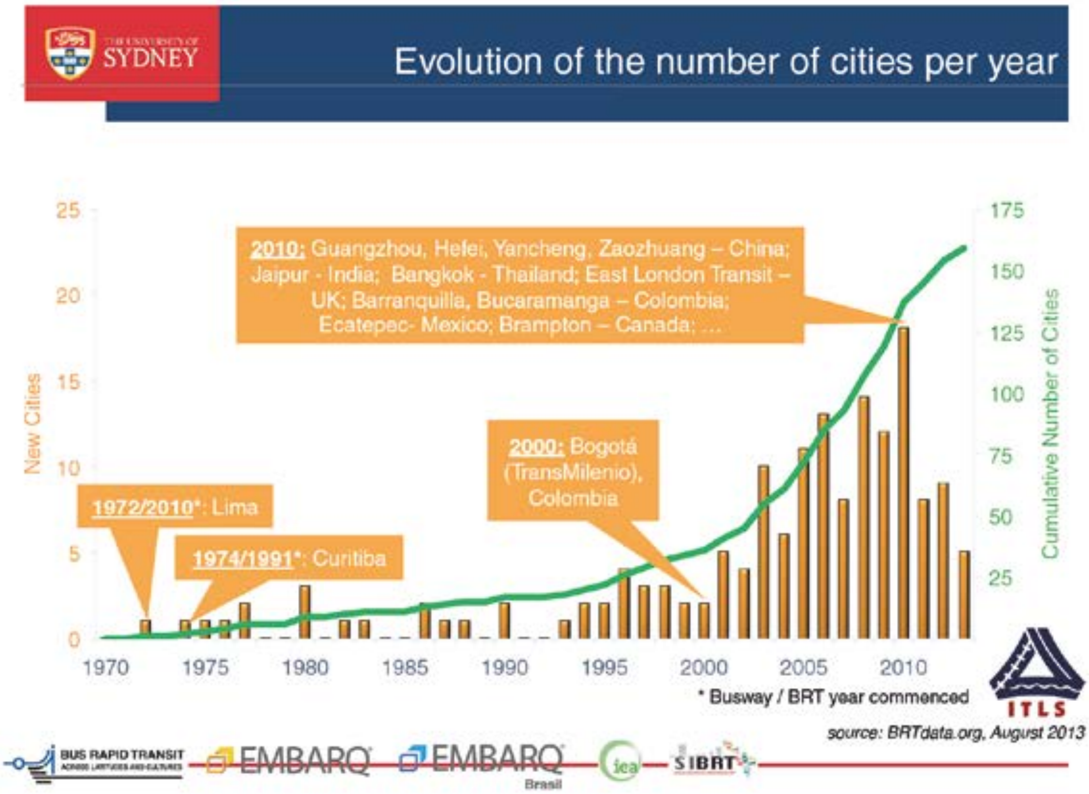
Evolution of the # of cities and km per decade
4119 km
3707 km
1025 km
507 km
Total length
Before 1990 (16 cities)
1991 - 2000 (19 cities)
2001 - 2010 (103 cities)
Since 2011 (22 cities)
ITLS
source: BRTdata.org, August 2013
BUS RAPID TRANSIT
EMBARQ
EMBARQ Brasil
iea
SIBRT



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Cities with the most used BRT/Bus Corridors Networks 2010

Name	Corridors	Km	Pax/day
Prioridade Transporte Colectivo, Sao Paulo, Brasil	10	301.3	6,843,664
Rede Integrada de Transporte, Curitiba, Brazil	6	72.0	2,260,000
TransMilenio, Boogta, Colombia	7	84.0	1,700,000
Busways, Taipei, China Taiwan	10	30.3	1,680,000
Tehran BRT, Iran	5	91.0	1,440,000
Prioridade Transporte Colectivo, Porto Alegre	10	57.2	1,170,000
Guangzhou BRT, China	1	22.5	800,000
Optibus, Leon, Mexico	4	31.0	700,000
Metrobus, Istanbul, Turkey	2	43.0	700,000
Metrorapid, Los Angeles, USA	21	390.2	464,600
Metrobus, Mexico City, Mexico	2	50.0	450,000
Metrobus-Q, Quito, Ecuador	3	42.2	440,000
Prioridade Transporte Colectivo, Belo Horizonte, Brazil	2	23.7	435,000

Dark color strong segregation, stations with prepayment

Source: EMBARQ BRT/Bus Corridors Database, January, 2011

Cities with the Longest BRT/Bus Corridors Networks 2010

Name	Corridors	Km
Metrorapid, Los Angeles, California	21	390.2
Prioridade Transporte Colectivo, Sao Paulo, Brazil	10	301.3
SmartBus, Melbourne, Australia	4	233.0
MIO, Cali, Colombia	6	179.0
Trans Jakarta, Jakarta, Indonesia	10	172.2
LINK, Phoenix, USA	4	128.0
Metrobus, Monterrey, Mexico	3	101.0
Tehran BRT, Iran	5	91.0
Trans Hulonthanlangi, Indonesia	3	90.0
Trans Jogja, Indonesia	3	90.0
TransMilenio, Bogota, Colombia	7	84.0
TransMetro, Pekanbaru, Indonesia	2	74.0
Rede Integrada de Transporte, Curitiba, Brazil	6	72.0

Dark color strong segregation, stations with prepayment

Source: EMBARQ BRT/Bus Corridors Database, January, 2011

16 New Cities with BRT/Bus Corridors in 2010

Name	Corridors	Km	Stations	Buses	Passengers/ Weekday
Guangzhou BRT, China	1	22.5	26	800	800,000
Hefei BRT, China	2	12.7	14	65	65,250
Yancheng BRT, China	1	8.0	21	20	20,000
Zaozhuang BRT, China	1	33.0	24	20	20,000
Jaipur Bus, India	1	7.1	10	20	6,200
Trans Hulonthanlangi, Indonesia	3	90.0	84	15	1,920
Tans Musim, Indonesia	2	60.0	69	15	1,920
Batik Solo Trans, Indonesia	1	30.0	35	15	1,920
Bangkok BRT, Thailand	1	15.9	12	20	10,000
East London Transit, UK	1	20.0	40	18	9,000
Corredor de Ônibus de João Pessoa, Brasil	1	2.5	5	111	100,000
Transmetro, Barranquilla, Colombia	1	13.4	15	92	32,000
Metrolinea, Bucaramanga, Colombia	1	8.9	24	131	75,000
Mexibus, Estado Mexico, Mexico	1	16.0	32	63	63,000
Metropolitano, Lima, Perú	2	27.0	35	627	160,000
Züm, Bradford, Canada	1	28.5	17	15	7,500

Source: EMBARQ BRT/Bus Corridors Database, January, 2011

BRT in numbers 2010

- 120 cities with BRT Systems and Bus Corridors
- 280 corridors
- 4,335 km
- 6,683 stations
- 30,000 buses
- 26.8 million passengers per weekday
  - 1% of the world´s urban population (2010)
  - 1.4 times the combined population of New York and Newark (2010)

Rapid growth of BRT Systems and Bus Corridors in 2010, specially in developing cities

- 16 cities started operations in 2010 (13% growth)
  - China (4), Indonesia (4), Colombia (2), India, Thailand, Mexico, Perú, UK, Canada
  - 21 corridors; 396 km; 464 stations; 2,047 buses
  - 1.4 million passengers per weekday (5% growth)
- 7 cities expanded corridors in 2010, 125 km
- 49 new cities with corridors under construction
- 16 cities expanding their corridors
- 31 new cities in planning stages

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Curitiba, RIT, 72 km median busways
1.2 million passengers per day
Initial Bus Corridor 1972
Full BRT in 1982

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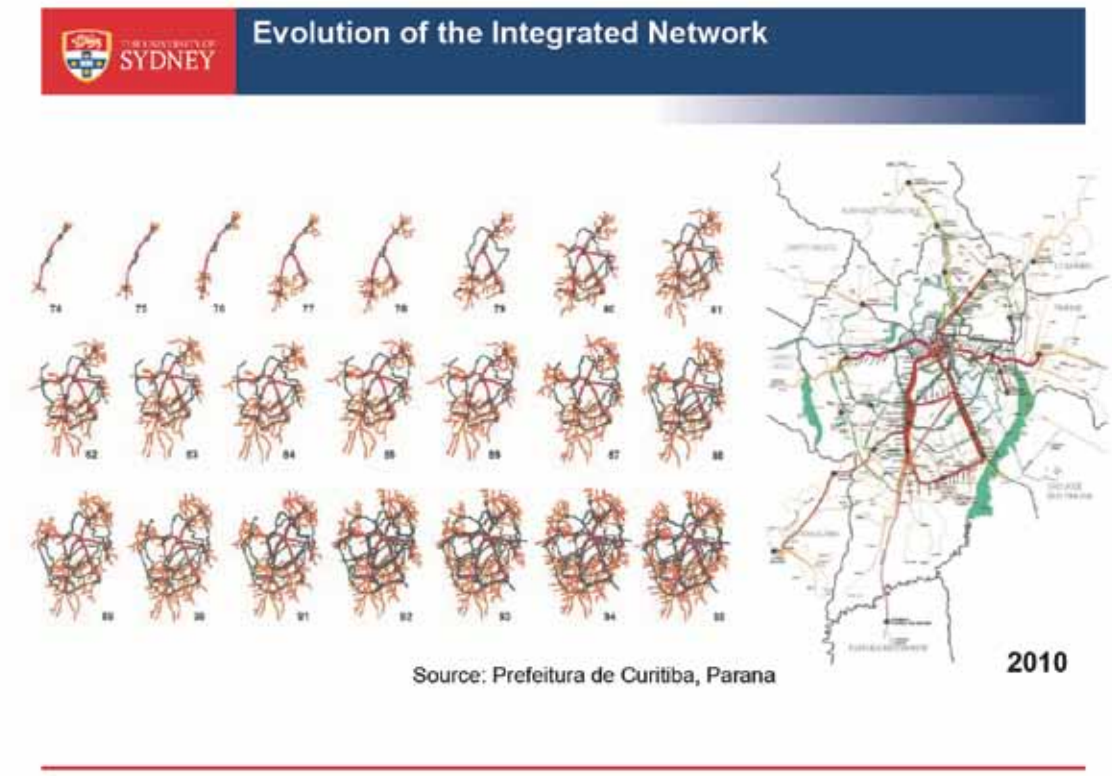
1. Making buses run like surface metro – Curitiba 1982

- median bus-ways longitudinally segregated
- tube stations with fare prepayment and level access
- physical and fare integration
- dispatch control at terminal stations.
- differentiated services:
  - Expresso, Ligerao, Ligeirinho, Interbairros, Alimentador
  - Special services downtown, hospitals, touristic bus, schools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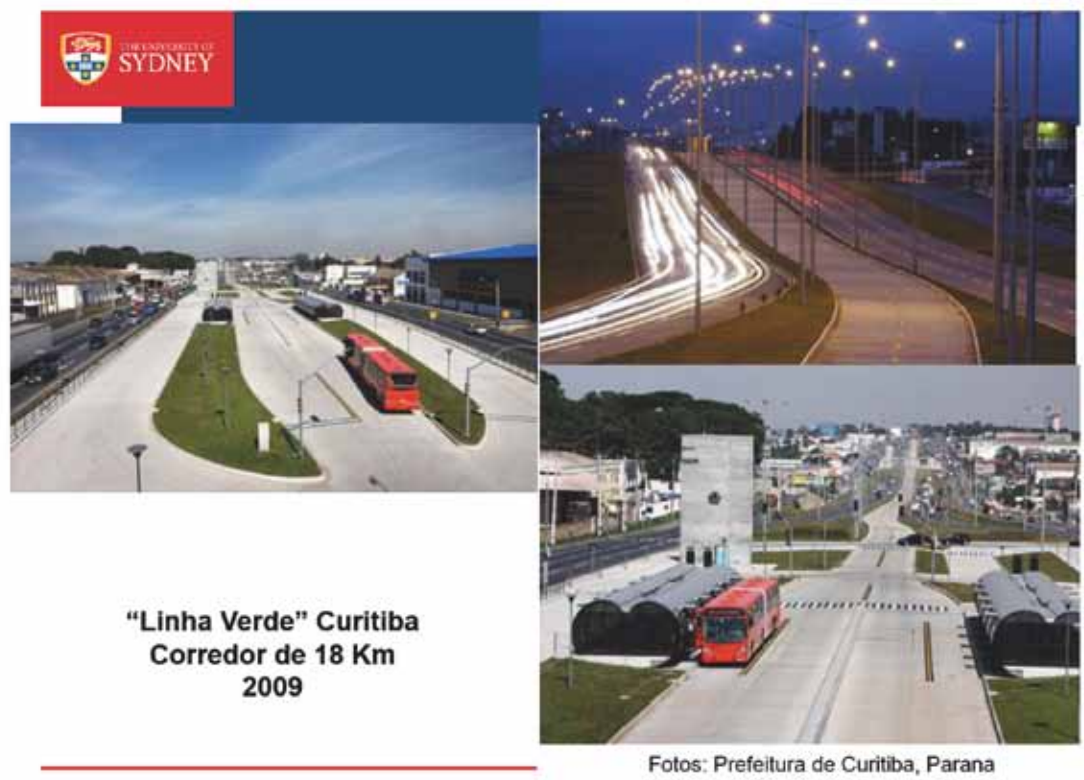
Evolution of the Integrated Network
2010
Source: Prefeitura de Curitiba, Parana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"Linha Verde" Curitiba
Corredor de 18 Km
2009
Fotos: Prefeitura de Curitiba, Parana

Foto: Prefeitura de Curitiba, Paraná

Expansión de Capacidad
"Corredor Boqueirao"
2010

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2. Implementing buses of high level of service, The Trans Val de Marne TVM – Paris 1993

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Implementing buses of high level of service, The Trans Val de Marne TVM – Paris 1993

- Is the most used BHLS
- 1993 (13 km) and
- 2007 (7 km)
- 20 km bus lanes, 95% dedicated, mostly central segregated
- 29 stations (@ 700m)
- 39 articulated buses, specially designed and branded for the system

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Implementing buses of high level of service, The Trans Val de Marne TVM – Paris 1993

- Information systems
- 23 km/h
- 17 km/h minimum peak
- 3.5 min headway (peak)
- Interval plus 3 minutes for 96% of the pax
- 66,000 trips/day, growing 7% per year
- Good integration with pedestrians and rail (4 RER and 1 subway)

New vehicle Créalis for the BHLS routes

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Interesting developments 2010 plus

- Government Agencies – moving from corridors to integrated systems and collaborative efforts – SIBRT
- Growing Public Private Partnerships PPP for systems operation – Latin America, India, South Africa
- Increased support from the national level - programs in Mexico, Colombia, India, Indonesia, France, US
- Interest of manufacturers in BRT, new buses, alternative fuels from India, Indonesia and China - complement the high bus production of Brasil
- Fare collection, control, user information systems technologies consolidated

ITLS

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Salient issues

- Poor understanding on what is BRT
- Institutional and financial risks – poor contracting, institutional set ups and fare level definition mechanisms
- *"The bus industry needs a 'wake-up' call. The opportunities are extensive, but the industry is far too traditional (often complacent), often lacking lateral thinking and not pro-active enough."* Hensher D. "A bus-based transitway or light rail? Continuing the saga on choice versus blind commitment" Road & Transport Research, Vol 8 No 3 September 1999.
- Strong preference by decision makers for rail alternatives without adequate alternatives analyses
  - Hot debates in Curitiba, Bogotá, Quito, Lima, Sao Paulo, Delhi, Mumbai, Bangalore, Washington DC, Sydney…

ITLS

Thredbo 12: Types of Bus-based transit According to Transport Demand Needs and Urban Environment* They must be included in the mix of options (Juan C Munoz *et al*, 2012)

Type	Main Features	Throughput/ Performance	Application
Basic Bus Corridor	Median or curbside lanes, on board payment, conventional buses	500-5,000 pphpd 12-15 km/h	Low density corridors, suburbs
Bus of High Level of Service BHLS	Infrastructure, technology and advanced vehicles for enhanced service provision	500-2,500+ pphpd 15-35 km/h	Small urban areas, historic downtown, suburbs
Medium BRT	Single median lanes, off board payment, information technologies	5,000-15,000 pphpd 18-23 km/h	Medium density corridors, suburb/ centre connections
High Capacity BRT	Dual median lanes physically separated, large stations with prepayment, large buses, information technologies, combined services	15,000-45,000 pphpd 20-40 km/h	High demand, dense, mixed use corridors, central city

* Variations apply, need to design according to local context; pphpd=passengers per hr per direction

Assessment of Patronage Drivers for BRT

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What are Desirable Features of a Good BRT System: Drivers of Patronage

Hensher, Mulley and Li (2012)	Hensher and Golob (2008)	Hensher and Li (2012)
Maximum fare	Average fare per trip	Average fareper trip
Service frequency	Peak headway	Headway
Car mode share	Trunk vehicle capacity	Average distance between stations divided by population density
Number of BRT stations interacted with extension of segregated with-flow lanes	Number of stations	Number of existing trunk corridors
Pre-board fare collection		Pre-board fare collection and fare verification
Doorways for passengers on left and right sides of bus		Doorways located on median and curbside
Longitudinal location of with-flow bus lanes on sides		Existence of an integrated network of routes and corridors
		Modal integration at stations
		Total length of BRT corridor
		Opening year relative to 2011
		Quality control oversight from an independent entity/agency
		Latin America (Location of BRT)

Hensher, D.A. and Golob, T.F. (2008) Bus rapid transit systems – A comparative assessment. *Transportation* 35 (4), 501-518.
Hensher, D.A. and Li, Z. (2012) Ridership Drivers of Bus Rapid Transit Systems, *Transportation*, online 26 February 2012, DOI: 10.1007/s11116-012-9392-y.
Hensher, D.A., Mulley, C., and Li, Z. *(2012)* Drivers of Bus Rapid Transit Systems –Influences on Ridership and Service Frequency

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VOTING PREFERENCES MODEL

› People (and therefore politicians should) look for systems which give

1. fast overall journey time to destination frequent services,
2. low fares
3. value for money for the taxpayer,
4. packages which give an outcome that will last for many years,
5. a network that is cost effective to operate,
6. systems that give wide network coverage, and
7. interchanges between services and modes

› Targeting can be same for users and non users EXCEPT for

- Frequency
- Interchanges

Which matter much more to public transport users

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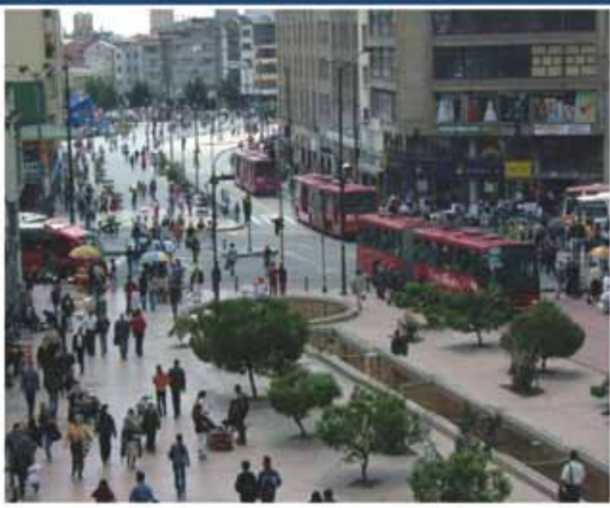
Bogotá, TransMilenio, 90 Km busways

1,8 milion pax/day



Bogotá TransMilenio
Eje Ambiental Avenida Jiménez

Photo ITDP


Express Way Lanes
TransMilenio, Bogota
EMBARQ


5. Introducing high speed buses on
expressways – Istanbul 2008
High commercial speed
42 km/h (now 35 km/h)
30
EMBARQ

- 45 Km central bus ways on expressway (100% segregated)
- Long station platforms -90m, separated 1.1 km on average
- Non-grade queue jumpers to access the Bosphorus Bridge, (mixed traffic)
- Low floor buses (articulated and bi-articulated)
- 30,000 passengers/ hour/ direction, 15 sec interval
- 600,000 passengers/day

Expresso Tiradentes – Sao Paulo

Foto: SPTrans

- 22.5 km corridor
- Long stations –from 55m to 260m, with overtaking lanes
- Combines multiple direct services on the same infrastructure.
- 27,000 pphpd
- 350 buses phpd
- 800,000 passengers per day

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Running way guidance

Mechanical	Optical	Magnetic

Essen since 1980, Leeds, Cambridge since august 2011

Rouen, France (2001), Castellón de la Plana, Spain (2008), Nimes, France (2010) and Bologna, Italy (2010). Tested in Las Vegas, Nevada

Eindhoven (2004)

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Running way guidance costs

	Km (Pax/Day)	Type of Guidance	Capital Cost (M€)	Cost/Km (M€)
Teor – Rouen, France	30 (49,000)	Optical	Infra 165 Buses 28 Total 193	Infra 5.5 Buses 0.9 Total 6.4
Spurbus Essen, Germany	16 [4] (17,000)	Kerb Guided	Infra N.A. Buses 0.35/ unit	N.A.
TVRCAS Castellon, Spain	2 (3,200)	Optical (trolleybus)	Infras 22 Buses 8 Total 30	Infra 11.0 Buses 3.8 Total 13.8
Cambridge, UK	25 (20,000)	Kerb Guided	Infra 85 Buses N.A.	Infra 3.4

Source: Finn et al, 2011

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Examples of Costs of Different Vehicle Technologies in Europe (Thousand €)

Propulsion	Standard	Articulated	Double-articulated
Diesel	200	300	600
CNG	250	350	650
Hybrid	300	500	850
Trolley	400	650	1,000
Fuel Cell*	> 1,000	-	-

Source: Finn et. al (2011) * Not yet in commercial operation

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ITS – Fare Collection

- Advanced contactless smart cards are the most common media; flexible, secure, convenient
- Technologies:
  - MIFARE, introduced in 1994, market share of more than 70%
  - Octopus, in Honk Kong since 1997: applications in the Netherlands, Dubai and New Zealand
  - Cubic, in 40 markets around the world
  - Visa/Mastercard
- New: NFC and EMV; for use with cellular phones; under development in 80 countries

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ITS – Planning and Operations

- Advanced route design – heuristics
- Bus and crew scheduling
- Advanced bus and crew scheduling
- Advanced operational control AVL/CAD
- Control: holding, early doors closing, TSP
- Traffic Signal Priority TSP

Common Problems and Challenges

IMAGE OF BUS

Most preferred Image	
BRT standard vehicle (%)	9.6
BRT modern vehicle (%)	15.3
LRT standard vehicle (%)	15.4
LRT modern vehicle (%)	53.1

- "Anyone who lives in Sydney's fast growing north west knows what a short-sighted idea it is to suggest buses should replace the rail link," O'Farrell (Premier of New South Wales) says (June 2012).
- "The idea of putting more buses onto an already crowded road system just beggars belief."

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Common Problems and Challenges

- Rushed implementation – several components incomplete
- Very tight financial planning – non technical user fares, some systems at risk
- Very high occupancy levels (160 pax/bus standard for articulated buses is not accepted by the users)
- Early deterioration of infrastructure (lack of road surface reinforcement or problems in design/construction)
- Implementation of fare collection systems requires longer time tables and very tight supervision
- Insufficient user education

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What is in a Name? Time to Rethink? Image of Bus?

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THE DILEMMA WITH THE B WORD (BUS)

- The image of 'bus' seems to be a big part of the problem
- It is time for a radical move – a name change for BRT.
- **Dedicated Corridor Transit** (DCT) (Or **Dedicated Corridor Rapid Transit –DCRT)**.
- This emphasises that rapid transit is the sell, not the mode

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DCT or DCRT

- **Dedicated Corridor Transit** (DCT) (Or **Dedicated Corridor Rapid Transit –DCRT)**.
- This places the matter fairly and squarely where it belongs:
  - the corridor delivering transit services
  - with transit defined as all candidate public transport modes, OR
  - defined online as "public transportation system for moving passengers".
- It is the qualities that a bus based system can give for DCT that we must show how to sell
- Not be driven to argue the benefits of steel track over bitumen.

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