7. Choosing Transit Mode

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1 Introduction

The Report

1.1 This is the seventh and last in a series of documents describing the proposed London Guided Busway Scheme and providing background material. It provides comparisons of the key characteristics of different types of road and rail based transit systems.

1.2 The full list of documents is as follows:

1. Executive Summary
2. The Scheme
3. Consultation Report
4. Guided Bus Explained
5. Guided Bus in Action
6. Implementing Guided Bus
7. Choosing Transit Mode

Structure of this report

1.3 Chapter 2 of this report provides a comparison of the key characteristics of the different forms of road and rail based rapid transit.

2 Rapid transit modes – a comparison

Mode choices

2.1 There is a wide range of road and rail based transit technologies available to towns and cities seeking ways of countering growing traffic congestion, addressing air quality issues and increasing public transport mode share. The purpose of this chapter of the report is to review the range of transit technologies that are available, to assess their characteristics and to provide a comparison between transit systems in order to identify where and how they may be most appropriately applied.

2.2 The spectrum of technologies considered is given below:

Rail-based systems:

- Heavy rail mass transit.
- Light rail – highly segregated or street-running.
- Monorail.
- Automated people movers.

Bus-based systems:

- Bus priority with a high level of segregation.
- Busways.
- Kerb guided bus.
- Rail guided bus (often described as a tram on tyres).

2.3 In order to provide a systematic assessment and comparison of these transit systems, a simple framework has been devised to compare how they are implemented and their main physical and operational characteristics. This framework is shown in Table 2.1. A second framework shown in Table 2.2 has been used to show the types of application that are best suited to each form of transit system.

2.4 Table 2.1 shows a wide range of values for passenger-carrying capacity of different systems and it indicates a particularly wide range for busways and guided busways.

2.5 In 2004 Transport for London, in Light Transit in London, suggested a range of maximum capacities for different types of transit system. Those values are shown in Table 2.3. Some are very different to those given in Table 2.1.

2.6 For many years, it was considered that there was a simple hierarchy relating scale of demand to type of transit system. The bus was at the bottom of this hierarchy with tramways, light rapid transit, mass transit and suburban rail in turn becoming more appropriate as the scale of demand increased. The experience with BRT in South America has led to questioning of the relevance of this simplistic hierarchy with BRT systems able to handle higher passenger flows than many light rail and mass transit systems.

2.7 Table 2.3 provides a comparative overview of the implementation and annual costs of the different transit technologies whilst a more detailed comparison of the costs of light rail and guided busway is provided in Table 2.4.

2.8 It is not easy to make direct and robust comparisons between the implementation and annual costs of different transit systems for a number of reasons set out below:

- Every city is different in terms of topography, the spatial distribution of land uses, demographics, built environment and cultural heritage and therefore presents its own unique set of challenges and constraints that will influence implementation costs.
- Extensions to existing systems yield economies of scale and efficiencies of operation and will therefore yield different implementation rates per route kilometre and different annual costs, whether measured per passenger or per vehicle kilometre.
- Direct cost comparisons between systems built in different countries at different times are affected by movements in exchange rates, construction cost prices indices and inflation that will have been different in different countries

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- Extensions to existing systems yield economies of scale and efficiencies of operation and will therefore yield different implementation rates per route kilometre and different annual costs, whether measured per passenger or per vehicle kilometre.
- Direct cost comparisons between systems built in different countries at different times are affected by movements in exchange rates, construction cost prices indices and inflation that will have been different in different countries.
- Every country has a different set of institutional requirements that will require certain items of cost to be included or excluded or treated in some particular way that will affect direct cost comparisons – for example, the different ways of obtaining powers and funding for system construction in different countries will affect costing as will different accounting rules, depreciation conventions and tax rates.
- At a more specific level, light rail vehicles vary in design, size and sophistication with consequent implications for any direct comparison between the costs of different networks; the number and spacing of stations or stops varies between networks; and busway systems can vary in terms of the extent of 'off-busway' works to provide priority on existing highway.

2.10 It is also the case that it is not easy to compare the implementation and annual costs of public transport networks in different cities that use the same transit technology for similar reasons. In consequence, we have not attempted to reduce the costs of different systems to a common price base in this analysis.

Table 2.6 Characteristics of transit modes

Characteristic	Heavy rail mass transit	Light rail	Monorail	Automated people movers	'Whole route' bus priority	Busways	Kerb guided busways	Rail guided bus
Segregation								
Type of segregation	Subway, elevated or fenced	Not necessary	Elevated	Subway, elevated or fenced	Segregated from traffic in bus priority – needs enforcement	Segregated from traffic – needs enforcement	Segregated from traffic – self-enforcing	Segregated from traffic – needs enforcement
Level of segregation	Fully segregated	Ranges from full segregation to street running	Fully segregated	Fully segregated	Partial segregation	Fully segregated	Fully segregated	Partial segregation
Degree of severance at street level	High if at street level	Low	Not applicable	High if at street level	Low	Medium	Medium	Medium
Accessibility								
From street level for mobility impaired users	Requires lifts if elevated or subway	Operates at street level	Requires lifts if elevated	Requires lifts if elevated or subway	Operates at street level	Operates at street level	Operates at street level	Operates at street level
Vehicles	Accessible from platform	Accessible from platform	Accessible from platform	Accessible from platform	Accessible from raised kerb – needs accurate kerb docking	Accessible from raised kerb – needs accurate kerb docking	Accessible from raised kerb – automatic kerb docking	Accessible from raised kerb – automatic kerb docking
Stations/stops	High platform	High/ low platform	High platform	High platform	Raised kerbs	Raised kerbs	Kerb height	Low platform
Capacity								
Rolling stock (passengers per car, number of vehicles)	100-150 pass/car 3-12 cars	180-230 pass/tram. Multiple operation feasible	40 pass/car 2-7 cars	40 pass/car 2-4 cars	100 (articulated bus)	100 (articulated bus)	80	140
Route/corridor (minimum headway, maximum vehicles/direction/hour)	Min headway 90 seconds	Min. headway 90 seconds	2 minutes	2 minutes	1 minute	Single lane 1 minute Two lanes 20 seconds	1 minute With overtaking at stops 30 seconds	2 minutes
Service/route (max persons/direction/hour)	15,000-80,000	18,000	8,000	5,000	6,000	6,000-45,000	4,800-9,600	4,200
Performance								
Maximum speed (km/hour)	80-100	80 (or street	20-40	70		80	100	80

		speed limit)						
Average (km/hour)	40	35	20-30	35	20-25	27 (Transmilenio)	80 (Adelaide express buses)	20 (Caen)
Maximum feasible gradient (adhesion)	4%	10%	5%	7%	13%	13%	13%	13%
Minimum curve radius (metres)	---	15 (low speed)	50-100	25-30	Not applicable	Not applicable	Not applicable	Not applicable
Land take								
Width needed for double track on straight alignment (metres)	8.5	8.5	7.0	8.0-8.8	Lane width – 4m ideal & 3.5m minimum	Carriageway 7.3m 2x 0.5m side strips	Two lanes and median strip 5.8m 2x 0.5m side strips	7.0
Sustainability								
Power source(s)	Overhead electric power supply (or rarely diesel)	Overhead electric power supply (or rarely diesel)	Electric at track level	Electric at track level	Diesel, electric or hybrid	Diesel, electric or hybrid	Diesel, electric or hybrid	Diesel, electric or hybrid
Emissions	Remote from point of use if electric	Remote from point of use if electric	Remote from point of use	Remote from point of use	Diesel to Euro V Remote from point of use if electric	Diesel to Euro V Remote from point of use if electric	Diesel to Euro V Remote from point of use if electric	Diesel to Euro V Remote from point of use if electric
System specific characteristics								
Are utilities diversions essential?	Yes	Yes	To a limited extent	Yes	No	To a limited extent	To a limited extent	Yes
Notes: Figures are indicative – for example, vehicle capacity depends on standing to seating ratio; vehicles from different manufacturers have different capabilities; minimum curve radius is set by speed; and average speed depends on distance between stops and speed of boarding which, in turn, relate to number of doors and ticketing system.								

Source: Compiled by author

Table 2.7 Suitability of transit technologies for different urban and suburban applications

Application	Level of demand	Heavy rail mass transit	Light rail	Monorail	Automated people movers	'Whole route' bus priority	Busways	Kerb guided busways	Rail guided bus
Single corridor	Low	x	√	√	√	√	√	√	√
	Medium	x	√	√	√	√	√	√	√
	High	√	x	x	x	x	√	x	x
Corridor connecting few origins with few destinations	Low	x	√	x	x	√	√	√	√
	Medium	x	√	x	x	√	√	√	√
	High	√	x	x	x	x	√	x	x
Corridor connecting many origins with few destinations	Low	x	x	x	x	√	√	√	x
	Medium	x	x	x	x	√	√	√	x
	High	x	x	x	x	x	√	x	x
Corridor connecting many origins with many destinations	Low	x	x	x	x	√	√	√	x
	Medium	x	x	X	X	√	√	√	X
	High	x	x	x	x	x	√	x	x

Source: Author

Table 2.8 Transit systems - passenger carrying capacities

Technology	Maximum capacity (passengers per hour per direction)
Standard bus	2,500-4,000
Busway	4,000-6,000
Guided bus	4,000-6,000
Tram/Light rail	12,000-18,000
Heavy rail	10,000-30,000

Source: Light Transit in London, TfL, 2004

Table 2.9 Transit systems - cost comparisons (1)

	Heavy rail mass transit	Light rail	Monorail	Automated people movers	'Whole route' bus priority	Busways	Kerb guided busways	Rail guided bus
Infrastructure costs	High	High	High	High	Low	Medium	Medium	Medium
Annual operating costs	High	Medium	Medium	Low	Medium	Medium	Medium	Medium
Annual maintenance costs	High	Medium	Medium	Medium-High	Low	Low	Low	Medium

Source: Author

Table 2.10 Transit systems - cost comparison (2)

	Light rail systems						Kerb guided bus systems	
	Firenze	**Montpellier Line 1**	**Mulhouse Lines 1+2**	**Nottingham Line 1**	**Paris Line T3**	**Valenciennes**	**Cambridge**	**Luton-Dunstable**
Route length (km)	7.4	15.2	11.7	14.4	28.0	9.5	23.0	9.8
No. of stations/stops at opening date	n/a	27	23	23	n/a	19	11 (on busway)	5 (on busway)
Number/type of vehicle	17	30	27	15		17	23	29
	Multi-articulated	Multi-articulated	Multi-articulated	Multi-articulated	Multi-car	Multi-articulated	Conventional bus	High quality bus
Overall cost (£m)	300.2	336.0	214.8	229.0	860.0	232.0	124.3	96.5
Overall cost/route kilometre (£m)	40.6	22.1	18.4	15.9	30.7	24.4	5.4	9.8
Infrastructure cost/route kilometre (£m)	30.4	19.8	14.8	n/a	n/a	20.0	5.3	7.7
Cost per vehicle (£m)	4.4	1.2	1.5	n/a	n/a	2.5	n/a	0.25
Gauge (where known)	Standard	Standard	Standard	Standard	Standard	Standard	---	---
Vehicle capacity (seated plus standing)	276	205	n/a	191	n/a	n/a	n/a	n/a
Maximum speed (km/hour)	70	70	70	80	100	70	90	80
Average speed (km/hour)	19.3	n/a	n/a	24.7	n/a	n/a	n/a	n/a
Year of opening	2010	2000	2006	2004	n/a	n/a	2010/2011	2012

Notes:
Scheme costs relate to year of opening and have not been reduced to a common price base. All figures in Euros were converted to £GBP at May 2010 exchange rates.
Montpellier trams were lengthened to 44m after the system opened with a consequent increase in capacity.
Paris Line T3 is a tram train with 25Kv AC overhead electrification, whereas the other four light rail systems operate at 750vDC.
Costs per kilometre for the Luton-Dunstable Busway are based on the busway length of 9.8km and not overall bus route length – see paragraph 4.47 for more detail.
The overall cost for the Cambridge Busway includes the capital cost of buses, but excludes the cost of on-street works – see paragraph 4.34 for more detail.

Source: Compiled by author