Transport Reviews

ISSN: 0144-1647 (Print) 1464-5327 (Online) Journal homepage: http://www.tandfonline.com/loi/ttrv20

Urban rail systems: Analysis of the factors behind success

Ela Babalik-Sutcliffe

TRANSPORT REVIEWS, 2002, VOL. 22, NO. 4, 415–447

Taylor & Francis
Taylor & Francis Group

Urban rail systems: analysis of the factors behind success

ELA BABALIK-SUTCLIFFE*

Department of City and Regional Planning, Middle East Technical University, Ankara 06531, Turkey

(*Received 6 March 2001; revised 18 November 2001; accepted 18 December 2001*)

Investment in urban rail systems has increased rapidly over the past decades. While there have been some successful systems, a significant number have failed to be as successful as expected in improving public transport and urban environment. These experiences have led to a considerable debate in the literature about the effectiveness of new urban rail systems and whether it is worthwhile investing in them. While these debates continue, political support for metros, and particularly light rail systems, is still strong, and investment in them is very likely to continue. Hence, it is extremely important to understand the factors that make these systems successful. The paper presents the findings of a research aimed at identifying these factors based on the analysis of eight new urban rail systems: four in the USA, three in the UK and one in Canada. The paper presents the results of the performance analysis of the case studies as well as a detailed analysis of the factors that affected the performance of each system. Based on the case study analysis, a comprehensive list of factors that make urban rail systems successful is presented. The analysis also facilitates a comparison between the experiences of the three countries, and focuses on the effects of different operating environments and different planning approaches on the performance of urban rail systems. The paper concludes with a comparison of the findings of this research to those of previous studies.

1. Introduction

Since the 1970s, there has been a significant increase in urban rail investment. A total of 139 new urban rail systems, metros and light rail transit (LRT) systems have been built world-wide in the past three decades. These systems were, in general, planned as instruments to solve transport, land-use and environmental problems associated with the extensive use of the car. However, not all of them have been successful in tackling these problems: some new systems carried very low numbers of passengers, and hardly had any effect on public transport usage, car traffic, air quality or the urban environment. These experiences have given rise to a broad area of debate in the literature. An important part of the debate focused on the patronage, that is, the number of passengers carried, and the cost of new rail systems: researchers demonstrated that the forecast levels were not attained in a number of cases (Pickrell 1990, 1992, Mackett 1998, Richmond 1998). In addition to the overestimation of patronage, it has been discussed that other benefits expected from urban rail investments, such as an increase in public transport usage and a reduction in traffic congestion and air pollution, were also being overestimated

*E-mail: ebaba@arch.metu.edu.tr

Transport Reviews ISSN 0144-1647 print/ISSN 1464-5327 online © 2002 Taylor & Francis Ltd
http://www.tandf.co.uk/journals
DOI: 10.1080/01441640210124875

(Gomez-Ibanez 1985, Hass-Klau and Crampton 1998, Mackett and Edwards 1998, Richmond 1998). The impact of new metros and light rail systems on land-use and urban growth has also been limited. It has been discussed that urban rail systems had positive land-use effects only when they were supported with other improvement packages such as a pedestrianization scheme in city centres (Simpson 1988, 1989, Walmsley and Perrett 1992, Black 1993, Hass-Klau and Crampton 1998, Hass-Klau *et al*. 2000).

These findings suggest not only that some urban rail systems have been unsuccessful, but also that a number of them would not have been built if the costs and benefits were correctly predicted. In spite of these findings, political support for urban rail investment continues. Recently, the Environment, Transport and Regional Affairs Committee (2000: xxi) of the House of Commons in England stated that:

'If the Government believes that it is important to attract motorists out of their cars, alternative forms of public transport must be put in place first. As the evidence shows, people will not switch to public transport unless it is reliable, frequent, efficient, safe and clean with affordable fares. Light rapid transit systems meet these criteria, and so, where appropriate, they should be pursued.'

In the USA, the Intermodal Surface Transportation Efficiency Act (ISTEA) 1991 and, more recently, the Transportation Equity Act for the 21st Century (TEA21) 1998 both provide for a Federal Government contribution to urban rail investment in cities where air quality falls below certain standards (Federal Transit Administration 1998). Even when air quality is not a concern, the Federal Government contribution is very common and usually comprises up to 80% of the capital cost of an urban rail system (Walmsley and Perrett 1992, Paaswell 1995, Hass-Klau and Crampton 1998).

In Continental Europe, in both Germany and France, national policies and funding arrangements appear to be even more committed to the development of urban rail, particularly light rail systems, in response to the worsening of urban transport problems. Hass-Klau and Crampton (1998) showed that in Germany, the Federal Government contribution to the cost of urban rail investments was recently raised to be up to 75% in the former West Germany, and up to 90% in the former East Germany, and that in France, all guided modes on rail were eligible for state subsidy without ambiguity.

To summarize, there is political support for urban rail systems and investment in them is likely to continue. Hence, it is important for planners and politicians to know what makes these systems successful, and what hinders their success. This paper intends to find answers to these questions. It presents the results of a research (Babalik 2000) that has been carried out on eight new urban rail systems, with the objective of identifying the factors behind success and failure. In the original research, a planning framework was produced as policy guidance for urban rail planners and operators. The framework helped to review the planning background and operation of an urban rail system, assess the suitability of various factors within its planning and operation, and based on this assessment it helped to predict how successful the system was likely to be, and how its success could be enhanced through the implementation of various policies that helped to overcome possible negative effects of unsuitable factors. Detailed information on the method and product of the research can be obtained from Babalik (2000) and other sources (Mackett and Babalik 2001). The present paper focuses on the main analysis of the

research and the findings about the factors that make urban rail systems successful or otherwise.

In the following sections, first the urban rail systems analysed are presented together with information on their planning background. Second, the performance analysis and its results are presented, and factors that contributed to the success of each system, as well as the factors that hindered their success, are discussed in detail. Then, the experiences of the eight case studies and the findings of the research are generalized, and a comprehensive list of factors that affect the success of urban rail systems are presented. In the last section, the findings of the study are compared with the findings of previous research.

2. Case study analysis

2.1. *Case study selection*

The research on which this paper is based aimed to conduct a comparative analysis on new-generation urban rail systems and explore the factors that affected their success. The underlying objective was to provide a comprehensive list of factors that affect success, and based on these factors, to design a planning guidance for urban rail planners that can help them enhance the success of their systems. It was aimed to apply the planning guidance to new urban rail systems in the UK that were being developed. In addition, the findings were planned to be used to propose ways to enhance the success of new metro and light rail investments in Turkey.

To ensure a systematic selection of case studies, a number of criteria were defined that can help select cases appropriate for the main objectives of the research. The criteria were: the age of system (those opened after 1970 and before 1995 were selected so that primary information on their development could be obtained and their impacts on land-use could be assessed); the scale of system (medium-sized systems were selected so that they were comparable with those in Turkey); the population of the city that the system serves (cities with a population of between 500 000 and 3 million people were selected so that differences resulting from major population variations could be eliminated, and the cases could be comparable in size with those in Turkey); and a country's political structure within which the system is built (systems built in former socialist countries were not selected since planning approaches in such countries might be different from those in the rest of the world, and the evaluation of these differences were not within the scope of the study). In addition to these criteria, there were practical considerations that affected the choice of systems. It was essential to interview experts involved in the development of the systems to obtain information on the success of the systems and factors that affected success. It was planned to conduct face-to-face interviews because some of the issues were sensitive, particularly when dealing with relatively less successful systems and the factors behind these. Hence, a common language between the interviewer and interviewees appeared to be an important criterion in selecting cases, and, therefore, the study focused on English-speaking countries. Another issue was the willingness to cooperate of the planners and operators.

Taking these concerns into consideration, the following systems were studied: Miami Metrorail, St Louis MetroLink, San Diego Trolley and Sacramento Light Rail, all in the USA; Vancouver SkyTrain in Canada; Tyne and Wear Metro, Manchester Metrolink and Sheffield Supertram, all in the UK (table 1).

2.2. *Background information*

2.2.1. *Urban characteristics*

The cases have been selected from cities with similar populations. However, the way population is spread over the urban area varies between cities. The US cities, as one might expect, are relatively low density (table 2). Canadian cities have generally higher densities of population compared with US cities (Mercer 1999). Indeed, the population density in Vancouver is higher than the US cities and not much lower than one of the UK ones. Among cities in the UK, Newcastle upon Tyne has the highest average density for population, followed by Manchester.

The urban form in the US cities is mostly based on gridiron street patterns with urban sprawl in low density. Of these, Miami and Sacramento show characteristics

Table 1. Systems under investigation.

Country	City	Name of system	Opening year
USA	Miami	Metrorail	1984
	St Louis	MetroLink	1993
	San Diego	Trolley	1981
	Sacramento	Light Rail	1987
Canada	Vancouver	SkyTrain	1986
UK	Newcastle upon Tyne	Tyne and Wear Metro	1980
	Manchester	Metrolink	1992
	Sheffield	Supertram	1994

Table 2. Characteristics of the urban areas served.

	Population	Population density (persons per km^2)	Income per capita (£)	Car ownership: cars per household	Annual public transport trips per person (1998)
Miami	1 937 094	412	8 245	1.49	39
St Louis	2 444 099	185	8 980	1.67	22
San Diego	2 498 016	244	9 764	1.78	30
Sacramento	1 481 102	124	9 275	1.80	19
Vancouver	1 800 000	706	8 474	1.65	126
Newcastle upon Tyne	1 095 152	2 039	7 601	0.61	179
Manchester	2 499 441	1 943	7 813	0.81	90
Sheffield	1 262 630	810	7 431	0.77	121

Source: Great Britian Office for National Statistics (1998a,b); Department of the Environment, Transport and the Regions (1999a,b); Federal Transit Administration (2000); Greater Vancouver Regional District (1999); US Census Bureau (1999).

Calculations of the population density of urban areas may be affected by the way urban boundaries are defined. Definitions used here are those adopted by the Federal Transit Administration in the USA; Great Britian Office for the National Statistics in the UK; and Greater Vancouver Regional District in Vancouver, Canada.

Income data for US cities are from 1990 census; for UK cities data are for 1991; for Vancouver data are for 1995, but deflated to 1990.

of Sun-Belt cities with their extremely car-oriented urban forms. Although the overall population density in Miami is relatively high, it was observed that urban activities were scattered across a large urban area and that urban sprawl was the dominant form of development. San Diego, although a Californian city, is slightly different in that urban sprawl has been limited because of topographic barriers and the Mexican border (Walmsley and Perrett 1992). In addition, Mexican immigration into the city has changed the housing and development tradition in San Diego by making it more tolerant to medium- and high-density housing. In St Louis, the population density is low; however, urban activities have not scattered much across the city, but located along a radial corridor which the city has historically grown along. Vancouver and cities in the UK also have radial corridors along which urban growth has taken place. However, the current growth trends, which are very much car-oriented, result in urban sprawl. Urban sprawl also leads to the decentralization of main urban activities from central business districts (CBDs) to out-of-town centres. This trend is common in all the case studies; however, among them San Diego, Sacramento, Vancouver and Manchester have relatively strong CBDs in terms of economic vitality: CBDs in these cities are the main location for employment and retail.

The economic conditions in the cities are summarized in table 2. The UK cities seem to have lower average income per capita compared with the North American ones. Since currency conversion has been made using purchasing power parity indexes, allowances have been made for the differences between the economies of the different countries. Car ownership levels appear to reflect income levels to some extent. In San Diego and Sacramento, where the income per capita is the highest, car ownership levels are also the highest. On the other hand, the significant difference in car ownership levels between North America and the UK cannot be explained merely by differences in income. Car-oriented urban form, as well as the traditionally low usage of public transport in US cities, must be among the reasons why car ownership levels are so high there. Indeed, public transport usage levels are much higher in cities in the UK compared with the US ones. It is also remarkable that in Vancouver, where the number of cars per household is as high as in the US cities, public transport usage is also very high: it is comparable with the usage in UK cities.

2.2.2. *Physical characteristics*

The physical characteristics of the urban rail systems are presented in table 3. It can be seen that one of the systems, Miami Metrorail, is a full metro. Two, Vancouver SkyTrain and Tyne and Wear Metro, are light rapid transit systems, that is, they use light rail vehicles that run on exclusive tracks and use a third rail for power. Vancouver SkyTrain is an automated system: it is operated without drivers. Miami Metrorail also has an automated section: in the city centre, it is integrated into an automated people-mover system, the Metromover. The remaining five are light rail systems, and most of them run at grade with partial segregation from other traffic, except St Louis MetroLink, which has an underground section and is fully segregated.

The systems in San Diego and Newcastle upon Tyne are the most extensive ones. Consequently, they have the highest number of stops. Although not as extensive, Sheffield Supertram also has a high number of stops. As a result, the average distance between its stops is extremely low.

2.2.3. *Operating characteristics*

The operating characteristics of the systems are presented in table 4. It is seen that Vancouver SkyTrain has a remarkably high frequency of service while Sacramento LRT is the least frequent with 15-minute intervals all day. On the North American systems, travelcards that provide unlimited journeys on both the urban rail systems and buses have been introduced: daily, weekly, monthly and annual cards are available. In the UK, because of the deregulated nature of the bus industry, it is difficult to introduce travelcards. When this research was conducted, there were no travelcard arrangements in Manchester or Newcastle upon Tyne, although there were studies for introducing them in both cities. In Sheffield, there is a daily travelcard, and a 1-hour card that provides unlimited journeys on buses and

Table 3. Physical characteristics of the systems.

Systems in:	Technology	System length (km)	Number of routes	Grade separation	Segregation from other traffic	Number of stops	Average stop spacing (km)
Miami	metro (automated section)	33.8	1	separated	complete	21	1.61
St Louis	light rail	27.2	1	both	complete	18	1.51
San Diego	light rail	80.4	3	at grade	partial	48	1.68
Sacramento	light rail	29.2	2	at grade	partial	29	1.01
Vancouver	light rapid (automated)	28.9	1	seperated	complete	20	1.45
Newcastle	light rapid	59.1	3	both	complete	46	1.28
Manchester	light rail	31.0	2	at grade	partial	26	1.19
Sheffield	light rail	29.0	2	at grade	partial	45	0.63

Source: Data were provided by experts involved in the planning or operation of the systems.

Lengths of the systems in 1998 are taken as the basis. On the other hand, in land-use related analysis, very recent extensions to the systems, such as the Mission Valley extension of San Diego Trolley and the Salford extension of Manchester Metrolink, are not included because it is too early to observe any land-use impact.

Table 4. Operating characterisitcs.

Systems in:	Headway (min)	Service hours per day	Mean speed (km/h)	Fare structure	Travelcard covering bus and rail	Transfer between bus and rail
Miami	7.5/15	18.30	49.9	flat	yes	a reduced fare
St Louis	7/10 – 15	19.00	56.3	flat + free zone	yes	a reduced fare
San Diego	10/15 – 30	20.36	46.6	zonal	yes	free
Sacramento	15	19.39	46	flat + CBD	yes	free
Vancouver	2.5/5	20.07	45.5	zonal	yes	free
Newcastle/Tyne	7.5/10 – 15	18.5	30	zonal	no	full fare
Manchester	6/12	18	36.2	zonal	no	full fare
Sheffield	6/15	18	26	zonal	yes	full fare

Source: Data were provided by experts involved in the planning or operation of these systems.

the tram. However, operators have stated that these have not been used very extensively mainly because bus cards, which are exclusively for bus journeys, are cheaper. In cities in the UK, there are no transfer fares between buses and rail, and passengers must pay the full fare when transferring, while in Miami and St Louis passengers can transfer by paying a reduced fare, and in San Diego, Sacramento and Vancouver transfers between buses and the rail systems are free as long as the journey is within the same zone. In St Louis, there is also a free-fare zone, where free journeys are offered on the light rail system between six stations in the city centre at off-peak times of the day. In most of the cities, bus fares and urban rail fares are the same, except in Miami, where metro fares were more expensive than bus fares in the initial years of operation, and in Sheffield, where bus fares and travelcards were cheaper than those of the light rail.

2.3. *Performance analysis*

In the study that this paper is based on, the success of an urban rail system was defined in terms of the fulfilment of expectations from the investment. Expectations are the objectives of investing in urban rail. Based on previous research (Fouracre *et al*. 1990, Walmsley and Perrett 1992, ECMT 1994, Simpson 1994) and the analysis of the case studies, it was accepted that there were five main objectives that most new systems were developed to achieve: attaining a high patronage, being cost-effective, increasing total public transport usage, helping to reduce car traffic and having a positive impact on land-use and urban growth patterns. The last two objectives have subobjectives such as reducing growth in car usage, preventing or relieving traffic congestion, reducing air pollution, helping to stimulate development in the CBDs and in declining areas that might be under regeneration, and helping to change urban growth patterns from car-oriented to more public transport-friendly forms.

To measure the performance of the systems in meeting the above objectives, it was necessary to define certain criteria that can indicate success or failure regarding the associated objective. Three criteria were defined for each objective (table 5). For the objectives regarding car traffic and land-use, the choice of indicators was quite explicit since they are based on subobjectives: the fulfilment of them can help attain the main objective. For the other objectives, the choice of indicators was shaped by two factors: the availability of data for all the case systems studied and previous comparative research on urban rail systems (Pickrell 1990, Parkinson 1992, Dunphy 1997, Mackett and Edwards 1998), which showed that there were some criteria commonly used in performance analysis, such as the comparison of forecast and actual patronage, comparison of capital and operating cost with patronage, and the analysis of farebox recovery ratio.

Three of the objectives used criteria that indicated a change, in most cases a form of improvement. The assessment of whether the systems resulted in an improvement was based on monitoring and impact studies that the planners provided, and on interviews with planners and academicians. For two objectives, high patronage and cost-effectiveness, the assessment of success was made by using numeric indicators. In these cases, it was difficult to determine which values indicated success; therefore, a standard value had to be defined so that the performance of the systems could be compared with it. When data were available, comparison was made with national or continental averages, that is the average performance of other urban rail systems built in the same country or continent. When data were not available, comparison

was made with an average of the case systems: systems that were relatively most successful were identified.

Figure 1 provides an overview of the patronage of the systems since their opening. The systems in Tyne and Wear and Vancouver carry the highest number of

Table 5. Criteria analysed for measuring the success of systems in attaining their objectives

Objectives	Criteria for the attainment of objectives
Attaining high patronage	patronage is not lower than the forecast patronage per route-km is higher than the national/continental average vehicle load is higher than the case study average
Building and operating the system cost-effectively	capital cost per passenger is less than the national /continental average operating cost per passenger is less than the case study average farebox recovery ratio is higher than the case study average
Increasing public transport usage	modal share of public transport increased after the new system bus patronage did not decline due to the new system patronage of the new urban rail system is increasing
Preventing/solving traffic congestion and environmental problems	monitoring studies/interviews indicate a reduction in growth in car usage monitoring studies/interviews indicate relief in car traffic monitoring studies/interviews indicate an improvement in air quality
Improving the land-use and urban growth patterns	impact studies/interviews indicate new development at the city centre impact studies/interviews indicate new development in declining areas impact studies/interviews indicate an improvement in the pattern of urban growth

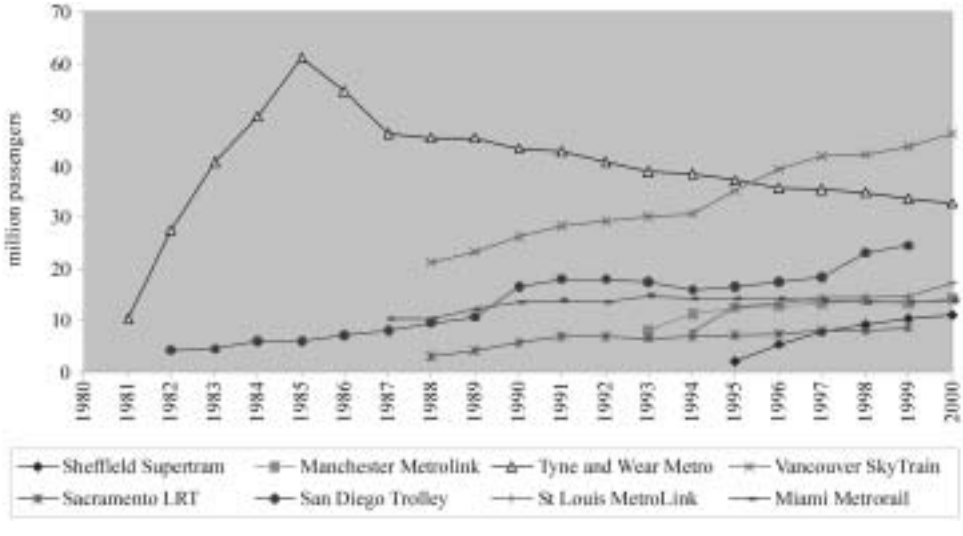

Figure 1. Patronage trends of the systems. *Source*: Department of the Environment, Transport and the Regions (1998, 1999a, 2000), Federal Transit Administration (2001b). Experts through interviews or documents provided data.

passengers, although the former has been experiencing a decline in its patronage since 1985. The San Diego Trolley has the third highest patronage, followed closely by the systems in St Louis, Miami and Manchester. Among them, patronage on Miami Metrorail seems to have been in a slight decline since 1993. Sacramento LRT and Sheffield Supertram have the lowest levels of patronage, but both systems, particularly the latter, have experienced a steady increase in their patronage levels.

Analysis and comparison of patronage levels with other variables, and the analysis of the financial success of the systems are presented in tables 6 and 7, respectively. National and continental averages, and an average of the case study systems, are also provided for comparison. Patronage indicators help to distinguish the systems in Vancouver, St Louis, Tyne and Wear, and Manchester as those that are relatively more successful. The former two are particularly successful when compared with other systems in their countries. Compared with their Continental European counterparts, none of the UK systems appear successful, but Sheffield Supertram, in particular, has the lowest values for patronage indicators. In financial

Table 6. Performance indicators in attaining high patronage (1999).

	Passengers per route km	Vehicle load: passengers per vehicle	Forecast and actual patronage[1] Projected year	Projected patronage	Actual patronage	Difference (%)
Miami Metrorail	412 258	18	1986	202 000	36 000	−82
St Louis MetroLink	516 576	37	1993	13 000	24 515	+89
San Diego Trolley	305 566	23	1981	9 500	12 000	+26
Sacramento LRT	288 371	21	1987	20 500	12 000	−42
Vancouver SkyTrain	1 508 651	45	1996	100 000	136 000	+36
Tyne and Wear Metro	572 881	50	1985	219 000	208 900	−5
Manchester Metrolink	425 806	34	1996	35 700	44 500	+25
Sheffield Supertram	358 621	15	1996	70 700	18 700	−74
US average for metros	1 007 224	21				
US average for LRTs	361 188	26				
Canadian average for metros	2 916 667	n/a				
Canadian average for LRTs	1 241 096	n/a				
European average for LRTs	772 812	n/a				
Average of the case systems	508 629	32				

Source: Department of the Environment, Transport and the Regions (2000); Federal Transit Administration (2001b); data provided by experts through interviews or documents; for sources of country and continent averages, see Babalik (2000).

n/a, not available.

Metros in Atlanta, Baltimore, Cleveland, Los Angeles, San Francisco and Washington, Light Rail Systems in Baltimore, Buffalo, Dallas, Denver, Los Angeles, Miami, Portland, and San Jose were used for calculating US averages; metros in Montreal and Toronto, and Light Rail Systems in Edmonton, Calgary and Scarborough were used for calculating Canadian averages; Light Rail Systems in Grenoble, Nantes, Paris, Strasbourgh, Rouen, Utrecht, Valencia, Lausanne, and Docklands (London) were used for calculating European averages.

([1])Projections have been made over different times, and this will affect the relative accuracy of the forecasts.

Table 7. Financial performance of the systems (1998)[1].

Systems in:	Capital cost (£) (1998 prices)	Annualized capital cost[2] per passenger (£)	Operating cost per passenger (£)	Total annual cost per passenger (£)	Passengers per staff member	Fare revenue per passenger (£)	Farebox recovery ratio (%)
Miami	1 058 285 200	6.46	2.40	8.85	31 949	0.67	29
St Louis	259 738 400	1.47	0.87	2.33	91 574	0.37	46
San Diego	609 386 900	2.18	0.76	2.94	55 347	0.55	68
Sacramento	164 725 600	1.68	1.20	2.88	52 777	0.49	40
Vancouver	843 383 500	1.67	0.53	2.19	119 196	0.19	38
Tyne/Wear	533 216 600	1.25	0.76	2.02	53 354	0.58	77
Manchester	175 659 500	1.05	1.69[3]	1.71	69 000	0.99	143[3]
Sheffield	271 074 300	2.42	1.15	3.40	36 800	0.60	52
US average for metros		3.63	1.39	4.78	43 257	0.29	27
US average for LRTs		3.10	1.33	4.43	44 077	0.37	25
Canadian average for metros		n/a	n/a	n/a	n/a	n/a	n/a
Canadian average for LRTs		1.73	n/a	n/a	n/a	n/a	n/a
European average for LRTs		1.29	n/a	n/a	n/a	n/a	n/a
Average of the case systems		2.03	0.88	2.84	60 939	0.49	56

Source: Department of the Environment, Transport and the Regions (1998, 1999a); data provided by experts through interviews or documents; Federal Transit Administration (1999, 2000).

US dollars and Canadian dollars are converted to English Sterling using the purchasing power parities index provided by the OECD (1999).

n/a, not available.

See table 6 for the systems used to calculate the national and continental averages.

([1])Fare revenue and farebox recovery ratio are based on 1997 data.

([2])Capital costs are discounted to 1998, and annualized over 30 years at 8%.

([3])Operating cost data for Manchester is based on it's performance in 1996 reported by Knowles (1996) since the current operating cost data are kept confidential.

terms too this system is not very successful. Miami Metrorail also has a poor financial performance. The systems in St Louis, San Diego, Vancouver, Tyne and Wear, and Manchester, on the other hand, appear as the financially successful ones.

2.4. *Results of the performance analysis*

The overall success of the systems, considering five of the objectives defined, and using the method described above, is shown in table 8. None of the systems met any criteria regarding the objective associated with car traffic and air pollution. It is also seen that none of the systems caused an increase in the modal share of public transport. However, there was no evidence that they had a negative effect on bus patronage either: new systems did not result in a decline in bus usage. For other criteria, they have varying degrees of success.

The analysis revealed that Vancouver SkyTrain was the most successful system among the case studies: it performed well in most criteria, except those regarding car traffic. It had a high patronage; it was cost-effective; it increased public transport usage; and it had positive impact on the city centre and on declining sites. The system also had a profound impact on urban growth: the SkyTrain corridor became the main corridor for urban development while some of its station areas became new

Table 8. Overall success of the systems.

	To have high patronage			To build and operate the system cost-effectively			To increase public transport usage			To reduce traffic congestion and environment problems			To improve the land-use and urban growth patterns			
Systems in:	Passengers per km	Vehicle load	Forecast versus actual	Capital cost/ passenger	Operating cost/ passenger	Farebox ratio	Modal increase in PT	No decline in bus use[1]	Patronage increase on system	Less car usage	Relief in congest-ion	Better air quality	Positive effect on city centre	Positive effect on slums	Urban growth along system	Total number of ticks
Miami								√								1
St Louis	√	√	√	√	√			√	√				√			8
San Diego			√	√	√	√		√	√				√		√	8
Sacra-mento				√				√	√							3
Vancou-ver	√	√	√	√	√		√	√					√	√	√	10
Tyne and Wear		√		√	√	√		√					√			6
Manche-ster			√	√	√	√		√	√				√			7
Sheffield								√	√							2

([1])Owing to the opening of the urban rail system.

town centres, surrounded by dense residential development. The systems in St Louis, San Diego and Manchester were also successful. St Louis MetroLink had high patronage; it was cost-effective to build and operate; it had a positive impact on the overall public transport usage; and it affected the economic vitality of the city centre in a positive way. San Diego Trolley was also a very cost-effective system; it had positive impact on public transport usage levels; it contributed to the improvement of the CBD area; and at some of its station sites, development densities increased significantly. Manchester Metrolink had a higher level of patronage than that forecast; it was very cost-effective; and it improved public transport usage levels along certain corridors. The metro in Newcastle upon Tyne was slightly less successful than the above systems because its patronage had been declining; however, it performed well in the cost-effectiveness analysis, and had some positive effects on the city centre. The systems in Sacramento and Sheffield were not very successful: both had poor patronage levels compared with the others, performed poorly in the cost-effectiveness analysis, and had limited impact on land-use and urban growth patterns. On the other hand, on both systems, patronage has been increasing steadily, and this seems to have had a positive effect on overall public transport usage. The performance of Miami Metrorail was observed to be rather poor: it had poor levels of patronage, performed poorly in the cost-effectiveness analysis, and had negligible effects on public transport usage, land-use and urban growth.

To verify that the analysis is a fair judgement of the systems analysed, the results have been compared with the outcomes of previous studies. It has been seen that the findings are compatible with those of previous research. Indeed, Miami Metrorail has been shown to be an unsuccessful system by Kain (1988: 209), Pickrell (1990: xi, 1992: 162) and Walmsley and Perrett (1992: 80), particularly in terms of its patronage and financial performance. The success of St Louis MetroLink has been reported by the analysis of Warren (1995: 23). The good performance of San Diego Trolley in terms of patronage, cost-effectiveness, and impacts on the CBD and urban growth are compatible with the findings of Glick (1992: 75–76) and Walmsley and Perrett (1992: 73). Bernick and Cervero (1997: 251–264) also supported the finding that development densities increased at some Trolley stations. Findings regarding the Sacramento light rail verifies the predictions of Johnston *et al.* (1988: 466), who argued that from both the patronage and cost point of view, the system was not likely to be a success. As for Vancouver SkyTrain, the finding of this study, that the system had important effects on urban development, supports the evidence of Walmsley and Perrett (1992), TRB (1996: 35) and Mackett and Edwards (1998: 237). For the UK systems, parts of the land-use impact analysis have been based on previous impact studies, such as Davoudi *et al.* (1993), Heseltine and Mulley (1993), Knowles (1994, 1996), Haywood (1998, 1999) and Senior (1999). In addition, the analysis verifies the findings of some other research. The results regarding the patronage and city centre effects of Tyne and Wear Metro are compatible with the findings of Walmsley and Perrett (1992: 11–12). The observation that Manchester Metrolink was cost-effective, and that it helped to enhance public transport usage, but that it was not so successful in terms of impacts on traffic and land-use, supports the findings of Mackett and Edwards (1998: 238–240). Hass-Klau *et al.* (2000: 18) also argued that the system in Manchester was generally cited as a success while the Sheffield Supertram's achievement had been modest in terms of both patronage levels and cost-effectiveness. Fox (1996: 66) also noted that the financial success of the latter had been limited.

2.5. *Reasons for success or failure*

Throughout the performance analysis, possible reasons for success or failure were explored. This was based on fieldwork, previous research on the selected systems, interviews with the planners and operators, and interviews with researchers who carried out monitoring, or impact studies of the systems. The factors that seem to have affected success cover a wide range. They are summarized in table 9, which lists separately the factors that enhanced the success of the systems and the factors that hindered their success.

The success of SkyTrain was to some extent associated with the urban form and the overall usage of public transport in Vancouver: population density and public transport patronage were fairly high, and the city had radial urban corridors suitable for operating public transport systems. The high frequency of service was also reported by operators to be a possible contributing factor that attracted passengers. In addition, it was observed that buses were reorganized to feed into the system, and this may have had a positive impact on the SkyTrain patronage, as well as on the overall public transport usage. Some marketing actions also contributed to the system's success: to demonstrate that the automated technology was safe to use, a segment of the SkyTrain was opened to the public earlier than the rest of the system on which free journeys were offered. In addition to these factors, interviews with the planners of the SkyTrain and with experts from several planning agencies in Vancouver revealed that an important reason for the good performance of SkyTrain was the supportive planning actions of the municipalities. During its construction, the municipalities redeveloped old industrial areas that parts of the system were located in and channelled most of their investment to develop the rail corridor. Local plans were adapted to the system; station areas were rezoned; joint development schemes were implemented; and some government buildings were relocated at SkyTrain stations. In addition, some municipalities introduced development incentives along the SkyTrain corridor to attract private developers and encourage development. These incentives are known as transit-oriented development (TOD) incentives, since they aim to create high-density development that can encourage more usage of public transport. There are various types of TOD incentives such as development bonuses, tax reductions and reductions in car parking requirement, while in Vancouver development bonuses were the most extensively used one. The municipalities in Vancouver adapted their planning policies to the rail system not only by introducing TOD incentives, but also by strictly restricting major retail and office development in areas that were far from the SkyTrain corridor. All these actions resulted in dense office and residential development along the corridor (figures 2 and 3), which, in consequence, generated trips on the system. Another factor contributing to the development of station sites may be that during the planning of the system it was decided that only one station would accommodate a park-and-ride facility while other station sites would be planned for high-density, transit-oriented development. Lack of car parks may have had a negative effect on attracting car drivers to the system; however, it is certain that vigorous planning actions to develop the station sites increased development densities along the rail corridor, and hence increased the SkyTrain patronage.

One of the factors behind the success of St Louis MetroLink was the urban form with a dominant radial corridor as Warren (1995) argued. Because the city had grown along the radial corridor, the corridor accommodated many urban activities, such as office and retail centres, hospitals, universities, recreation areas and sport

Table 9. Factors behind the success of the systems.

	Factors that enhanced success	Factors that hindered success
Miami Metrorail	Joint development projects	Inconvenient urban form and low density Problems in public relations System serving low income areas combined with high fares and transfer fares Weak and declining CBD Technology inconvenient for the urban area
St Louis MetroLink	Radial corridor Location of line and stations Providing access over the river Improvement and integration of bus services Free journeys at the city centre at off-peak Security staff on board and at stations Providing car parks at station sites	Weak and declining CBD Lack of comprehensive redevelopment project for the CBD Using most station areas for surface car parks
San Diego Trolley	Location of the first line Integration of buses with the system City centre redevelopment project Joint development projects Transit oriented development schemes	Weak integration of local plans with the Trolley in some municipalities
Sacramento Light Rail	Strong and economically vital CBD Integration of buses with the system Free transfers between buses and the system Pedestrianization of a city centre street	Inconvenient urban form and low density Part of the route serving high income neighbourhoods that are against transit orientated development Inconvenient location of routes Lack of funds to improve buses Poor service levels (low frequency)
Vancover SkyTrain	Medium-high density urban area Substantial levels of public transport useage High Frequency of service Integration of buses with the system Planning the system as a part of the regional plan Adapting local plans to the rail sytem Redevelopment of old industrial sites Development bonuses (TOD incentives) Joint development schemes Relocating government buildings at stations Early opening of a section for demonstration	Provision of only one park and ride facility
Tyne and Wear Metro	High density urban area with radial corridors	Lack of integration with buses Poor co-ordination between the metro

(continued)

Table 9. Continued.

	Substantial levels of public transport usage Location of lines and their extensiveness City centre redevelopment project Integration with buses in initial years	and the local plans and recent urban projects
Manchester Metrolink	High density urban area with radial corridors Substantial levels of public transport usage Providing rail access through the city centre High frequency Location of lines: replacing rail commuter service and providing city centre rail link Renewal of some city centre buildings Pedestrianisation of a city centre street	Lack of integration with buses Poor integration of local municipal plans with LRT
Sheffield Supertram	Medium density urban area with radial corridors Substantial levels of public transport usage Ticket sales on board by an additional staff Signalling priority has been improving	Small and weak CBD System serving low income neighbourhoods combined with competition from buses Low segregation and low signalling priority Demolition of high density residential areas Poor co-ordination with the renewal project

Figure 2. Burnaby Metrotown Station, Vancouver: the station is integrated with new office development and retail centre.

Figure 3. Vancouver: a new government office and residential development taking place at a SkyTrain station.

stadiums. Being located at this corridor, the system provided access to most of these activity centres. The stations were also conveniently located to access them. Furthermore, new developments located at the light rail stations, such as a new sports stadium, and the conversion of some sites into retail centres in the city centre stations generated trips on the system. Another reason behind its high patronage seemed to be the substantial improvement it created in the overall accessibility of the area: the MetroLink provided access over the Mississippi River, where the road bridges were very congested at peak-times. In addition, interviews with planners and operators revealed that the integration of buses with the light rail had significant effects. In all the North American cases, buses and urban rail systems were integrated with each other; however, in St Louis, bus services were also radically improved and modernized: bus routes were shortened and simplified, and both the old and new routes were integrated with light rail stations. Some operating policies also had positive effects on the system. Offering free light rail journeys in the city centre at off-peak times attracted passengers. There was also an improvement in the economy of the city centre, which indicates that this policy may have enhanced the economic vitality of the CBD by attracting visitors to the central city. Policies aimed at enhancing the security image of the system also had significant effects because crime was a severe social problem in the city (East – West Gateway Co-ordinating Council 1996). Employment of additional security staff on board, at stations and at parking areas of the light rail system was an effective policy since it seemed to have created an image for the MetroLink that it was safe when compared with buses (Bi-State Development Agency 1995). In addition to the above policies, car parks at light rail stations were effective in attracting passengers to the system. Most of the stations outside the city centre were planned to accommodate car parks. It was observed that these were used to their full capacity, so they were seen to have been effective in attracting car users. On the other hand, they were surface car parks, and therefore

may have hindered development at station sites. In addition, the lack of a comprehensive city centre regeneration project may have limited the success of the system since the city centre is in decline. Some buildings at LRT stations were redeveloped as mentioned above, but these were only piecemeal actions. There was a city centre renewal project which was at the planning stage in 1998; however, it is believed that both the city and the light rail system would have benefited more if the project had been introduced together with the light rail investment.

In San Diego, one of the reasons for the good performance of the Trolley was the location of the first line: it was in a corridor that had the highest level of public transport usage. Besides this, the line provided access between two very important trip attracting and generating areas: the CBD and the Mexican border. Hence, the location decisions ensured a good patronage to a certain extent. The integration of the buses with the light rail, travelcards and free transfers between them also seem to have enhanced the patronage on the light rail. In addition, the CBD was very strong economically, and this had various positive effects: it helped to generate trips on the system, which in return helped the system have a strong developmental impact on the city centre. The economic strength of the CBD was partly due to a redevelopment project in the city centre, carried out by the City of San Diego, the city centre municipality. Fieldwork and interviews show that this project contributed to the success of the Trolley, since the two projects were very well integrated into each other: the Trolley was designed to serve most of the new developments within the redevelopment project, while the project was adapted to the Trolley and brought about the location of new development and activity centres at its stations (figure 4). The City of San Diego also implemented joint development projects and TOD schemes that were effective in increasing development densities and improving the urban environment in the vicinity of Trolley stations in the city centre. Outside the city centre, the system had some developmental impact when supported with joint-

Figure 4. High-density residential development in the San Diego city centre: it is well integrated with the Trolley route.

development projects; however, it is important to note that not all municipalities were eager to modify their planning policies for the Trolley. There were vacant and declining areas along the routes that did not receive investment from municipalities, although in some cases the Trolley was extended to these sites with expectations that the municipalities would develop their new town centres in the vicinity of new Trolley stops.

For Manchester Metrolink too, the location of the lines was an important factor. The system replaced a rail commuter service, which was located along two corridors of well-developed residential areas with a considerable level of commuter patronage. The already existing commuting demand certainly contributed to the success of the light rail; however, it should be noted that the Metrolink attained a much higher patronage than that of the commuter lines it replaced. Providing a more frequent service compared with the former commuter service, and providing access through the city centre seemed to be among the reasons (Knowles 1996). The pedestrianization of a city centre street and renewal of some city centre buildings also contributed to the success of the system by improving the CBD area, although the latter actions were not initiated by the Metrolink, but followed an IRA bomb attack which destroyed parts of the city centre. In addition, the urban form of the city, with its high population density and radial corridors, and relatively high public transport usage were suitable factors for light rail operation. On the other hand, bus deregulation, which prevented the integration of the system with buses, may have limited its success. In addition, it was observed that support from the municipalities to invest at, and develop, the Metrolink corridor and the station areas was limited.

The high population densities and high levels of public transport usage in Newcastle upon Tyne were among the contributory factors in the performance of the metro there. Besides this, the system is extensive and serves the majority of town centres, and a high proportion of residential settlements and employment centres in the metropolitan area. A city centre redevelopment project, which was implemented in the early 1980s, also seemed to have contributed to the effectiveness of the system. In addition, the system was very well integrated with buses when it opened for service although integration was lost after the deregulation of buses in 1985. The current decline in the metro patronage may be attributed to the loss of this integration as well as to recent investments, which conflicted with the metro. For example, Metro Centre, a large shopping centre, was developed in an out-of-town location not served by the metro. This area used to be a derelict site, and therefore was announced by the Central Government to be an Enterprise Zone (EZ): planning rules were relaxed, resulting in the construction of the Metro Centre. In addition to the EZ, a part of the city was under a regeneration project carried out by the Tyne and Wear Development Corporation (TWDC), an Urban Development Corporation (UDC) appointed by the Central Government as a temporary planning agency for the purpose of regenerating declining dock areas. The developments realized by the TWDC were not very supportive of the Metro either. In fact, the regeneration area had limited interaction with the Metro; however, as Byrne (1999: 135) argued, 'the form of development achieved by the TWDC with a very high office/car-park content is quite contrary to long established county (but not Newcastle City) policies asserting the significance of public transport and the desirability of locating large office development adjacent to peripheral Metro stations'. Byrne's observation also implied that the policies of the city council were not supportive of the Metro. Indeed, the interview with city council planners revealed that the Metro and the location of

its stations were not among the main factors that determined planning decisions regarding new residential, commercial and office development.

Miami Metrorail, as mentioned before, did not perform well when compared with other case studies. An important reason for this appears to be the unsuitable urban form. As already mentioned, the city had sprawled over a very large area, urban activities had scattered across the city and the development pattern was very much car-oriented. As a result of these factors, the metro could not penetrate the population or urban activities substantially. Very few of the stations served activity centres that could generate or attract trips on the metro. Furthermore, the CBD was economically weak. Although there were piecemeal actions to redevelop some station sites in the city centre, the area overall was in decline, and could hardly generate trips. Along one of its lines, the metro serves a low-income residential area, which relied on public transport; however, it failed to attract the inhabitants of this area. There appear to be three reasons for this. First, in the initial years of operation, trips on Metrorail cost more than trips on buses. Second, there were transfer fares between buses and the metro, which may have discouraged low-income residents from using the metro. Third, it was stated by the planners interviewed in Miami that some citizens had a very strong negative reaction to the building of the Metrorail because it passed through, and divided, their community. As a result of its negative external effect, the local image of the Metrorail remained poor. In addition to these factors, the technology of the city-centre segment of the system may not have been very suitable for the city: Miami has suffered crime-related urban problems, and has become the crime capital of the USA (Mohl 1983, East–West Gateway Co-ordinating Council 1996). As described above, the city centre part of the Metrorail is an automatic system, and operating trains without any staff on board does not seem to be suitable for an urban area where crime and personal safety are important issues. In spite of all the factors that hindered the success of the system, joint development schemes at station sites had a slight, but positive, impact on the development densities in the corridor. However, the dominant use in the new developments was retail, which is not a very public transport-friendly use, and therefore their overall impact on patronage and land-use remained limited. There were other planning actions that were aimed at attracting development to the rail corridor; however, they failed to appeal to private developers. For example, reductions were offered in the amount of car parking required for new developments that located along the rail corridor, a planning incentive, which had been effective in some of the other US cities. In Miami, however, it failed to appeal to developers because they considered car parks to be an important marketing tool for selling property in Miami, since it is an extremely car-oriented city.

In Sacramento, the urban form was unsuitable like in Miami, except that the CBD was strong and economically vital, and this may have had a positive impact on the system's patronage. Among the reasons that hindered success, the high-income profile of the citizens, and particularly of the employees working in the CBD (Walmsley and Perrett 1992: 74) seems to be significant. The system serves high-income neighbourhoods in parts of its route, and this not only affected the patronage on the light rail, but also hindered the success of TOD schemes: during field trips and interviews with experts, it was seen that the development tradition and public values were against high-density and transit-oriented development in Sacramento. High- and even medium-density housing is associated with overcrowding, low income and, to some extent, with urban crime issues. In spite of the efforts of planners to increase

densities along the system by introducing development bonuses or tax incentives, private developers did not cooperate because there was limited market for high-density housing in the city. The location of the routes and stations also had some negative effects on the success of the system: there were very few attractions along the lines, which could generate or attract trips. In addition, financial problems, which resulted from the cost of construction exceeding the budget, prevented the improvement of buses and their integration with the light rail system in its initial years of operation. The frequency of the system also remained poor as a result of financial problems. On the other hand, after the initial years of operation, buses were reorganized and integrated with the light rail, and free transfers were offered between the two systems. These improvements affected the light rail in a positive way since its patronage increased significantly after the integration with buses. In addition, the pedestrianization of a city centre street where the system ran improved the urban environment and helped enhance the image of the light rail. TOD incentives were also positive planning actions, but as mentioned above, they failed to be effective. Another planning action that failed to be successful was the relocation of two government buildings at a new light rail station with the anticipation that further development would be attracted to the site. However, new development did not occur (figure 5).

There were several factors that hindered success in Sheffield. The system served low-income neighbourhoods, and planners who were interviewed argued that those with low incomes should not be the target population of light rail. In fact, this issue seems to be associated with the public-transport-operating regime. Serving low-income areas hindered success in Sheffield because there was competition from buses: bus fares and travelcards on buses were cheaper while there were no through- or

Figure 5. Two government office buildings located at a light rail stop in Sacramento: they failed to attract further investment and development.

transfer-fares to encourage the usage of the tram. This operating environment made buses the preferred mode, particularly in low-income areas. There were also some design and planning issues that may have hindered the success of Supertram. The system is mostly street running, and it had rather poor signalling priority in traffic, which resulted in its being slow and unreliable. Short distance between stops also seems to have decreased its average speed (tables 3 and 4). These became particularly important problems because the tram had to compete with buses. Another factor was the lack of coordination between planning agencies: the routes were designed to serve some high-density council flats, which were demolished by the local authority during the construction of the system. In addition, one of the lines was planned to help revitalize a declining industrial area, which was the subject of a regeneration project led by an Urban Development Corporation. However, the line and its stops were poorly located for serving new activity centres developed within the project. It has been argued by Dabinett *et al.* (1999) and Lawless (1999) that the two projects were poorly integrated because of the lack of coordination between the transport providers and the development agency. In spite of these factors, which hindered success, there were some factors that may have helped the performance of the system. The urban area was suitable for urban rail operation since population density and public transport usage were considerably high; however, the CBD was small and economically weak, and therefore did not contribute much to the system's performance by attracting or generating trips. On-board ticket sale was introduced by employing additional staff on each tram. This operating policy was introduced to address the problems related to fare evasion and the usage of ticket machines, but it also helped to improve the image of the system, particularly in terms of personal safety. Signalling priority was also improved. These might be among the factors that contributed to the patronage of the Sheffield Supertram, which, although poor compared with other cases, has been increasing steadily.

A final note can be added on the reasons behind the poor performance of all the systems observed here in improving traffic conditions or the air quality. In none of the cities was the introduction of urban rail systems accompanied by policies that restricted car parking in the city centres or discouraged car usage along the rail corridors. It may be argued that some effects would have been observed on traffic levels if such policies were implemented; however, there is no evidence to substantiate this argument.

3. What makes urban rail systems successful?

The factors behind the success of the observed systems, which have been summarized above, can be grouped under the following headings: urban factors, planning factors, operating policies and supportive urban policies. In addition to these four sets of factors, there also appear to be various external factors that indirectly affect success, as described below.

3.1. *Urban factors*

It was observed that there were some factors regarding the urban area, such as the vitality of the CBD, the urban form, level of public transport usage and economic profile of the citizens served, that had important effects on the success of the systems. The findings suggest that an economically vital CBD, which is the main centre for both employment and retail, can contribute to the success of an urban rail system since it can generate and attract trips on the system (provided

that the system serves the CBD). In addition, cities that have grown along radial corridors with a high density of development are suitable for urban rail investment since this urban form enables rail systems to penetrate important parts of the population, and to serve various urban activities, because it is common in cities with radial growth that urban activities are located along radial corridors. Development density and urban form not only affect the patronage, but also influence the success of land-use policies that may be implemented to support the systems, as evident in Miami and Sacramento. In addition, high levels of public transport usage and a positive local image for the rail systems in terms of personal safety are contributory factors for successful metros or light rail systems. Although car ownership may be anticipated as an important factor, the case study analysis showed that there were successful systems in cities with very high car ownership levels, such as Vancouver, San Diego and St Louis. It appears that public transport usage levels are more important, as evident from the success in Vancouver where public transport usage was considerably high although car-ownership levels were also very high.

Findings suggest that local economic conditions also influence the success of urban rail systems, and that local economy of areas that they serve is more important than the overall economic trends and average income levels in a city. Low-income neighbourhoods may be unsuitable for urban rail operation, particularly when different forms of public transport cannot be integrated into each other, hence there is competition from other modes, especially in fares. The analysis also showed that very high-income neighbourhoods were not suitable for urban rail either, as evident in Sacramento. In addition to income levels, the economy of the areas served was found to be important: economically strong CBD areas are likely to generate trips on urban rail systems. Besides, following the positive developmental impact of the Trolley in San Diego city centre, it can be suggested that urban rail systems have stronger land-use impact in areas where economic conditions are favourable, although in the case of San Diego, the support from the municipality was also an important factor.

3.2. *Planning factors*

Some factors regarding the planning of urban rail systems were also observed to be effective. Integrating the systems into other urban projects, such as urban renewal; and integrating them with bus services are likely to increase their effectiveness. In addition, planning their routes in a way that they result in a very significant improvement in accessibility may help the systems have high patronage levels, as evident in the Manchester case where the LRT provided a rail link across the city centre, and the St Louis case where the LRT provided access over the river. Locating the systems at corridors where there is already a high demand for public transport; locating the lines in well-developed areas so that they can penetrate substantial parts of the population; and locating stations at trip attracting and generating activity centres can also result in high levels of patronage. In planning, it is also important that the external effects of route and station location decisions are judged and handled well, since these may create opposition against the rail systems, as experienced in Miami. Providing car parks at station areas may help enhance success because they encourage car users to ride the systems. On the other hand, when car parks are at the expense of development in station sites, they may hinder long-term success of urban rail systems.

Among the planning factors, design features, such as technology, level of segregation, and grade separation, were found to have limited effects on urban rail performance; however, it was observed that some design attributes were not suitable for certain urban areas. For example, full segregation and automatic technology may not be very appropriate choices if there are crime and safety related issues in an urban area, because both features may lead to an image of being isolated. Nevertheless, this potential problem can be overcome by employing additional security staff on board and at stations, as observed in St Louis. In addition, following the Sheffield experience, it can be argued that design features that decrease the speed and reliability of systems may hinder success, particularly if there is competition from other forms of public transport.

3.3. *Operating policies*

Operating policies can be effective tools because they encourage more usage of urban rail systems, and hence help to increase their patronage. Policies, such as providing a frequent service, introducing travelcards, offering free transfer to buses, offering free travel on some parts of the systems, marketing and advertising (e.g. organizing demonstration tours on the systems or offering free journeys on initial days of operation), and providing security staff on board, at stations and at car parks, are likely to make urban rail systems attractive, and hence increase their patronage and overall success.

3.4. *Urban planning policies*

Supportive urban planning policies can be very effective too. Policies, such as adapting urban development plans to urban rail systems, offering incentives for transit-oriented development, implementing joint-development projects, locating public developments at stations, pedestrianizing city centre streets, implementing city centre redevelopment projects, and implementing urban renewal projects at declining sites along the systems, can make rail corridors attractive for new development, and hence create a more public-transport-oriented urban form. These policies not only help to attain the objectives associated with urban form, but also contribute to the patronage.

The analysis also showed that in urban areas that are very car-oriented, some urban planning policies may fail to have any significant effects. When urban development is dominated by car usage and not public transport, piecemeal actions, such as implementing joint development projects and offering TOD incentives, have negligible effects. In such urban areas, more comprehensive planning efforts may be required to change the development tradition.

3.5. *External factors*

During the analysis of operating and urban planning policies, it was observed that in some cases many of them were implemented while in others the number of policies was limited. The comparison of the case studies in terms of their experience with operating policies (table 10) and supportive urban policies (table 11) points to a stark difference between the North American and the UK systems. This finding implies that there may be factors that indirectly affect the success of urban rail systems because they affect the formulation and implementation of policies.

Table 10 shows that in cities in the UK, very few of the operating policies described above were implemented. Travelcards were limited; there were no free

Table 10. Operating policies implemented in the case study cities.

	Miami	St Louis	San Diego	Sacramento	Vancouver	Newcastle upon Tyne	Manchester	Sheffield
Providing frequent service					√		√	
Introducing travelcards	√	√	√	√	√			√
Offering free transfer to buses			√	√	√			
Offering free travel		√						
Marketing and advertising		√	√	√	√			
Providing security staff on board and at stations		√			√			√

In Sheffield, the security image of the system has been enhanced by introducing additional staff for ticket sale on board.

transfers or even transfer tickets between buses and rail systems; and no examples of free journey zones. There appear to be two main factors behind this. The first is that urban rail systems in the UK are expected to cover their operating costs fully. Local governments are discouraged from subsidising urban rail systems. Consequently, it is very difficult to implement some of these policies because they are likely to increase the operating cost. Furthermore, except the Tyne and Wear Metro, these systems are operated by private companies who may not find it economically viable to implement these policies because of the increase in operating costs. The second factor is the deregulation of buses outside London. It has not been possible to integrate the systems with buses, introduce travelcards, or offer free transfers between bus and urban rail systems, which were among the most common and most effective policies in the North American cases. In contrast to their UK counterparts, the North American rail systems are subsidised by local governments, and operated by public entities, which in most cases are also the operators of bus systems. As a result, operating policies have been implemented extensively in most North American cities, except in Miami where it was stated by the operators that financial bottlenecks, which resulted from the high capital and operating cost and limited revenue due to low patronage, prevented their implementation.

Table 11. Supportive urban policies implemented in the case study cities.

	Miami	St Louis	San Diego	Sacramento	Vancouver	Newcastle upon Tyne	Manchester	Sheffield
Adapting plans to new system		√	√		√			
TOD incentives	√	√	√	√	√			
Joint development projects	√		√		√			
Relocating public buildings at stations	√	√		√	√			
Pedestrainising streets			√	√		√	√	
Redevelopment of the city centre or in station areas in CBD			√			√	√	
Urban renewal (to support the system)		√			√			

Urban regeneration realised by the Sheffield Development Corporation is not considered as a supporting planning action because of its limited integration with the supertram.

As observed with operating policies, supportive urban policies were not implemented in cities in the UK as extensively as in the North American ones (table 11). One of the reasons for this is that urban planning in the UK has become very much fragmented over the past two decades, and although there have been several urban projects that could have complemented urban rail investments, they were not coordinated. Fragmentation in planning seems to be a result of various interventions by the Central government. One form of intervention was the Enterprise Zones, the effects of which were discussed earlier for the Newcastle case: a large regional shopping centre was built in an area that was not served by the Metro, and it affected not only the economic vitality of the Newcastle city centre, but also the patronage of the Metro. Another example of Central government intervention in planning was the Urban Development Corporations (UDCs). UDCs were appointed by Central government to regenerate declining areas within cities, where the municipalities lost their planning powers. As a result, the UDC programme created a significant fragmentation in planning in English metropolitan cities (Lawless 1990,

Parkinson 1990, Imrie and Thomas 1999). Because of the poor coordination between UDCs and other local governments, the regeneration projects, which could have been designed as complementary projects for the rail investments, did not help the rail systems, and in some cases even contradicted them.

Lack of an upper-tier local government in metropolitan areas in the UK is another factor causing fragmentation in planning and inhibiting coordination between transport and urban planning. Metropolitan county councils were abolished in 1985 in the UK, and since then, there has been no comprehensive strategic planning of metropolitan areas. Local development plans are created by the municipalities, which are called city or district councils, while transport planning is carried out by a separate agency at metropolitan level. Although city and district councils participate in the transport planning process, they do not necessarily change their plans to support transport investments. Indeed, very few supportive urban policies were implemented by the city and district councils included in this study. This seems to be because the coordination between these councils and the transport planning agencies were limited, which may be due to the lack of metropolitan governance.

To a certain extent, the Vancouver case also supports the argument that strong regional/metropolitan government can play an important role in the success of urban rail systems. As mentioned earlier, the municipalities in Vancouver were very supportive of the SkyTrain project, and modified their local plans to channel development along the SkyTrain corridor. This may be because the regional government in Vancouver coordinated transport plans and local urban plans by incorporating them into a regional plan. This coordination between plans provided coordination between planning agencies, which resulted in urban planning policies being extremely supportive of the urban rail investment. On the other hand, there may be other reasons for extensive implementation of supportive urban policies in Vancouver. That is because the regional government was temporarily abolished during the construction of the rail system, and hence the regional plan lost its legitimacy, but local authorities nevertheless remained exceptionally committed to the regional plan. In fact, the local authorities were represented in the abolished regional government, and this may be a reason why they carried out the development policies of the regional government even after its abolition; however, in the US cities too, the local authorities take part in the metropolitan planning organizations, but as will be discussed below, they do not necessarily act in full coordination with the metropolitan plans. It can be argued that the local governments in Vancouver carried out the regional growth vision (which foresaw urban growth along the rail corridor) because the regional plan brought a legitimacy to their individual urban plans and projects, but it also appears that the planning approach in Canadian local governments was a factor behind the vigorous planning actions that supported the urban rail system: it is argued that local governments in Canada tend to have a non-partisan approach to municipal issues, and that this has created a 'value-free language of development' (Magnusson 1990: 173). This may be the reason why municipalities continued to invest and develop the rail corridor in compliance with the policies of the regional government even after it lost its planning power. In addition, Canadian municipalities are argued to have been traditionally engaged in entrepreneurial planning approaches in urban planning (Magnusson 1990, Hamel and Jalbert 1991, Keating 1991); therefore, they are experienced in implementing joint development projects, and formulating policies such as TOD incentives. As

described above, municipalities in Vancouver extensively implemented these types of policies. In addition to entrepreneurial planning techniques, Canadian local governments are also known to be able to adopt a strong regulation-based planning approach because the community is more tolerant of government intervention and planning in Canada than in most other western countries (Goldberg and Mercer 1986). This may explain how the municipalities in Vancouver made radical changes in their plans by rezoning the rail corridor in accordance with regional policies, and by restricting major development elsewhere.

In the US cities too, where more supportive policies have been implemented compared with the UK ones, planning tradition seems to be an important factor. Planning tradition in the USA is often described as being based on municipality-business partnership; hence the US local governments too are experienced in entrepreneurial techniques of planning (Wolman 1990, Fainstein and Fainstein 1991, Keating 1991, Pickvance and Preteceille 1991). Therefore, compared with their UK counterparts, they may be expected to be more successful in introducing attractive policies for private sector developers. Indeed, it was observed that TOD incentives and joint development projects have been used extensively and effectively in the US cases. On the other hand, although more supportive urban policies were observed in the US cases compared with the UK ones, it is not possible to argue that the coordination between the planning agencies in the USA is stronger than that in the UK. In fact, the US local government structure does not seem to be very suitable for a coordinated planning process either. Transport and urban planning are carried out by separate local governments. Unlike in the UK, there are regional governments in US metropolitan cities; however, these are mostly in the form of Council of Governments (COGs), which are often discussed as not being very effective in enforcing planning strategies on local governments because of their limited power and lack of fiscal resources (Zimmerman 1980, Johnson 1997). Hence, although COGs aim to improve the coordination between plans and projects introduced by different local governments, their policies are only in the form of recommendations. Indeed, it was observed in the US cases that coordination existed between transport planning agencies and urban planning agencies not because of their commitment to a regional government or its plan, but because they had a common interest, i.e. they had individual projects in the same urban area which could complement each other if integrated. Integration of the city centre redevelopment project in San Diego with the Trolley provides a good example.

Of the US case studies, Miami had a different form of metropolitan governance: modernization of a county government. Although it had more planning power and fiscal resources compared with COGs, its effectiveness has sometimes been limited as a result of certain factors, such as the definitions of its boundaries, and structural problems in the way the two-tier government system was adopted (Stowers 1996). The analysis here showed that coordination between transport and urban planning was not very strong either, with the exception of joint development implementations.

The above findings can be summarized as follows: the form and existence of metropolitan governments and the level of fragmentation in planning may affect the success of urban rail systems in various ways, because they influence coordination between planning agencies, and hence the formulation and implementation of policies. In addition, the tradition of urban planning in different countries is a factor, which, although external to the planning of urban rail systems, may nevertheless affect their success. Operating policies are also influenced by external factors, such as

the nature of the public transport industry, and government policy regarding the operation and financing of urban rail systems. External factors together with urban factors, planning factors, operating policies, and supportive urban policies affect the performance of urban rail systems.

4. Conclusion: comparison with previous research

Some of the findings of this study are consistent with those of previous research. For example, the impact of urban form on the performance of urban rail systems is a broad area of agreement in the literature, and the finding of this study that high-density development and the existence of radial corridors are suitable factors for urban rail investment, does not contradict Knight and Trygg (1977), Dunn (1980), Fouracre *et al.* (1990), Cervero (1994), ECMT (1994) and TRB (1996). This study showed that these urban factors were important not only for the patronage success of urban rail systems, but also for the success of complementary land-use policies.

The finding that favourable economic conditions can help urban rail systems have high patronage as well as strong land-use impact is compatible with the arguments in previous research that under favourable local economic conditions, transport investment, and rail in particular, is more likely to generate urban development along itself (Knight 1980, Simpson 1989), or at least increase the rate of urban growth (Banister and Hall 1995).

Integration of public transport modes has been discussed as a contributory factor for the success of rail systems, and this verifies the arguments of Warren (1995) and Hass-Klau and Crampton (1998). Findings regarding the effects of bus deregulation in UK cities outside London are compatible with the studies by Denant-Boemont and Mills (1999) and Environment, Transport and Regional Affairs Committee (2000). In this research, it has also been found that bus deregulation had negative effects on the performance of rail systems particularly when the physical features of the systems, such as level of segregation and stop spacing, reduce the average speed, and when systems are planned to serve low-income neighbourhoods. In addition to deregulation, this research has shown that the way the operating costs of urban rail systems are met may also affect their success because this influences operating policies.

The analysis showed that urban rail investment does not result in a reduction in traffic congestion, or an improvement in air quality. Expectations that rail systems will reduce traffic congestion are indeed overestimated as some critics, such as Gomez-Ibanez (1985), Hass-Klau and Crampton (1998) and Mackett and Edwards (1998), argue. On the other hand, in none of the cities observed here, were there policies of car restriction to accompany the introduction of the urban rail systems.

The study revealed that when urban planning policies are coordinated with transport investment, the result is an enhancement of the urban environment and development of the rail corridors, which in return increases the level of patronage on urban rail systems. These observations regarding the importance of integrating urban policies with urban rail investments support the arguments of Knight and Trygg (1977), Priest (1980), Skinner and Dean (1980), Miller *et al.* (1989), Glick (1992), Walmsley and Perrett (1992), Pucher (1994), Paaswell (1995), Mackett and Edwards (1996), TRB (1996) and Cervero and Landis (1997). Furthermore, recent policy documents in both the USA and the UK have increasingly emphasized the importance of coordinating transport and land-use planning policies for increasing the effectiveness of new urban rail systems. In the USA, the Federal Transit

Administration recently produced a planning guidance called 'Building Livable Communities with Transit' and presented how the benefits of transit investments can be enhanced by coordinating land-use policies with transit plans (Federal Transit Administration 2001a). In the UK, in the recent report by the Environment, Transport and Regional Affairs Committee (2000) of the House of Commons, it was argued that land-use planning policies have an important role to play in creating the type of densely developed corridors which can be most effectively served by LRT, and it is recommended that the government amends planning guidance to place even greater emphasis on integrating LRT schemes with urban development.

On the other hand, this study revealed important factors regarding the implementation and effects of urban planning policies. One of the findings was that these policies may have very limited effects in urban areas that are extremely car-oriented and very hostile to public transport. This finding verifies the arguments by Johnston *et al*. (1988), Kain (1988) and Wachs (1993) who argue the unsuitability of rail investment in very low-density Californian cities. Another finding regarding urban planning policies is that their formulation depends on institutional and political factors, as well as factors regarding planning tradition in different countries. Entrepreneurial planning tradition in North American cities enables the introduction of effective policies that attract private sector developers to the rail corridors. Although it is often discussed for the UK that the recent neo-liberal policies have resulted in a transformation of the planning approaches of UK local authorities, from regulationist towards entrepreneurial (Logan and Swanstrom 1990, Keating 1991, Parkinson 1990, Pickvance and Preteceille 1991), it is seen in this study that they have not yet adopted entrepreneurial planning techniques as successfully as their North American counterparts, at least in integration with urban rail investments. This may be due to the poor integration of transport and urban planning in the UK resulting from poor coordination between agencies; however, the research showed that coordination between transport and urban planning agencies in the USA was also weak. The latter argument is compatible with Banister (1994) who reports that there is a separation of transport and planning functions in US local governments.

To summarize, many critics, as cited above, argued that coordinating urban and transport plans would make urban rail systems successful; however, this study showed that planning coordination may be rhetoric: coordination between planning agencies is often weak due to fragmentation of planning and lack of strong metropolitan governments. When there are coordinated policies, these are often because of the individual efforts of each local authority. Hence, a final conclusion that can be drawn out from this research is that planners of urban rail systems, particularly those in the UK and USA, need to find alternative ways of strengthening the coordination between their plans and those of other local authorities, because within the contemporary local government structure policy coordination is not likely to exist spontaneously.

Acknowledgements

The author acknowledges the assistance of various experts working for the transport agencies, municipalities and other local government organizations in Miami, St Louis, San Diego and Sacramento, USA; Vancouver, Canada; and Newcastle upon Tyne, Manchester and Sheffield, UK. The organizations are: MetroDade Transit Agency and Metropolitan Dade County-Planning Department

in Miami; Bi-State Development Agency, East–West Gateway Co-ordinating Council, Citizens for Modern Transit, and Regional Commerce and Growth Association in St Louis; Metropolitan Transit Development Board, San Diego Association of Governments (SANDAG), and City of San Diego in San Diego; Sacramento Regional Transit District, Sacramento Area Council of Governments, City of Sacramento, and Capitol Area Development Authority in Sacramento; British Columbia Rapid Transit Company Ltd, BC Transit, Greater Vancouver Regional District (GVRD), City of Vancouver, City of Burnaby, and City of Surrey in Vancouver; Newcastle City Council and Nexus the Passenger Transport Executive in Tyne and Wear; Greater Manchester Passenger Transport Executive (GMPTE) and Manchester City Council in Manchester; South Yorkshire Passenger Transport Executive (SYPTE), Supertram Ltd, and Sheffield City Council in Sheffield. In addition, the technical assistance of Tom Parkinson, President of Transport Consulting Ltd, Vancouver; Tony Young, former Operational Planning Manager, GMPTE; John Keyworth, former Director of Planning, Sheffield Development Corporation (SDC); Patsy Healey, Simon Raybould and John Nelson, University of Newcastle; and Russ Haywood, Sheffield Hallam University, are gratefully acknowledged. In addition, the author gratefully acknowledges the Middle East Technical University in Ankara, Turkey, which funded the research; the Brian Large Trust, which partially funded the study trip to North America; and the University College London Graduate School, which contributed to the funding of the North America study trip as well as the study trips to Sheffield and Newcastle upon Tyne, UK. However, none of the organizations or people are responsible for the views or interpretations expressed here, for which the author takes responsibility.

References

Babalik E., 2000, Urban rail systems: a planning framework to increase their success. PhD thesis, University of London (submitted).

Banister, D., 1994, *Transport Planning in the UK, USA and Europe* (London: E&FN Spon).

Banister, D. and Hall, P., 1995, Summary and conclusions. In D. Banister (ed.), *Transport and Urban Development* (London: E&FN Spon), pp. 278–287.

Bernick, M. and Cervero, R., 1997, *Transit villages in the 21st Century* (New York: McGraw-Hill).

Bi-State Development Agency, 1995, *Market Research Report: On Board Survey Summer 1995* (Program Evaluation Department, Bi-State Development Agency).

Black, A., 1993, The recent popularity of light rail transit in North America. *Journal of Planning Education and Research*, **12,** 150–159.

Byrne, D., 1999, Tyne and Wear UDC — turning the uses inside out: active deindustrialisation and its consequences. In R. Imrie and H. Thomas (eds), *British Urban Policy: An Evaluation of the Urban Development Corporations* (London: Sage), pp. 128–145.

Cervero, R., 1994, Rail-oriented office development in California: how successful? *Transportation Quarterly*, **48,** 33–44.

Cervero, R. and Landis, J., 1997, Twenty years of the Bay Area rapid transit system: land-use and development impacts. *Transportation Research*, **31A,** 309–333.

Dabinett, G., Gore, T., Haywood, R. and Lawless, P., 1999, Transport investment and regeneration, Sheffield: 1992–1997. *Transport Policy*, **6,** 123–134.

Davoudi, S., Gilliard, A., Healey, P., Pullen, B., Raybould, S., Robinson, F., Silcock, D., Usher, D. and Wymer, C., 1993, *The Longer Term Effects of the Tyne and Wear Metro*. Transport Research Laboratory, Contractor Report 357.

Denant-Boemont, L. and Mills, G., 1999, Urban light rail: intermodal competition or coordination? *Transport Reviews*, **19,** 241–253.

Department of the Environment, Transport and the Regions, 1998, *Transport Statistics Great Britain*, 24th edn (London: HMSO).

Department of the Environment, Transport and the Regions, 1999a, *Transport Statistics Great Britain*, 25th edn (London: HMSO).

Department of the Environment, Transport and the Regions, 1999b, *Focus on Public Transport Great Britain*, 1999 edn (London: HMSO).

Department of the Environment, Transport and the Regions, 2000, *Transport Statistics Great Britain: 2000 Edition* [http://www.detr.gov.uk/].

Dunn, J. A., 1980, Co-ordination of urban transit services: the German model. *Transportation*, **9,** 33–43.

Dunphy, R. T., 1997, Review of recent American light rail experiences. Proceedings of Seventh National Conference on Light Rail Transit. *Transportation Research Board Conference Proceedings*, **8,** 104–113.

EastWest Gateway Co-ordinating Council, 1996, Where we stand: the strategic assessment of the St Louis Region (St Louis: East–West Gateway Co-ordinating Council).

ECMT, 1994, *Light Rail Transit Systems*. The European Conference of Ministers of Transport (ECMT) Publication, France.

Environment, Transport and Regional Affairs Committee, 2000, *Light Rapid Transit Systems*. UK House of Commons, Session 1999–2000, Eight Report (Norwich: HMSO).

Fainstein, S. S. and Fainstein, N., 1991, Economic development policy in the US federal system under the Reagan administration. In C. Pickvance and E. Preteceille (eds), *State Restructuring and Local Power: A Comparative Perspective* (New York: Pinter), pp. 150–170.

Federal Transit Administration, 1998, *TEA-21 Transportation Equity Act for the 21st Century* [http://www.fta.dot.gov/].

Federal Transit Administration, 1999, *National Transit Database 1997* [http://www.fta.dot.-gov/].

Federal Transit Administration, 2000, *National Transit Database 1998* [http://www.fta.dot.-gov/].

Federal Transit Administration, 2001a, *Building Livable Communities with Transit* [http://www.fta.dot.gov/].

Federal Transit Administration, 2001b, *National Transit Database 1999* [http://www.fta.-dot.gov/].

Fouracre, P. R., Allport, R. J. and Thomson, J. M., 1990, *The Performance and Impact of Rail Mass Transit in Developing Countries*. Transport and Road Research Laboratory, Research Report 278.

Fox, P., 1996, Tram operation in Sheffield: progress, problem and a crisis. *Light Rail Review*, **7,** 63–71.

Glick, F., 1992, Light rail transit and effective land use planning: Portland, Sacramento, and San Diego. *Transportation Research Record*, **1361,** 75–80.

Goldberg, M. A. and Mercer, J., 1986, *The Myth of the North American City: Continentalism Challenged* (Vancouver: University of British Columbia Press).

Gomez-Ibanez, J. A., 1985, The dark side to light rail? Experience of three new transit systems. *Journal of the American Planning Association*, **51,** 337–351.

Great Britain Office for National Statistics, 1998a, *1991 Census: Key Statistics for Urban and Rural Areas* (London: HMSO).

Great Britain Office for National Statistics, 1998b, Regional accounts 1996 Part 2. *Economic Trends*, **535**.

Greater Vancouver Regional District, 1999, *Greater Vancouver Key Facts* [http://www.gvrd.bc.ca/go/arch/keyfacts.html].

Hamel, P. and Jalbert, L., 1991, Local power in Canada: stakes and challenges in the restructuring of the state. In C. Pickvance and E. Preteceille (eds), *State Restructuring and Local Power: A Comparative Perspective* (New York: Pinter), pp. 171–196.

Hass-Klau, C. and Crampton, G., 1998, *Light Rail and Complementary Measures*. Report for the Department of the Environment, Transport and the Regions, by Environment and Transport Planning (ETP), UK.

Hass-Klau, C., Crampton, G., Weidauer, M. and Deutsch, V., 2000, *Bus or Light Rail: Making the Right Choice* (Brighton: Environmental and Transport Planning).

Haywood, R., 1998, South Yorkshire Supertram: final report on planning applications and land-use change research. Working paper, Sheffield Hallam University, School of Urban and Regional Studies.

Haywood, R., 1999, South Yorkshire Supertram: its property impacts and their implications for integrated land use-transportation planning. *Planning Practice and Research*, **14,** 277–299.

Heseltine, P. M. and Mulley, C., 1993, Longer-term benefits of the Tyne and Wear Metro. *Transportation Planning Systems*, **1,** 47–55.

Imrie, R. and Thomas, H. (eds), 1999, *British Urban Policy: An Evaluation of the Urban Development Corporations* (London: Sage).

Johnson, W. C., 1997, *Urban Planning and Politics* (Chicago: American Planning Association).

Johnston, R. A., Sperling, D., Deluchi, M. A. and Tracy, S., 1988, Politics and technical uncertainty in transportation investment analysis. *Transportation Research*, **21A,** 459–475.

Kain, J. F., 1988, Choosing the wrong technology: or how to spend billions and reduce transit use. *Journal of Advanced Transportation*, **21,** 197–213.

Keating, M., 1991, *Comparative Urban Politics: Power and the City in the United States, Canada, Britain, and France* (Aldershot: Elgar).

Knight, R. L., 1980, The impact of rail transit on land-use: evidence and a change of perspective. *Transportation*, **9,** 3–16.

Knight, R. L. and Trygg, L. L., 1977, Evidence of land-use impacts of rapid transit systems. *Transportation*, **6,** 231–248.

Knowles, R. D., 1994, Manchester Metrolink impact study 1990–1994. Working paper, University of Salford, Department of Geography.

Knowles, R. D., 1996, Transport impacts of Greater Manchester's Metrolink light rail system. *Transport Geography*, **4,** 1–14.

Lawless, P., 1990, Regeneration in Sheffield: from radical intervention to partnership. In M. Parkinson and D. Judd (eds), *Leadership and Urban Regeneration* (London: Sage), pp. 133–151.

Lawless, P., 1999, Transport investment and urban regeneration in a provincial city: Sheffield, 1992–96. *Environment and Planning C: Government and Policy*, **17,** 211–226.

Logan, J. R. and Swanstrom, T., 1990, Urban restructuring: a critical view. In J. R. Logan and T. Swanstrom (eds), *Beyond the City Limits* (Philadelphia: Temple University Press), pp. 3–24.

Mackett, R. L., 1998, Why are travel demand forecasts so often wrong (and does it matter)? Paper written for presentation at the UTSG Annual Conference, Dublin, January 1998.

Mackett, R. L. and Babalik, E., 2001, Enhancing the success of light rail systems. *Transport Economist*, **28,** 1–16.

Mackett, R. L. and Edwards, M., 1996, Guidelines for planning a new urban public transport system. *Proceedings of the Institution of Civil Engineers: Transport*, **117,** 193–201.

Mackett, R. L. and Edwards, M., 1998, The impact of new urban public transport systems: will the expectations be met? *Transportation Research*, **32A,** 231–245.

Magnusson, W., 1990, Progressive politics and Canadian cities. In D. S. King and J. Pierre (eds), *Challenges to Local Government* (London: Sage), pp. 173–194.

Mercer, J., 1999, North American cities: the micro-geography. In F. W. Boal and S. A. Royle (eds), *North America: A Geographical Mosaic* (London: Arnold), pp. 191–206.

Miller, C., Coomer, D. and Jameson, R., 1989, Role and function of transit in growth management: current issues in Florida. *Transportation Research Record*, **1237,** 64–76.

Mohl, R. A., 1983, Miami: the ethnic cauldron. In R. M. Bernard and B. R. Rice (eds), *Sunbelt Cities: Politics and Growth Since World War II* (Austin: University of Texas Press), pp 58–99.

OECD, 1999 [http://www.oecd.org].

Paaswell, R. E., 1995, ISTEA: infrastructure investment and land-use. In D. Banister (ed.), *Transport and Urban Development* (London: E&FN Spon), pp. 36–58.

Parkinson, M., 1990, Political responses to urban restructuring: the British experience under Thatcherism. In J. R. Logan and T. Swanstrom (eds), *Beyond the City Limits* (Philadelphia: Temple University Press), pp. 86–116.

Parkinson, T., 1992, Rail transit performance. *Transportation Research Record*, **1361,** 47–52.

PICKRELL, D. H., 1990, *Urban Rail Transit Projects: Forecast Versus Actual Ridership and Costs* (Washington, DC: US Department of Transportation).

PICKRELL, D. H., 1992, A desire named streetcar: fantasy and fact in rail transit planning. *Journal of the American Planning Association*, **58,** 158–176.

PICKVANCE, C. and PRETECEILLE, E., 1991, The significance of local power in theory and practice. In C. Pickvance and E. Preteceille (eds), *State Restructuring and Local Power: A Comparative Perspective* (New York: Pinter), pp 1–17.

PRIEST, D. E., 1980, Enhancing the developmental impact of rail transit. *Transportation*, **9,** 45–55.

PUCHER, J., 1994, Public transport developments: Canada vs the United States. *Transportation Quarterly*, **48,** 65–78.

RICHMOND, J. E. D., 1998, New rail transit investments — a review: summary paper. Taubman Centre, Kennedy School of Government, Harvard University and MIT Cooperative Mobility Research Program.

SENIOR, M. L., 1999, The short-term transport impacts of light rail: the evidence of secondary data from Greater Manchester's Metrolink. *Transportation Planning and Technology*, **22,** 149–180.

SIMPSON, B. J., 1988, *City Centre Planning and Public Transport: Case Studies from Britain, West Germany and France* (Wokingham: van Nostrand Reinhold).

SIMPSON, B. J., 1989, Urban rail transit — an appraisal. Transport and Road Research Laboratory, Contractor Report 140.

SIMPSON, B. J., 1994, *Urban Public Transport Today* (London: E&FN Spon).

SKINNER, R. E. and DEAN, T. B., 1980, Second generation US rail transit systems: prospects and perils. *Transportation*, **9,** 17–32.

STOWERS, G., 1996, Miami: experiences in regional government. In H. V. Savitch and R. K. Vogel (eds), *Regional Politics: America in a Post-city Age* (Thousand Oaks: Sage), pp. 185–205.

TRB, 1996, *Transit and Urban Form*. Transit Cooperative Research Program Report 16, Transportation Research Board (Washington DC: National Academy Press).

US CENSUS BUREAU, 1999 [http://www.census.gov/].

WACHS, M., 1993, Learning from Los Angeles: transport, urban form, and air quality. *Transportation*, **20,** 329–354.

WALMSLEY, D. and PERRETT, K., 1992, *The Effects of Rapid Transit on Public Transport and Urban Development* (London: HMSO).

WARREN, W. D., 1995, Why success in St Louis? *Transport News*, **180,** 22–26.

WOLMAN, H., 1990, The Reagan urban policy and its impacts. In D. S. King and J. Pierre (eds), *Challenges to Local Government* (London: Sage), pp. 145–172.

ZIMMERMAN, J. F., 1980, The government of metropolitan areas: United States. In D. C. Rowat (ed.), *International Handbook on Local Government Reorganization* (London: Aldwych), pp. 45–60.