

MAKING A SUCCESSFUL LRT-BASED REGIONAL TRANSIT SYSTEM: LESSONS FROM FIVE NEW START CITIES

Gregory L. Thompson, Professor, Department of Urban and Regional Planning Florida State University, Tallahassee

Jeffrey R. Brown, Assistant Professor, Department of Urban and Regional Planning Florida State University, Tallahassee

ABSTRACT

A new era of transit development began in 1981 when San Diego opened its first regional light rail transit (LRT) line. Since then, eleven other U.S. metropolitan areas that also previously had bus-only transit systems opened their own LRT lines. Several of these new LRT lines have since become the backbones of metropolitan transit systems. This paper examines five metropolitan areas where LRT lines serve as regional transit system backbones that carry 30 percent or more of total metropolitan area transit ridership. These areas are Dallas, Portland, Sacramento, Salt Lake City, and San Diego. The paper defines a successful LRT-based regional transit system as one with high riding habit and productivity for all combined modes in each metropolitan area, and as also having high LRT ridership and productivity. Based on these criteria, Portland emerges as a successful LRT-based regional transit system.

Our analysis reveals four characteristics of the Portland transit system that explain its strong performance: the network's dispersed nature, the overlay of a higher-speed, high-frequency regional LRT network atop the local bus system, the use of transfers to provide passengers easy access to a diverse array of destinations, and a large number of passengers going to non-CBD destinations. We examine the performance of all five metropolitan areas with respect to these characteristics using a combination of agency data and insights from interviews with key informants. We find that the most successful metropolitan areas have transit systems that possess many of the characteristics that account for Portland's transit success.

INTRODUCTION

A new era of transit development began in 1981 when San Diego opened its first regional light rail transit (LRT) line. Since then, eleven other U.S. metropolitan areas that also previously had bus-only systems opened their own LRT lines. Several of these new LRT lines have since become the backbones of metropolitan transit systems, carrying a large share of the metropolitan area's total transit ridership. In this paper, we examine transit performance in five metropolitan areas with LRT systems that opened since 1981 where LRT functions as the backbone of a regional bus-and-rail transit system. Using

Portland as the model of a successful system, we identify four characteristics that by their presence or absence help to explain variation in transit performance in Portland, Dallas, Sacramento, Salt Lake City, and San Diego. These four characteristics are: the network's dispersed nature, the overlay of a higher-speed, high-frequency regional LRT network atop the local bus system, the use of transfers to provide passengers easy access to a diverse array of destinations, and service deployed so that it attracts a large number of passengers going to destinations outside the central business district (CBD). We discuss the roles of each of these characteristics, both individually and collectively, in contributing to strong transit performance.

LITERATURE REVIEW

Scholars examining the performance of light rail transit have typically looked at the mode as a stand-alone entity, rather than as a component of an integrated transit system, and/or have tended to emphasize the role of non-transit factors such as urban structure and land use policy as important contributors to ridership and performance. Scholars writing on the first subject tend to compare LRT to bus in terms of ridership, cost, and productivity, and usually find LRT deficient (1, 2, 3, 4, 5). Scholars writing on the second subject tend to emphasize the role that strong CBDs and transit-oriented development (TOD) land use strategies play in leading to higher ridership or larger transit commute mode shares (6, 7, 8, 9, 10). These two literatures tend to be quite distinct, with little connection between them. However, one characteristic they largely have in common is a tendency to ignore the role that LRT might play in the context of a regional transit system.

There is, however, a small but growing literature that emphasizes the role that rail transit, either LRT or heavy rail, can play as a trunk line (or backbone) in an integrated bus-rail regional system. Vuchic (11) discusses the use of LRT as the backbone of a regional system that embraces a family of interconnected modes. Brown and Thompson (12) found that successful rail metropolises use rail as the backbone of a multdestination network that is structured to provide access to important destinations throughout the region. Brown and Thompson (13) find that comparisons of bus versus rail performance have been clouded by a failure to consider the variety of roles these two modes actually play. They find that rail is a stronger performer in terms of ridership and productivity, both for itself and the regional transit system as a whole, because it serves as the backbone of an integrated system whereas express bus-based services tend to be isolated due to the desire to provide one-seat rides. Thompson and Matoff (14) found similar results in their study of multdestination versus radial transit systems in nine metropolitan areas. This paper extends this line of inquiry by seeking to understand the causes of variation in transit performance in five metropolitan areas in which LRT serves as the regional transit backbone.

DATA AND METHODOLOGY

We examine the performance of LRT-based regional transit systems in five U.S. metropolitan areas in 2006. We define a regional transit system as being LRT-based if LRT

accounts for 30 percent or more of total metropolitan area transit ridership (measured on a passenger miles basis). The five metropolitan areas that we examine are Dallas, Portland, Sacramento, Salt Lake City, and San Diego. Each of these metropolitan areas is centered on a city that implemented LRT as part of a previously bus-only transit system since 1981. The five metropolitan areas have populations between 2 million and 6 million (15). We define the metropolitan areas as encompassing the counties identified by the Office of Management and Budget (16).

Our method involves evaluating the performance of each metropolitan area's transit system in order to identify the most successful system, examining that system to determine which characteristics account for its success, and then evaluating the set of five metropolitan areas in terms of the extent to which their transit systems exhibit each of these characteristics. A metropolitan area's transit system consists of the aggregation of all fixed-route services in the metropolitan area. The transit agencies included in this study are: Dallas Area Rapid Transit (DART), Fort Worth Transportation Authority (The T), Trinity Railway Express (TRE), and Denton County Transportation Authority (DCTA) for Dallas; Tri-Met and Clark County (CC) Transit for Portland; Sacramento Regional Transit (RT), Unitrans, Yolo County Transit, and Roseville Transit for Sacramento; Utah Transit Authority for Salt Lake City; and San Diego Trolley, Inc. (SDTI), North County Transit District (NCTD), Chula Vista Transit (CVT), Metropolitan Transit System (MTS), and National City Transit (NCT) for San Diego.

We measure system success 1) by examining riding habit (passenger miles per capita) and productivity (passenger miles per revenue mile) at a metropolitan scale for all fixed-route modes and 2) by examining LRT ridership (passenger miles) and productivity (passenger miles per revenue mile). We construct metropolitan scale measures of riding habit and productivity by identifying all transit agencies in each metropolitan area that provide fixed-route service and aggregating the fixed-route ridership and service statistics to produce metropolitan totals. We do not consider vanpool or demand responsive services in this analysis.

Our analysis uses a combination of quantitative and qualitative data. We obtained ridership (passenger miles) and service (revenue miles) data from the National Transit Database using the Florida Department of Transportation's (FDOT) web-based data extraction tool (17). We obtained population data from the U.S. Census Bureau (15). Using these data, we calculated riding habit (passenger miles per capita) and productivity (passenger miles per revenue mile) for the combination of all transit agencies providing fixed route service in each metropolitan area. We also obtained mode specific ridership (passenger miles) and service (revenue miles) for LRT and for the total of all fixed-route bus service in each metropolitan area (17). We use these data to construct mode-based productivity measures (passenger miles per revenue mile) and to calculate the percent of all ridership and service provided by each mode. For Dallas and San Diego, we obtained commuter rail statistics which we report for completeness.

We also obtained data from individual agencies about passenger activity (by mode, by station/stop, and in some cases, by time of day and direction) for some study areas (18,

19, 20). We obtained geographic information system (GIS) shapefile data that we used to construct maps of the regional transit systems in each metropolitan area (21, 22, 23, 24, 25).

We provide context for these data by drawing on information gained in interviews with key informants in each metropolitan area. The key informants are individuals with a long-range perspective on bus and light rail transit development. These interviews provide information about the regional transit vision, the role the agency hoped that light rail and bus transit would play within this vision, the present-day operation and passenger use of the transit system, and other insights about systems planning.

TRANSIT PERFORMANCE IN FIVE LRT NEW START CITIES

In evaluating the performance of each metropolitan area's LRT-based regional transit system, we consider both individual mode and total regional performance. We judge a regional transit system to be successful if it meets four criteria: high metropolitan area riding habit, high metropolitan area service productivity, high LRT ridership, and high LRT productivity. Metropolitan area riding habit refers to the total number of passenger miles consumed on all fixed route transit modes in the metropolitan area expressed on a per person basis (passenger miles per capita). Metropolitan area service productivity refers to the number of passenger miles per revenue mile for all fixed-route modes in each metropolitan area. LRT ridership refers to the number of passenger miles traveled by LRT patrons. LRT service productivity refers to the number of passenger miles per revenue mile for LRT service.

Table 1 provides mode-based and metropolitan area ridership and productivity statistics. The top panel reports LRT ridership, service, and productivity information and expresses LRT ridership and service as percentages of all fixed route service in each metropolitan area. The panel shows that LRT ridership and service is highest in Portland and San Diego, followed by Dallas. Sacramento and Salt Lake City have much lower LRT ridership and provide much less LRT service than the other three metropolitan areas. In each of the five metropolitan areas, LRT ridership accounts for 30 percent or more of the entire metropolitan area's transit ridership. The LRT ridership shares range from a low of 30 percent in Dallas to a high of 50 percent in Sacramento. LRT service accounts for a much smaller percent of the metropolitan area total than LRT contributes to ridership. LRT accounts for between 13 percent (Dallas) and 27 percent (Sacramento) of metropolitan area transit service. Thus, LRT is carrying a disproportionate share of metropolitan transit ridership, as one would hope. The far right column of the top panel reports LRT productivity. The most productive LRT service is in Salt Lake City, followed by Portland. Sacramento's LRT system has the lowest productivity.

The middle panels provide the same information about commuter rail services (where applicable) and fixed-route bus service. Particularly striking are the differences in bus route productivity in the five metropolitan areas. Portland has much higher bus productivity (10.32 passenger miles per revenue mile) than the other metropolitan areas. Salt Lake City ranks second, with Dallas and San Diego not too far behind. Sacramento has

the lowest bus productivity (7.38 passenger miles per vehicle mile) of the five metropolitan areas, though it is not too much lower than San Diego.

TABLE 1 Transit Agency Performance in Five LRT New Start Cities (2006)

Metropolitan Area	Agency	Ridership		Service		Productivity
		Passenger Miles	% of Metro Area Fixed-Route Total	Revenue Miles	% of Metro Area Fixed-Route Total	Passenger Miles per Revenue Mile
Light Rail Transit						
Dallas	DART	136,797,106	30%	5,096,186	13%	26.84
Portland	Tri-Met	179,875,394	39%	6,377,513	19%	28.20
Sacramento	RT	78,181,014	50%	3,888,222	27%	20.11
Salt Lake City	UTA	86,039,042	37%	2,827,710	14%	30.43
San Diego	SDTI	208,875,499	44%	8,180,189	22%	25.53
Commuter Rail						
Dallas	TRE	33,023,714	7%	1,087,437	3%	30.37
San Diego	NCTD	42,970,414	9%	1,298,922	3%	33.08
Fixed-Route Bus Service						
Dallas	DART, The T, DCTA	283,748,664	63%	32,591,274	84%	8.71
Portland	CC, Tri-Met	276,834,579	61%	26,821,806	81%	10.32
Sacramento	Unitrans, RT, Yolo, Roseville	79,388,437	50%	10,758,943	73%	7.38
Salt Lake City	UTA	148,984,636	63%	16,732,379	86%	8.90
San Diego	CVT, MTS, NCT, NCTD	226,843,780	47%	27,846,175	75%	8.15
Metropolitan Area Fixed-Route Transit (Total)						
Dallas	All	453,569,484		38,774,897		11.70
Portland	All	456,709,973		33,199,319		13.76
Sacramento	All	157,569,451		14,647,165		10.76
Salt Lake City	All	235,023,678		19,560,089		12.02
San Diego	All	478,689,693		37,325,286		12.82
Metropolitan Area Riding Habit			Population	Passenger Miles per capita		
Dallas			6,003,967	75.54		
Portland			2,137,565	213.66		
Sacramento			2,067,117	76.23		
Salt Lake City			2,039,542	115.23		
San Diego			2,941,454	162.74		

Source: FDOT (2008), U.S. Census Bureau (2008).

Figure 1 provides a capsule history of bus and LRT ridership over the two decades preceding the data shown in Table 1. Each metropolitan area is shown as a graph panel. The panels all feature the same scale (expressed as millions of passenger miles) and cover the

same time period (1984-2006). Bus ridership is shown on top of LRT ridership in each graph.

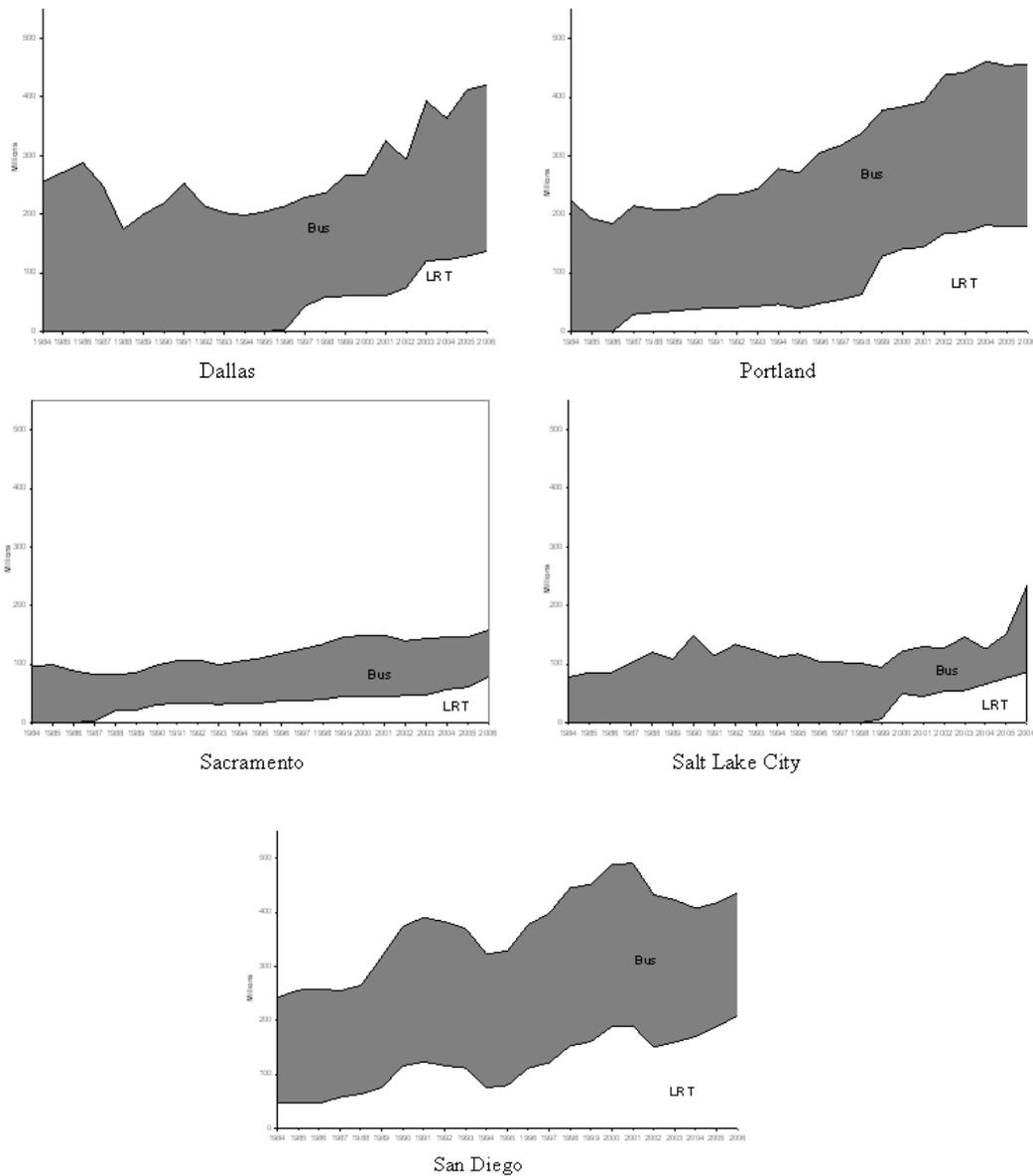


FIGURE 1 Bus and LRT Ridership in Five Metropolitan Areas (1984-2006)

Two things stand out in these graphs. First, there is a sizeable difference in the magnitude of ridership among the five metropolitan areas. Ridership in Dallas, Portland,

and San Diego is large and roughly comparable, although the metropolitan areas are different in terms of their total populations, leading to different riding habit as we discuss below. Ridership is much lower in Sacramento and Salt Lake City, although their populations are not very different from that of Portland. These two metropolitan areas historically have provided much less service per capita than the others (17). This fact can also be seen in the service statistics (revenue miles) for both metropolitan areas' LRT and fixed-route transit total reported in Table 1.

Second, the recent ridership increases experienced in all the cities save Salt Lake City appear to be due almost entirely to increased LRT ridership. LRT ridership has increased steadily in Dallas, Portland, Sacramento, and Salt Lake City. San Diego has also experienced a general increase in LRT ridership, although it has experienced two periods of retrenchment. Bus ridership is flat or declining in Dallas, Portland, San Diego, and Sacramento. Salt Lake City shows similar trends save for a remarkable doubling of bus ridership in 2006.

Our other gauges of transit performance are metropolitan area service productivity and riding habit. The far right column in the fourth panel of **Table 1** reports overall transit productivity for the five metropolitan areas. In 2004, fixed-route service productivity for the U.S. (excluding New York City, which alone accounts for 40 percent of all U.S. transit ridership) was 11.1 passenger miles per revenue mile (26). All the metropolitan areas except Sacramento had productivity above this number in 2006. Among the five metropolitan areas, Portland stands out with the highest productivity, followed by San Diego and Salt Lake City.

The bottom table panel reports metropolitan area population and riding habit (passenger miles per capita). Riding habit adjusts ridership for population differences among the metropolitan areas. In 2004, riding habit for the U.S. (excluding New York City) was 99 passenger miles per capita (26). Three of the five metropolitan areas have 2006 riding habit higher than this number: Portland, San Diego, and Salt Lake City. Portland stands out with significantly higher riding habit (213.66 passenger miles per capita) than second-ranked San Diego (162.74 passenger miles per capita). Dallas and Sacramento ranked at the bottom in both metropolitan area riding habit and productivity.

Despite its high LRT productivity noted earlier, Salt Lake City falls in the middle both in terms of overall riding habit and productivity. Salt Lake City's relatively good performance is the result of the reported doubling of its bus ridership in 2006 without an increase in service. Prior to 2006, Salt Lake City's LRT line performed well by itself, but the bus service had very low productivity (3.06 passenger miles per bus mile in 2004), partly because the LRT line pulled so many riders away from the buses (12).

Based on the transit performance statistics shown in **Table 1**, Portland emerges as the most successful of the five metropolitan areas. It ranks first in metropolitan area riding habit and service productivity, which are the gauges of overall transit performance. Its LRT system ranks second to San Diego in ridership and second to Salt Lake City in productivity. Portland thus emerges at or near the top in the four measures we proposed to evaluate the performance of LRT-based regional transit systems.

FOUR CHARACTERISTICS OF SUCCESSFUL LRT-BASED REGIONAL TRANSIT SYSTEMS

So why is Portland so successful? Many scholars would point to the importance of land use policies in Portland that encourage more compact development and the proliferation of transit-oriented developments as fundamental to the success of the metropolitan area's transit system (9, 27, 28). While these factors are undoubtedly positive contributors to ridership, our previous research identifies four important characteristics of Portland's transit system that enable its success (12). First, Portland has a dispersed transit network that serves a wide array of the region's travel destinations. This dispersed network actually predates LRT development, which has been able to tap into its existence. Second, Portland uses LRT to provide a high-speed regional service overlay atop the local bus system. The combined bus-rail network provides relatively quick travel between the metropolitan area's activity centers. Third, Portland relies on easy transfers between its bus and rail systems, as well as bus-to-bus transfers, to connect more destinations than would be possible with a system based on one-seat rides. Finally, Portland's transit system is organized to attract a large number of non-CBD riders. This is important given the emergence of many other activity centers in the Portland area. The four characteristics are collectively hallmarks of a regional, LRT-based multideestination transit system.

We use the four characteristics in evidence in Portland as evaluation criteria against which we evaluate the other metropolitan areas. We hypothesize that variation in transit performance discussed earlier can be explained by variation in the extent to which the four characteristics are present in each of the metropolitan area's transportation system. Essentially, we see deficiencies with respect to these key characteristics as preventing the transit agencies in each metropolitan area from achieving higher ridership and productivity from their LRT-based regional transit systems.

Table 2 summarizes the results of the analysis that we discuss in more detail in the pages below. In the table, each of the metropolitan areas (including Portland) is scored against each characteristic. Metropolitan areas receive scores between 0 and 2, depending on the extent to which each characteristic is present. At the bottom of the table the scores are tallied. Portland scores highest overall, followed by San Diego, Dallas, Sacramento, and Salt Lake City. These scores roughly correspond to the rankings of the metropolitan areas on the riding habit and service productivity measures reported at the bottom of Table 1.

TABLE 2 Evaluation Matrix: Four Characteristics of Successful LRT Systems

Characteristic	Portland	San Diego	Dallas	Sacramento	Salt Lake City
Dispersed transit network	2	2	1	1	1
High-speed regional service overlay	1	1	1	1	1
Utilizes transfers to reach many destinations	2	1	1	1	0
High percentage of non-CBD-bound riders	2	2	1	1	1
Score	7	6	4	4	3

Evaluation Scores	2 Characteristic is fully present 1 Characteristic is partially present 0 Characteristic is not present
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Dispersed transit network

A dispersed transit network is one structured to serve an array of major destinations throughout the entire metropolitan area, as opposed to one in which service is concentrated on a single major destination (usually the CBD) and/or constrained to serve merely a portion of the metropolitan area. **Figure 2** provides maps of each of the metropolitan transit systems.

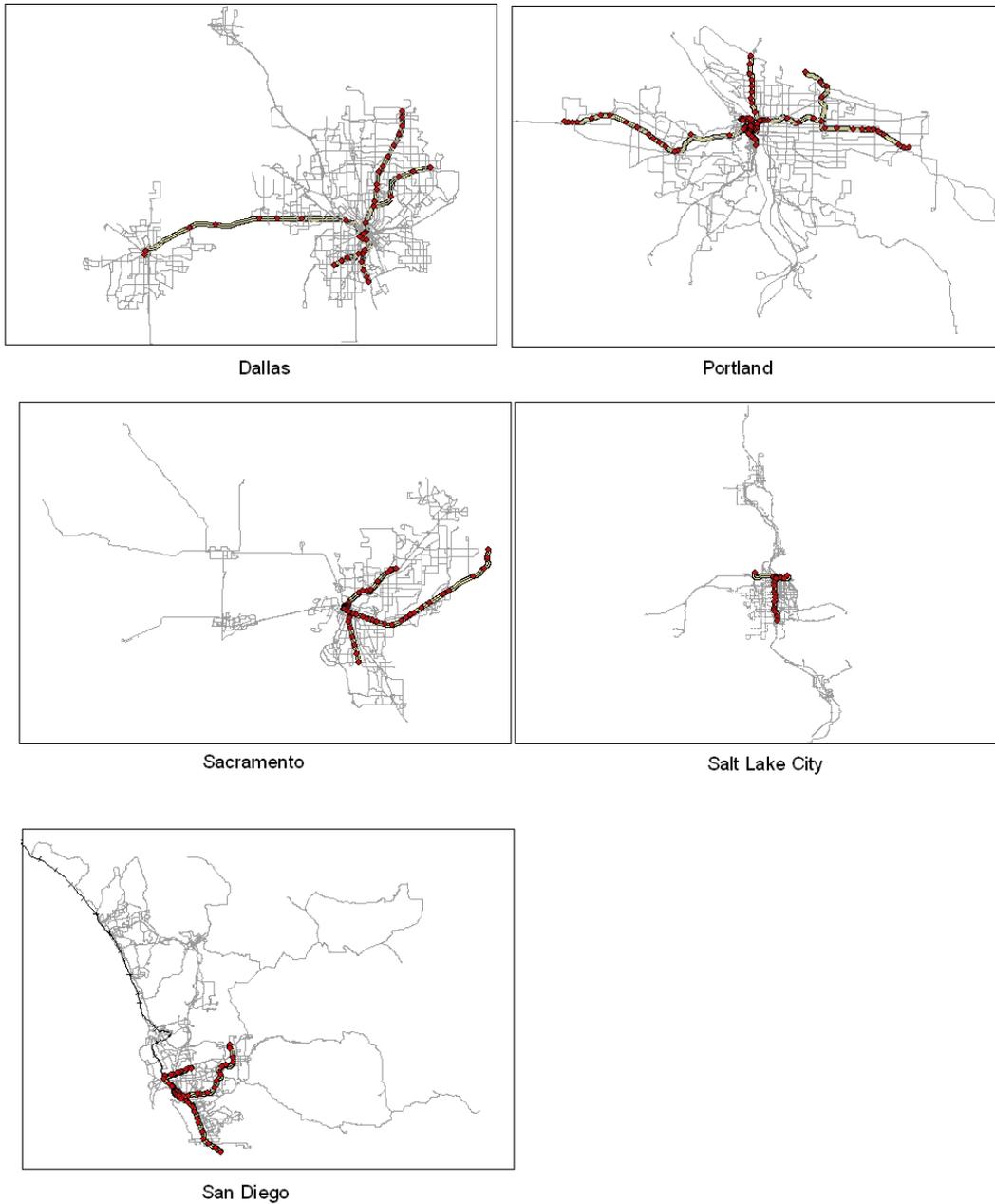


FIGURE 2 Regional Transit System Maps for Five Metropolitan Areas

Portland receives a high score in our evaluation matrix because it possesses a network that covers the entire metropolitan area and seeks to serve all the major activity centers. While nearly half Portland's bus routes serve the CBD, these routes serve many other destinations as well. Portland's bus and rail routes are integrated with each other by

design, either by functioning in a grid, or through the use of timed-transfer centers (12). This service structure has prevailed since the late 1970s, several years before the introduction of the first LRT service in the region.

San Diego also has a dispersed network (12). San Diego's local bus network, although operated by numerous agencies, is integrated by a centralized board into a cohesive network that blankets the metropolitan area. Bus and rail routes are well integrated with each other. A large percentage of bus routes terminate at rail stations rather than continuing to the CBD.

The other metropolitan areas are deficient with respect to the presence of a dispersed regional transit network (12). Dallas, Sacramento, and Salt Lake City possess partial networks. Dallas features a well-integrated, dispersed network of bus and rail routes in the eastern third of the metropolitan area, but has a traditional CBD-radial system in the western third (centered on Fort Worth) and lacks transit service in the large and growing employment centers around Arlington in the middle part of the region. These facts help explain why riding habit and productivity are lower in Dallas than in Portland.

Until 2000, Sacramento possessed a dispersed regional network in which bus and rail lines worked together to serve a wide array of major destinations within the metropolitan core county. Since 2000 LRT service has expanded farther out than previously, toward emerging employment centers in places like Folsom, but bus service has not been significantly restructured to provide connections between the rail stations and the final destinations. Thus, there now exists in the Sacramento area significant destination concentrations that are unconnected to the transit network.

Salt Lake City is somewhat of a hybrid. Many of its routes function as a CBD-radial system characterized by little integration between its bus services or between its rail and bus services. For these routes, bus and rail service compete with one another in providing patrons with service to the CBD. However, half the bus routes do not go to the CBD (12). When the north-south LRT line opened, some CBD express buses were discontinued, and they were replaced by a few east-west routes. In general, though, these east-west services are underdeveloped, being afflicted by gaps in coverage, significant route deviations, and/or low frequency service.

In many respects the present Salt Lake City system resembles Portland's east side bus network prior to its restructuring (12). At one time, Portland had numerous parallel east-west bus routes that provided low-frequency service to the Portland CBD. In about 1983, Portland eliminated some east-west routes, added service to others, and added high-frequency north-south bus routes. When the LRT began operation in 1989, it plugged into this network as another east-west line. The recently added north-south bus lines became major feeders and distributors from light rail stations. If the 1983 restructuring had not happened, LRT would have been a competitor with the poor quality parallel bus routes that already were there, and there would have been no high quality bus routes intersecting the LRT at right angles. Portland would have enjoyed much less patronage than it has since experienced on both its LRT and bus routes. This undesirable situation resembles the present condition in Salt Lake City.

High-speed regional overlay atop the local service

A high-speed regional overlay is higher-speed, high frequency service that lies atop the local network and works with it to allow travelers to quickly reach the wide array of major destinations in the metropolitan area. Each of the metropolitan areas is deficient in some respect in possessing such a network.

Portland's east-west LRT constitutes a relatively fast and frequent trunk line that is well integrated with local bus routes over its entire length across the metropolitan area and serves major destinations. However, Portland has recently focused its LRT investment on the CBD with two consequences (12). First, the crowding of vehicles downtown has slowed operating speeds through the CBD. Second, many emerging destinations, such as those on the east side of the Willamette River, are not served with a high-speed regional overlay because the resources are being focused on the CBD.

San Diego's LRT lines function well as a network of high speed, frequent network of trunk lines well-connected to local bus lines. However, the LRT system does not serve many large and growing employment corridors and thus does not constitute a fully regional system. Instead, express buses serve these corridors but lack the combination of speed, accessibility to intermediate destinations, and integration with local buses that the LRT parts of the transit network possess (13). San Diego's commuter rail line lacks the frequency of service to function well as part of a regional overlay.

Dallas's LRT lines also constitute a partial regional network that functions well in the eastern one third of the metropolitan area. However, there is no effective regional overlay in the central or western parts of the metropolitan area. Trinity Railway Express (TRE), the region's commuter rail system, cannot serve as an effective regional overlay because it does not serve important intermediate destinations either directly or via local bus connections.

Sacramento and Salt Lake City are deficient for two reasons. First, there are missing corridors in their regional networks. Second, their LRT lines are not as well integrated as they should be with local buses. This means that some regional destinations in the LRT corridors outside the two CBDs are not easily reachable. This is true for Sacramento only for its most recent LRT extensions.

Transfers are used to extend the array of destinations transit serves

Transfers are important evidence that passengers are taking advantage of integrated regional bus-rail transit systems to reach a wide array of regional destinations. If transfer activity merely indicated forced shifting from one mode to another we would expect to find high levels of transfer activity to be associated with stagnant or declining patronage transit systems. However, we find that high levels of transfer activity tend to be associated with strong and growing patronage systems.

Portland's transit system illustrates the importance of transfers for successful regional transit system performance. **Figure 3** shows average weekday LRT boardings by station in spring 2007 (20). The stations with the highest numbers of boardings are major

transfer centers, including the Cedar Hills, Beaverton, and Gateway Timed Transfer Centers, Hollywood, Northeast 82nd Avenue, and Northeast 60th Avenue.

San Diego displays a pattern similar to Portland's. **Figure 4** displays passenger activity prior to the opening of the non-CBD-serving Mission Valley LRT line (12). The most heavily patronized stops are those characterized by high transfer activity, including the region's two most heavily patronized stops (Old Town Transit Center and 12th and Imperial Station) (19). Half the top 20 transit stops in the region are major transfer centers, and nearly all these stops saw passenger activity increase between 2005 and 2006 (see **Table 3**). Most stops listed in the table with declining patronage between 2005 and 2006 are stops in the CBD. In January 2008, San Diego abolished free transfers as part of a budget balancing strategy (12). This poses serious challenges to a transit system whose structure is predicated on easy passenger transfer activity, and this is why we rated San Diego below Portland. The effects of this policy change on patronage will bear watching.

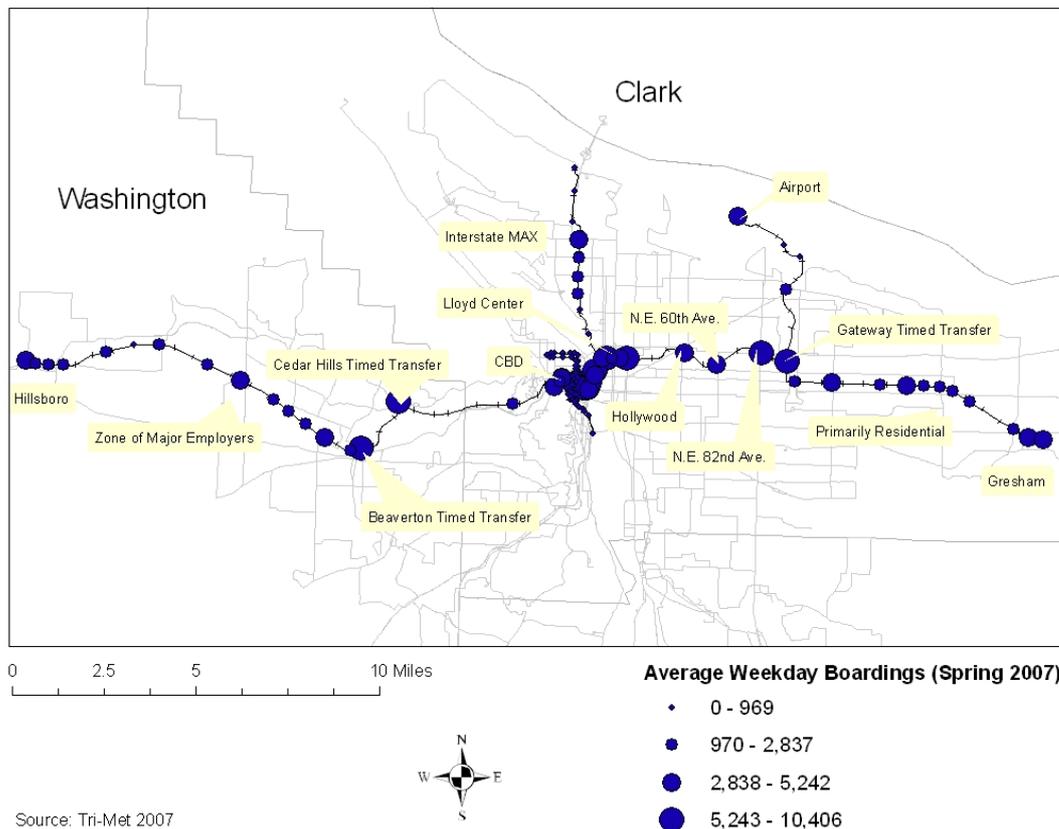


FIGURE 3 Average Weekday Boardings at Portland LRT Stations (Spring 2007)

We rated Dallas and Sacramento as partially possessing this characteristic because their partial regional coverage limits the array of destinations which patrons can use transfers to reach. However, in the integrated parts of their regional systems, both Dallas

and Sacramento are performing well. In Sacramento, in fact, the most heavily patronized LRT station is the 16th Street Transfer Station where patrons transfer between two LRT lines (18). We also classified Salt Lake City as partially possessing this characteristic. While half its bus routes do not go to the CBD, its bus and rail services are not well integrated in the LRT corridor, suggesting that transfer activity is minimal (12). Unfortunately, we were unable to obtain transfer data from UTA to shed further light on this issue.

A high percentage of non-CBD-bound riders are attracted to transit service

CBDs are in relative decline as employment centers and major transit destinations, so successful transit systems need to tap the non-CBD ridership market. Successful systems will thus have a high percentage of non-CBD-bound riders.

Evidence on the importance of the non-CBD market in Portland can be found in individual bus route ridership statistics, as well as the transfer activity data shown in Figure 3 earlier. The north-south bus routes intersecting the LRT at the 82nd Avenue and Hollywood stations are respectively the most and second most heavily patronized bus routes in the Portland metropolitan area, far surpassing patronage on routes that serve the CBD (20). These two routes run along arterial roads and serve strip commercial development.

TABLE 3 San Diego Top 20 Transit Stops in Fiscal Year 2005 and Fiscal Year 2006

Stop	FY 2005 Rank	FY 2006 Rank	FY 2005 Trip Ends	FY 2006 Trip Ends	% Change 2005-2006
Old Town Transit Center	2	1	20,574	31,958	55.33%
12th and Imperial Station	1	2	20,639	21,858	5.91%
International Border Station	3	3	19,849	20,949	5.54%
Iris Avenue Trolley Station	4	4	14,977	15,431	3.03%
H Street Trolley Station	5	5	11,972	12,210	1.99%
5th Avenue Station - C Street	6	6	11,034	11,182	1.34%
El Cajon Transit Center	11	7	8,799	10,935	24.28%
Euclid Trolley Station	7	8	10,381	10,622	2.32%
City College Station	8	9	10,243	10,565	3.14%
Fashion Valley Trolley Station	10	10	9,347	10,072	7.76%
Palomar Street Trolley Station	9	11	9,988	9,483	-5.06%
Civic Center Station	12	12	8,351	7,644	-8.47%
24th Street Trolley Station	14	13	7,656	7,583	-0.95%
American Plaza	13	14	7,938	7,170	-9.67%
Escondido Transit Center	16	15	6,629	7,157	7.97%
San Diego State University	36	16	2,281	6,968	205.48%
Vista Transit center	15	17	6,747	6,794	0.70%
Park and Market Station	21	18	5,618	6,106	8.69%
E Street Bayfront Trolley Station	17	19	6,397	5,959	-6.85%
Oceanside Transit Center	18	20	6,162	5,546	-10.00%

Source: SANDAG (2007)

In Dallas, 45 percent of afternoon boardings on the CBD-focused LRT system are made by passengers boarding in non-CBD locations. Clearly even the two limited networks in Sacramento and Dallas are being used heavily by non-traditional (i.e. non-CBD) riders. We have no data on passenger destinations for Salt Lake City, although the hybrid nature of its system suggests that it too carries sizeable non-CBD traffic, particularly to the university and other major activity centers at the eastern end of its east-west LRT line.

TABLE 4 Destinations of Weekday AM Peak Transit Riders in Sacramento and San Diego

Sacramento LRT Riders		
Destination	Number of alightings	Percent of all alightings
Downtown Sacramento LRT stations	4,813	37.44%
16th Street Transfer Station	1,453	11.30%
Other LRT Stations	6,590	51.26%
Total	12,856	100.00%

San Diego LRT Riders		
Inside San Diego CBD	6,687	33.97%
Outisde San Diego CBD	13,000	66.03%
Total	19,687	100.00%

San Diego Commuter Rail Riders		
Inside San Diego CBD	670	31.65%
Outisde San Diego CBD	1,447	68.35%
Total	2,117	100.00%

San Diego Bus Riders Using CBD-serving Express Routes		
Inside San Diego CBD	400	14.55%
Outisde San Diego CBD	2,349	85.45%
Total	2,749	100.00%

San Diego Bus Riders using CBD-serving Local Routes		
Inside San Diego CBD	2,517	23.37%
Outisde San Diego CBD	8,254	76.63%
Total	10,771	100.00%

Sources: RT (2007), SANDAG (2007).

Note: Sacramento data refer to 2007 and San Diego data to fiscal year 2006.

CONCLUSION

This paper identified four characteristics of the transit system in Portland that appear to explain its success in terms of high riding habit and productivity, and measured the extent to which these same characteristics are also present in four other new start cities where LRT carries 30 percent or more of all metropolitan area transit riders. In general, we find an association between metropolitan area transit performance, shown in Table 1, and the presence of these characteristics, as recorded in Table 2 and discussed in the text.

This work suggests a possible method for better planning regional transit services by setting forth attributes that these services need to possess in order to attract substantial ridership and thus obtain satisfactory riding habit and productivity. Future research should

apply this framework to other metropolitan areas of different sizes or whose LRT systems are of different lineage to test the whether these propositions can be generalized.

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