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Light Rail Lite or Cost-Effective Improvements to Bus Service?

Evaluating Costs of Implementing Bus Rapid Transit

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Bus rapid transit (BRT) is growing rapidly in popularity because it is viewed widely as an efficient and effective means to improve both transit service and patronage. This paper argues that two distinct views of BRT are emerging: (*a*) BRT as a new form of high-speed, rubber-tired, rail-like rapid transit and (*b*) BRT as a cost-effective way to upgrade both the quality and image of traditional fixed-route bus service. These two views carry different price tags because the cost of planning, constructing, and operating BRT depends on the complexity of new service features and on rises for BRT that offer service characteristics approaching those of light rail. This study fills a gap in the literature on the costs of BRT by examining in detail component costs—actual costs for recently implemented services and projected costs for planned new services—for a sample of BRT systems in North American cities. The study examined BRT costs of 14 planned and recently opened BRT systems to determine how the wide range of BRT service and technology configurations affect costs. The study found that although some of the most successful and popular new BRT systems are high-quality services operating in mixed traffic and implemented at relatively low cost, most BRT projects on the drawing boards are more elaborate, more expensive systems than many currently in service. Most new BRT projects emphasize elaborate LRT-type improvements to lines and stations in one or a few corridors rather than less splashy improvements (such as next-bus monitors, signal preemption, queue-jump lanes, and so forth) affecting more lines and modes in local transit networks. Among the 14 systems examined here, most could be characterized as light rail lite.

Bus rapid transit (BRT) is a hot new concept in public transit circles. Touted by some as leading a new wave of rail-like, high-speed, rubber-tired rapid transit lines, and by others as a cost-effective way to upgrade both the quality and image of local bus service, BRT has quickly come to mean many things to many people (*1*).

Which view of BRT predominates in North America? This paper explores the question by examining the cost-effectiveness of 14 current and planned BRT systems. By examining detailed component costs—actual costs for recently implemented services and projected costs for planned new services—the study investigated how BRT is defined and implemented by transit agencies in various cities around North America. The study found that while some of the most successful and popular new BRT systems are simply enhanced bus services operating in mixed traffic and implemented at relatively low cost, most of the BRT projects examined are more elaborate and far more expensive systems. Among these 14 systems, most could be characterized as light rail lite.

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DEFINING BRT

Investments in public transit have increased significantly over the past several decades in the United States, fueled by interest in and mandates for curbing urban sprawl, reducing traffic congestion, lessening automobile dependency, and protecting the natural environment from automobile pollution (*2*). Recently, many public officials have turned to BRT systems (*3*) as a more cost-effective way than light rail transit (LRT) to provide high-quality service and increase transit ridership (*4, 5*).

What exactly is BRT? The FTA defines it as a mode of public transportation that combines the quality of rail transit with the flexibility of bus transit. A recent Transit Cooperative Research Program report (*6*), defines "BRT" as follows:

> BRT is a flexible, rubber-tired rapid transit mode that combines stations, vehicles, services, running ways, and intelligent transportation system (ITS) elements into an integrated system with a strong positive image and identity. BRT applications are designed to be appropriate to the market they serve and their physical surroundings and can be incrementally implemented in a variety of environments.

BRT employs various facilities, services, amenities, and technologies to make buses faster, more reliable, more convenient, and safer. BRT can include basic operational enhancements (such as skip-stop service), minimally capital-intensive features (such as low floors, kneeling buses, and on-board electronic enunciators), moderately capital-intensive features (such as dynamic next-bus information at stops, centralized bus vehicle location systems, and traffic signal prioritization), as well as high-cost features (such as grade-separated running ways, elaborate stations, and dedicated rights-of-way).

Perhaps owing to its burgeoning popularity, BRT is an increasingly slippery concept. While some view BRT as a distinct transit mode (*3, 7*), others have argued that BRT is merely a synthetic term used to distinguish the next generation of bus service from current service—suggesting that all bus services will eventually adopt BRT technology as transit agencies tackle much needed modernizing of bus systems (*8*). The FTA has set forth one definition of BRT as an "option which can supply a quality of transportation service near to that of rail but at a reduced cost" (*9*). Others have defined BRT more explicitly as a

"rubber-tired transit system that mimics the positive components of a rail-based system" (*10*) and have even proposed new forms of nomenclature for BRT such as "*like* rail rather than light rail" (*10*) or "bus semi-rapid transit" (*11*). Carey has also argued that BRT "should include at minimum exclusive rights of way," suggesting that enhanced bus services operating in mixed traffic on city streets are not sufficiently distinct from traditional fixed-route bus service to be classified as BRT (*10*).

In contrast, others have taken the position that BRT need not be considered an alternative to LRT, but instead should be evaluated on its ability to improve transit service quality and attract new riders (*12*). Polzin and Baltes (*7*), for example, write, "Who cares what better public transit is called?" as long as it helps to win public and political support for an industry that generally carries with it a negative image.

Conceptually BRT lies along a continuum between rubber-tired LRT service at one end, and improved local bus service on the other—a wide continuum indeed. In either case, it is clear that many transit officials and planners hope to use BRT as a relatively low-cost way to improve the appeal of public transit for both current and potential riders.

With the difficulty in defining BRT comes the difficulty in assessing its costs. Most practitioners and scholars agree that BRT is a cost-conscious alternative to LRT or heavy rail transit (HRT) investment, but few studies have documented in detail the price tags that accompany various components of BRT systems.

RAPID RISE OF BRT IN NORTH AMERICA

Recent surveys of BRT projects in North American cities show that transit agencies have implemented or plan to implement redesigned or new services with a wide range of BRT features, and that BRT projects are in various phases of implementation (*6, 12–14*). Because of the technology's flexibility and ease of incremental implementation, transit operators can adopt some, most, or all BRT components to match service to travel demand. BRT offers flexibility not possible with traditional light rail or subway systems, which require rights-of-way acquisition (for fixed track, tunnels, viaducts, and stations) and specific technology "packages," such as communications systems, operating systems, track, maintenance facilities, and rolling stock, not amenable to phased implementation.

In lieu of such fixed and expensive infrastructure, BRT can use existing road infrastructure and transit vehicles, and can phase in additional BRT components incrementally, as political will and funding allow. The wide range of features that comprise BRT, their adaptability to different urban settings, and the ability to phase them in incrementally helps explain the extraordinary array of projects and proposals described as BRT in places such as Cleveland, Ohio; Nashville, Tennessee; and Los Angeles, California (*15–17*).

Despite the attention BRT has received in recent years, only a few North American BRT systems are currently in revenue service, and there is to date little comparative research describing system performance. Analyses of individual BRT routes, however, have produced encouraging results. Because of both wider stop spacings and traffic signal priority, the Metro Rapid service on congested Wilshire Boulevard in Los Angeles operates at speeds that are 75% faster than local service. Overall, Metro Rapid passengers on all lines enjoy door-to-door trip times savings of 28% over comparable local bus service (*18*). Transit trips made in the Seattle bus tunnel are 33% faster than on surface routes (*6*).

With respect to patronage, many new BRT services report substantial ridership gains. In Houston, Texas, for example, 30% of BRT riders surveyed did not previously use transit. In Los Angeles, the addition of Metro Rapid service along already highly patronized local routes has spurred a corridor ridership growth of up to 33%, and one-third of Metro Rapid customers are new riders (*6*). As a result of such dramatic ridership gains on its first BRT routes, the Los Angeles Metropolitan Transit Authority (MTA) has ambitious plans both to add new BRT routes and upgrade the current BRT stops and facilities (*18*).

In the absence of an established body of evaluative research on the performance and cost-effectiveness of BRT systems, researchers have focused on how relatively low-cost investments in infrastructure, equipment, operational improvements, and technology enable BRT systems to exceed typical bus system performance (*3, 7, 14*). Other research projects have compared the capital costs of BRT versus light and heavy rail projects and concluded that operating flexibility and lower infrastructure and equipment costs make BRT an attractive option for the expansion of public transit in mid-sized cities (*13*). For example, Sislak (*16*) reports that the capital cost of BRT in Nashville is 53% lower than a comparable LRT system would have cost, while the BRT service achieves "the same transportation utility as measured in speed and potential travel time savings" (*17*).

Because BRT can range from simple, low-technology service improvements, to new high-cost, capital-intensive service operating in exclusive rights-of-way, the cost of BRT development varies widely. BRT has attracted much recent attention in North America due to its patronage successes worldwide, but less attention has been devoted to its wide range of costs, partly due to the numerous definitions of BRT that have been adopted by practitioners and researchers alike. This paper aims to fill this gap in the literature by examining the latest cost estimates for a sample of recently opened and currently planned BRT services in North American cities. BRT costs are examined in detail, and how the wide range of BRT service and technology configurations affect costs is considered.

WHAT IS KNOWN ABOUT BRT COSTS?

The U.S. Department of Transportation has, since the 1998 enactment of the Transportation Equity Act for the 21st Century, actively encouraged transit systems around the United States to consider BRT (*19*). Accordingly, the FTA began a demonstration program in 1999 to fund BRT projects. Grants of $50,000 each were awarded to 10 transit agencies to plan and develop BRT projects (*8*). By 2001, the U.S. General Accounting Office (now the Government Accountability Office, GAO) reported that more than 200 transit agencies had sought federal funding for BRT projects (*13*).

A 2001 GAO report compares capital costs of light rail investment and bus rapid transit investments by examining 38 BRT projects around the United States, including demonstration projects and those in revenue service. The study also provides a conceptual framework for understanding the types of BRT in development in North America based on the road infrastructure, or "bus running ways," on which BRT operates, including

- Surface streets in mixed traffic,
- Dedicated lanes,
- High-occupancy vehicle lanes, and
- Grade-separated busways.

In their sample of 20 BRT systems and 18 LRT systems, GAO researchers found that the average capital cost per mile of LRT is between 150% and 5,000% higher than that of BRT, depending on the degree of implementation of BRT elements (see Table 1 and Figure 1).

TABLE 1 BRT and LRT Capital Costs (2001 dollars) (*13*)

Mode	No. of Facilities	Cost Range (per mile)	Average Cost (per mile)
Bus rapid transit			
Arterial streets	3	$200,000 to $9.6 million	$680,000
HOV lanes	8	$1.8 million to $37.6 million	$9.0 million
Busways	9	$7 million to $55 million	$13.5 million
Light rail transit	18	$12.4 million to $118.8 million	$34.8 million

Case studies have also compared the operational and capital cost effectiveness of LRT and BRT (*6, 12, 16, 17*). However, these studies generally fail to consider innovative or cost-conscious combinations of BRT components, and instead tend to assume that all BRT projects require a full deployment of expensive rights-of-way, stationlike bus stops, and transit priority signalization. Collectively, these BRT case studies do not consider whether relatively inexpensive incremental improvements, such as next-bus monitors at major stops, can significantly improve service and attract riders. Similarly, variability in project costs is not only determined by rights-of-way acquisition; the type of transit vehicle used, for example, can significantly affect project costs. To understand how various BRT components contribute to overall project costs, a sample of BRT projects is examined.

DISAGGREGATING BRT COSTS

This study both updates and elaborates on the cost estimates for BRT systems presented in the 2001 GAO report. The principal goal of this research is to develop representative estimates of the cost ranges of BRT program components in North America. Drawing on BRT budgets and cost projections, high and low costs are estimated for individual features of BRT systems. Included in cost estimates are a random selection of those agencies identified in the GAO report (*13*), as well as recent recipients of BRT demonstration project funding from the FTA. In addition, each transit agency was contacted for more detailed budgets (in some cases actual costs, in others projected) for the BRT projects. More than 30 transit agencies were contacted, and 14 agencies provided detailed BRT cost estimates. Several of the transit systems contacted reported the total capital cost of an entire BRT project, but were not able to provide disaggregated cost information; these systems were excluded from further study because of the inability to make component cost comparisons with other projects. Multiple attempts were made to contact nonresponding agencies, and as in many surveys, this sample may be subject to nonresponse bias. Additionally, only one agency in the sample of North American BRT systems (TransLink in Vancouver, British Columbia, Canada) is located outside the United States.

Two factors likely limit the ability to generalize these findings. First, a few low-cost BRT-like services emphasizing distinctive vehicle liveries, skip-stop service, and the like, but lacking technological components such as signal prioritization and next-bus information, were excluded from the sample universe. Second, the sample excludes BRT proposals developed after data collection was conducted in autumn 2002; given that BRT is still in an early stage of development, the components of BRT and their costs may be evolving over time.

Such caveats aside, the sample appears representative of the current state of BRT in North America. One test of the validity of this research is the distribution of the sample set of 14 BRT projects by type of bus running way. The sample of 21% of BRT projects on arterial streets, 43% of BRT projects in HOV lanes, and 36% of BRT projects in busways is similar to the survey of new BRT projects listed in the FTA's Annual Report on New Starts for fiscal years 2004 and 2005, as well as a BRT project inventory published in *Metro* magazine (*1*).

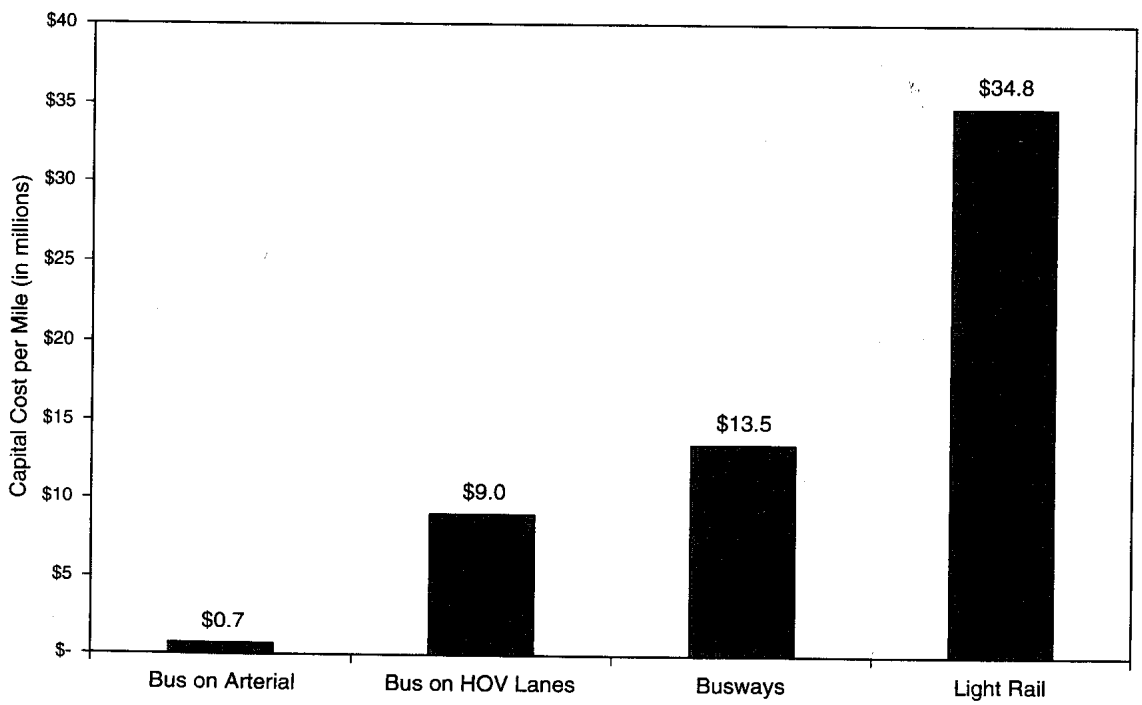

FIGURE 1 BRT and LRT capital costs per mile (2001 dollars) (*13*).

This study drew on three major sources of information: environmental impact studies or environmental impact reports prepared for the BRT projects; internal transit agency documents, reports, and budgets; and telephone interviews with transit agency planners and managers. The transit agencies and BRT projects studied are listed in Table 2.

For each BRT project analyzed, accounting practices and cost category assignment vary, perhaps not surprisingly, based on individual transit agency procedures. This complicates direct comparisons of costs. For example, while one agency may combine the cost of installing bus shelters with the cost of the bus shelters themselves, another agency may assign the installation cost of bus shelters to the total project construction costs. Additionally, "shared infrastructure"—such as loop detectors embedded in street pavement for automated vehicle locator (AVL) systems—is generally used not only by transit agencies but also by city or county departments of transportation and thus may be funded by either the transit agency or the city government, depending on local agreements. This can make such component costs "disappear" in some cases if non–transit-agency-incurred BRT costs are not explicitly considered.

The flexibility of BRT and, in particular, the ability to incrementally add BRT system components over time complicates comparisons of BRT systems based on similar characteristics. For example, one transit agency may introduce limited-stop service as part of its BRT rubric, while other systems may have already operated limited-stop service on some lines for years and would not assign such costs to new BRT service. This study, therefore, endeavored to disaggregate costs adequately to allow for meaningful comparisons between systems. Thus, capital costs were allocated into five broad funding categories, regardless of how the costs were accounted for locally:

- Traffic signal priority;
- Bus stops and bus stations and shelters;
- Intelligent transportation system (ITS), bus arrival information, and AVL systems;
- Right-of-way acquisition or improvements (including land acquisition, bus pads, and queue-jump lanes); and
- Vehicle acquisition.

In cases where transit agencies assigned noncapital costs to the implementation of BRT features, the costs were disaggregated. These noncapital costs included the design, planning, administration, marketing, and construction costs often associated with BRT capital improvements. Where these costs are reported and where the data can be disaggregated, the study reports and distinguishes them from capital costs. Some of the BRT projects examined propose elaborate, highly capital-intensive BRT systems with rail-like services, exclusive busways, and stations (such as Cleveland's Euclid Corridor and Boston's Silver Line), while other BRT projects operate in mixed-flow traffic (such as Los Angeles MTA's Metro Rapid) (*18*). Because right-of-way acquisition often carries the highest political and financial costs for new transit service using fixed guideways or dedicated lanes, a conceptual framework was developed to compare infrastructure needs and operating characteristics for three types of bus running ways (see Table 3).

This typology allowed the study to distinguish the level of capital investment in systems. For example, the per-mile cost to build Cleveland's BRT system cannot be directly compared to the same unit cost for Los Angeles's Metro Rapid system, because Cleveland's project involves a complete and extensive rebuild of corridor infrastructure (including street pavement, sidewalks, curbs, stations, exclusive busway, signalization, and public utilities), whereas the Metro Rapid BRT operates on surface streets (such as Wilshire Boulevard) that received few right-of-way improvements when BRT was established (*15*).

TABLE 2 BRT Projects Included in Sample

	City/BRT Project	Project Status	Cost Estimates	Information Source
Arterial streets	Oakland, CA (San Pablo Corridor)	Funding approved	Projected	Interview
	Los Angeles, CA (Wilshire I and Ventura I)	Revenue service began in 2000	Actual	Evaluation report
HOV lanes	San Jose, CA (Line 22 BRT)	Pending approval	Projected	Interview
	Vancouver, BC (98-B Line)	Revenue service began in 2001	Actual	Interview
	Los Angeles, CA (Wilshire II)	Pending	Projected	Final EIS/EIR
	Detroit, MI (SpeedLink)	Pending	Projected	Planning report
	Orlando, FL (Lymmo)	Revenue service began in 1997	Actual	Interview
	Nashville, TN (Urban Core BRT)	Pending	Projected	Feasibility Study
Busways	Eugene, OR (Eugene to Springfield BRT)	In construction	Projected	Interview
	Miami, FL (South Miami–Dade Busway Extension)	Extension to existing busway	Actual	Interview
	Honolulu, HI (City/County BRT)	Pending	Projected	Draft EIS
	Hartford, CT (New Britain–Hartford Busway)	Pending	Projected	Final EIR
	Cleveland, OH (Euclid Corridor BRT)	In construction	Projected	Interview

EIS = environmental impact statement; EIR = environmental impact report.

TABLE 3 BRT Capital Needs for Three Types of Bus Running Ways

	Infrastructure Needs	Operational Features
Arterial lanes	None to minimal	Buses in mixed-flow lanes
HOV lanes	Minimal changes (redesignate lanes)	Separated lanes, queue-jump lanes
Busways	Extensive construction (new busways and facilities)	Exclusive bus lanes, grade separation

Alternative typologies are possible, but because of the flexibility of BRT features and characteristics, the use of any possible classification scheme presents problems. For example, the Los Angeles Wilshire Rapid II line has designated rights-of-way in some portions and mixed flow in other portions of the same route. Given these factors, a broad, three-category classification scheme was chosen to remain consistent with earlier work by the GAO, and also to provide a sufficient number of BRT services to evaluate in each category.

A few other methodological issues warrant mention. First, for transit agencies that constructed grade-separated busways, capital costs of land acquisition can vary by geographic region because land costs vary dramatically from city to city, and from corridor to corridor within cities. Nevertheless, land acquisition is vital to transit system expansion in certain urban settings and development scenarios. Second, this study compares costs across BRT systems that are in varying stages of completion, and costs can change dramatically from conceptual estimates, to detailed planning and engineering estimates, to actual outlays. Previous studies of public transit capital development have shown the tendency to systematically underestimate actual costs, especially in large capital projects (*20–23*), and BRT may be no exception to this pattern. Although it may be less than ideal to compare actual and projected costs, the small number of BRT systems in revenue service at the time of this data collection precluded an exclusive focus on such systems.

Further, this analysis does not consider the political costs of implementing BRT. These costs—such as time and resources expended in negotiating jurisdictional issues (e.g., signalization and bus stop placement) or winning administrative approval to implement BRT service in lieu of other transit modes—are difficult to measure and reflect in monetary terms (*23*). Although omitted from the study, the political costs of any project that devotes large sums of public funds on infrastructural changes can be great (*24*).

Brief profiles of the 14 BRT projects analyzed, along with project capital costs, are summarized in Table 4. The table lists the full capital cost reported by transit agencies for BRT projects. All costs in this study are given in 2002 dollars; where appropriate, costs have been adjusted using the consumer price index reported by the U.S. Bureau of Labor Statistics.

COMPARING COSTS OF THREE BRT TYPES

Figure 2 shows the unit cost per mile for various BRT projects in North America, grouped by the type of bus running way used—arterial streets, high-occupancy vehicle (HOV) lanes, or separated busways.

TABLE 4 BRT Service Profiles (2002 dollars)

Arterial Streets	HOV Lanes	Busways
Oakland, CA (San Pablo Corridor)† Arterial street operation in mixed flow traffic $283,000 per mile (16 miles)	San Jose, CA (Line 22 BRT)† Selective use of queue-jump lanes $1.2M per mile (27 miles) 40 articulated low-floor, standard-design coaches at $465,000 each	Eugene, OR (Eugene–Springfield BRT) Exclusive bus lanes or guided busways Within ROW of existing arterials $3.5M per mile (4 miles)
Los Angeles, CA (Wilshire I and Ventura I) Arterial street operation in mixed flow traffic $195,000 per mile (25.7 miles and 16.7 miles, respectively)	Vancouver, BC (98-B Line) Exclusive median busway $1.8M per mile (9.9 miles) 28 articulated low-floor buses at $405,000 each	Miami, FL (South Miami–Dade Busway Extension)† Exclusive two-lane busway on an abandoned freight right of way $7.3M per mile (11.5 miles)
	Los Angeles, CA (Wilshire II)† Dedicated lane on arterial streets $5.8M per mile (25.7 miles) 97 articulated buses at $848,500 each	Honolulu, HI (City/County BRT)† Exclusive median bus lanes $11.5M per mile (32.2 miles)
	Detroit, MI (SpeedLink)† Exclusive lane arterial operation No new roadbed reconstruction $6.3M per mile (247.5 miles)	Hartford, CT (New Britain–Hartford Busway)† Exclusive two-lane busway built on abandoned freight right of way Use of articulated buses $15M per mile (15 miles)
	Orlando, FL (Lymmo) Exclusive lane arterial operation $9.1M per mile (2.3 miles)	Cleveland, OH (Euclid Corridor BRT)* Complete rebuild of Euclid Ave. Exclusive center median busway with platform stations Enhanced pedestrian zones New exclusive bus and auto lanes $29.8M per mile (7 miles) 20 diesel/electric articulated 60-foot buses at $1.2 million each
	Nashville, TN (Urban Core BRT)† Exclusive bus lanes on arterial streets $10.7M per mile (4.2 miles)	

NOTE: Vehicle costs are provided for agencies that specifically procured buses for their BRT project. ROW = right-of-way.
†Planned or proposed project (not in revenue service at time of data collection).
*In construction at time of data collection or interview.

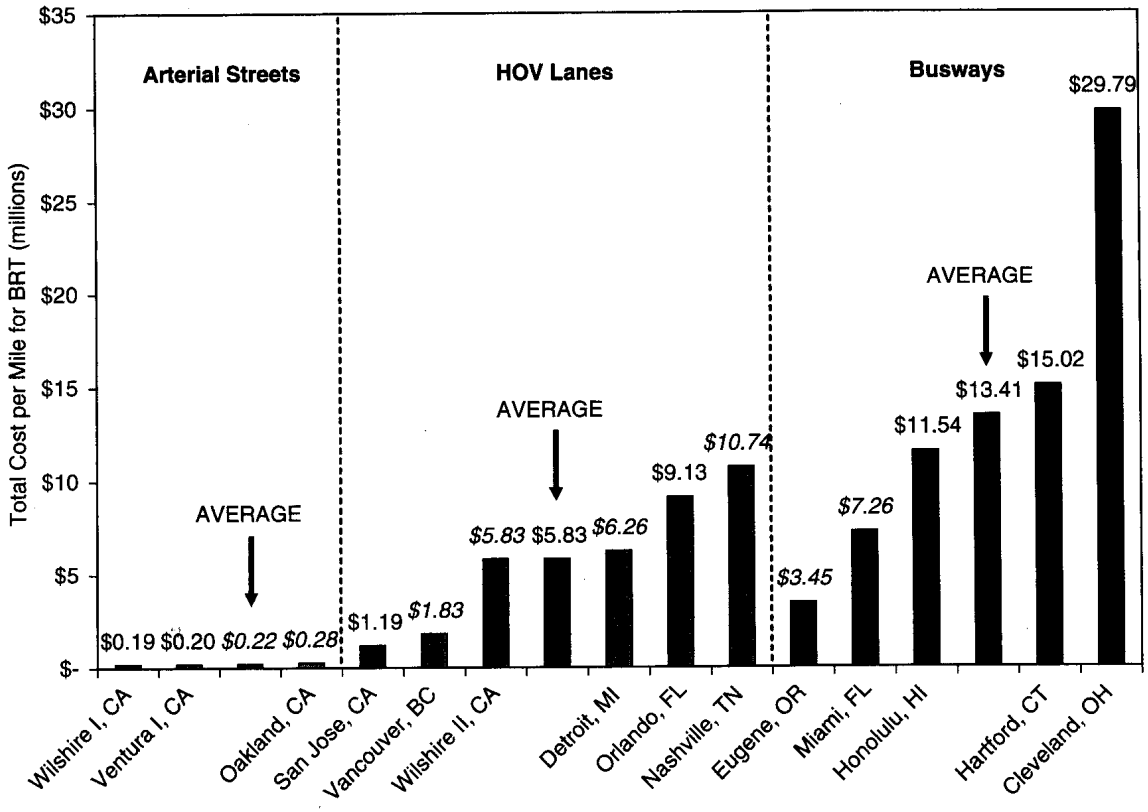

FIGURE 2 Comparison of BRT project costs (2002 dollars) (italics indicate percentages of proposed costs; nonitalics indicate percentages of actual costs).

The findings are consistent with other studies, in particular the 2001 GAO report discussed earlier, and suggest that BRT services on arterial streets in mixed-flow traffic cost significantly less than BRT services in either HOV lanes or on dedicated busways.

However, the ownership and construction costs of infrastructure used by BRT systems make cost analyses of BRT systems somewhat complicated. Despite the fact that BRT services often take advantage of HOV lanes that are paid for using other sources, some HOV-lane BRT projects cost more per mile than systems operating on separate busways paid for by transit agencies. For example, Nashville's HOV-BRT estimated cost per mile is more than three times that of the Eugene, Oregon, BRT project, and 50% more than the South Miami–Dade Busway extension, both of which include extensive busway investments. In the case of Nashville's system, the project required the design and construction of a $5 million bridge connecting the system to arterial streets. Design costs and contingency reached $7 million and $10 million, respectively—spread across a relatively short corridor of 4 mi. Similarly, the Euclid Corridor project has high costs for right-of-way acquisition because the entire corridor (through the center of Cleveland) requires complete reconstruction (*15*). Civic improvements associated with the Euclid Corridor project, including urban design enhancements and transportation–land use coordination, are intended to stimulate economic growth and revitalization in downtown Cleveland (*16*).

To disentangle the cost of right-of-way acquisition from other BRT costs, Figure 3 shows the relative role of right-of-way costs in three typical BRT projects. For light-rail-like BRT service (such as Cleveland's Euclid Corridor), right-of-way costs can account for well over half of all project costs.

Likewise, Figure 4 shows the relative role of land acquisition, right-of-way improvements, other capital costs (such as ITS components, stations and vehicles), and noncapital costs (such as design, administration, marketing, construction, and contingency) for each of the systems analyzed, excluding Orlando, Florida, for which sufficiently disaggregated data were not available. For some projects, BRT vehicles and other equipment are the only costs incurred, while for others, land acquisition and right-of-way costs comprise the bulk of project expenditures.

Costs for the three arterial-type BRT systems analyzed range from $190,000 per mile to $280,000 per mile—a fairly narrow range, and far less variable than for BRT systems using HOV lanes and busways. Taken as a whole, BRT systems can reach costs as high as $29.7 million per mile for the Euclid Corridor in Cleveland. Capital costs for these high-end BRT projects begin to resemble the price tags of some LRT projects. For example, the costs of LRT reported by the GAO averaged $36.4 million per mile (in 2002 dollars), and ranged from a low of $12.5 million per mile in Sacramento to a high of almost $124 million per mile in Buffalo (due to expensive tunnel construction) (*13*).

Perhaps the most important finding from this disaggregated analysis of costs is an expected one: most BRT service improvements are relatively inexpensive to implement. Table 5 shows that, except in cases like Hartford, where elaborate BRT stations are proposed, BRT stop improvements (which work to increase passenger security, comfort, and certainty with lighting, maps, weather protection, and so forth) range from $38,000 to $450,000 per stop. AVL and signal priority systems (again with one rather unique exception) that help to increase transit vehicle speeds and travel time reliability range from $16,000 to

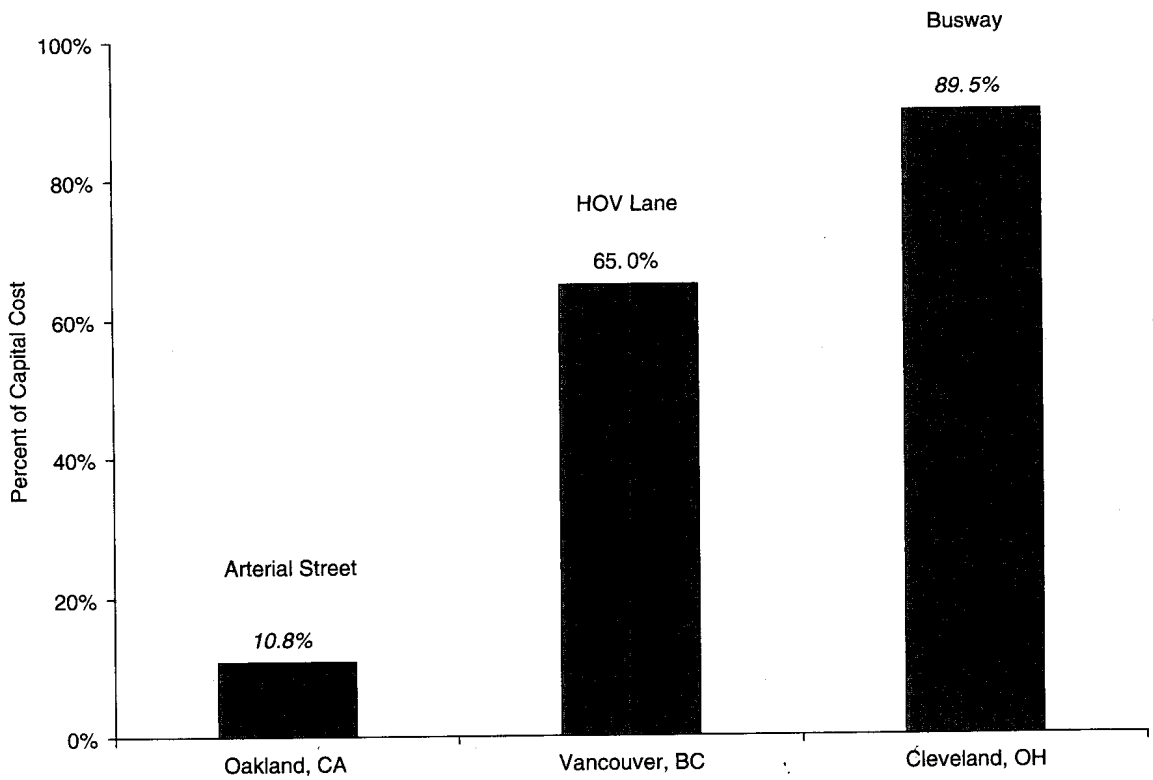

FIGURE 3 Rights-of-way and property acquisition as a percentage of total capital cost (italics indicate percentages of proposed costs; nonitalics indicate percentage of actual costs).

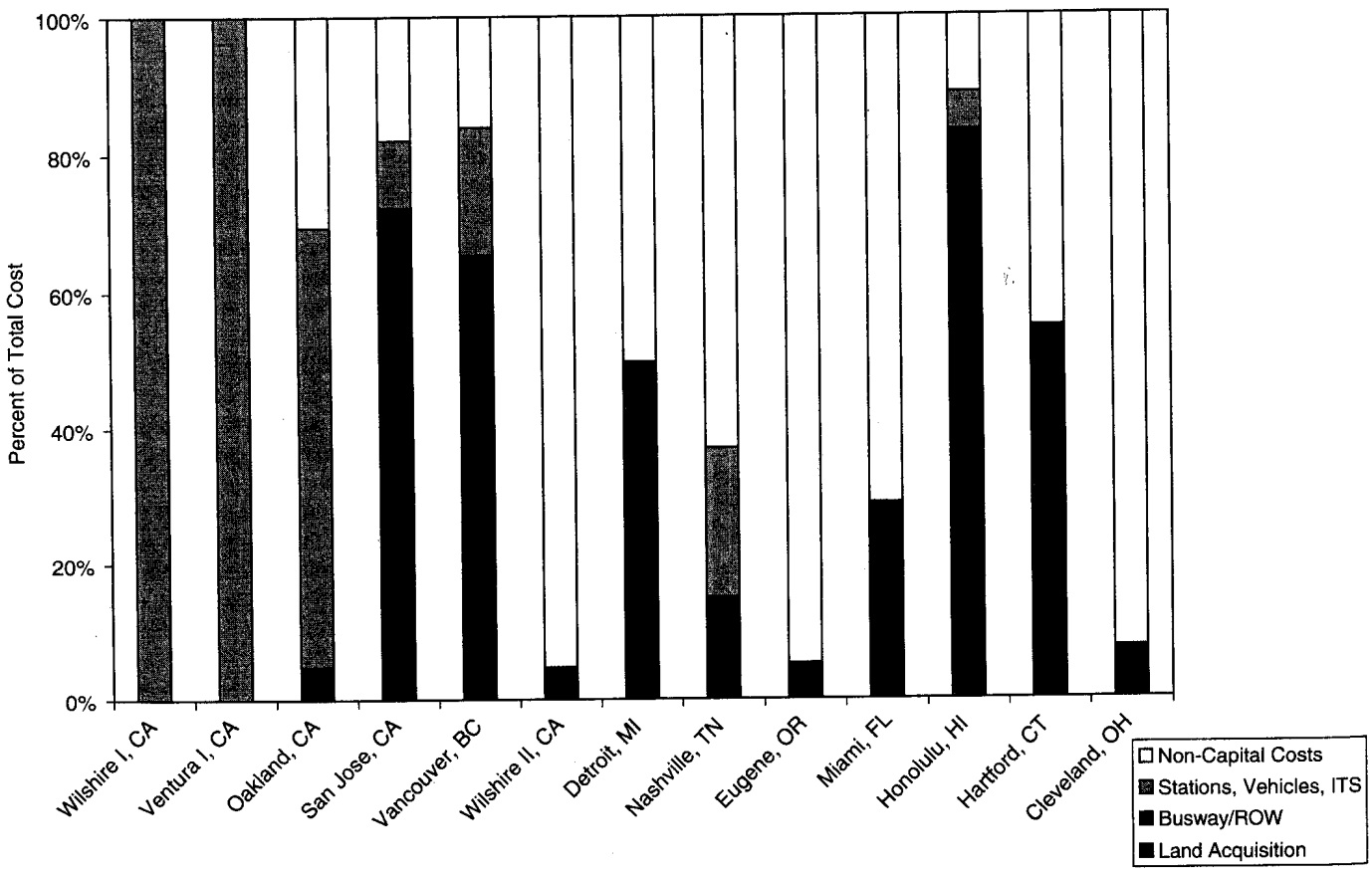

FIGURE 4 Cost of land acquisition and busway as percentage of total project costs, by BRT project.

TABLE 5 Low and High BRT Costs by Type of Infrastructure (in thousands, 2002 dollars)

		Bus Stop/Station (per stop)	AVL/Signal Priority (per mile)	Bus Arrival Information (per stop)	ROW Improvement (per mile)	Property Acquisition (per mile)
Arterial	Low	$38 L.A. Wilshire I	$83 Oakland	$6 Oakland	$8 Oakland*	NA
	High	$57 L.A. Ventura	$100 L.A. Wilshire I	$10 L.A. Wilshire I		NA
HOV	Low	$135 Vancouver	$34 Santa Clara	$53 Santa Clara*	$253 L.A. Wilshire II	$295 Vancouver*
	High	$450 Nashville	$1,800 Nashville		$2,500 Detroit	
Busway	Low	$240 Eugene	$16 Eugene	NA	$5,100 Hartford	$162 Eugene
	High	$240,000 Hartford	$468 Honolulu	NA	$7,000 Honolulu	$2,200 Cleveland

*Cost information available for only one BRT system in category.

$480,000 per route mile. And real-time bus arrival information systems at stops, which can significantly reduce passengers' perceptions of wait and transfer burdens, range from just $6,000 to $23,000 per stop. (Because of space limitations, a full table of disaggregated capital and noncapital costs is not included in this paper; these data, however, are available from the UCLA Institute of Transportation Studies website at http://www.its.ucla.edu/research/BRT.)

Finally, this analysis shows that even vehicle acquisition costs, which vary only moderately for most standard fixed-route buses, vary dramatically among BRT systems. For example, Table 4 shows that San Jose's Line 22 Rapid Bus Corridor uses low-floor standard design buses that cost $465,000 per vehicle; Cleveland's diesel and electric articulated buses cost two-and-a-half times more at $1.2 million per vehicle.

IMPLICATIONS FOR POLICY

These findings raise some important questions for transit planners and public officials. As noted at the outset of this paper, BRT has been touted as a way to improve service quality and attract new riders for little additional cost. Further, BRT supporters frequently argue that service components can be mixed and matched to fit local conditions, and phased in over time as both demand and funding allow. This analysis of disaggregated BRT costs for 14 transit agencies shows that, with the exception of exclusive rights-of-way and stations, most BRT service improvements are relatively inexpensive to implement. For example, next-bus indicators—which range in this sample from $6,000 to $53,000 per stop—can substantially reduce the perceived burden of waiting and transferring, while signal-priority systems can increase speeds (thereby lowering the number of vehicles and drivers needed to provide a given level of service). The successful Wilshire Boulevard BRT in Los Angeles, which increased corridor transit ridership by one-third, is an example of such low-cost service.

If one views BRT as primarily a lower-cost form of light rail transit, then capital-intensive BRT proposals are to be expected. If, on the other hand, one views BRT as a way to complement and improve existing bus transit networks, then the lower-cost, minimalist approach to BRT prevails.

So how is BRT currently defined in the United States? Only three of the 14 BRT projects analyzed here could be characterized as low-cost, "big-bang-for-the-buck" BRT systems. The other 11 systems examined have actual or projected costs in excess of $1 million per mile; eight of the 14 systems exceed $5 million per mile; and four exceed $10 million per mile.

What explains transit agencies' proclivities for developing relatively high-cost, LRT-like BRT projects? Researchers have long noted that federal and many state transit finance programs favor capital over operational transit improvements (*25–30*). Put simply, elected officials find it more attractive to cut ribbons in front of new capital projects—BRT or otherwise—than to celebrate more subtle, and often transparent, operational improvements, such as signal prioritization. This phenomenon may lead transit officials to favor visible and tangible improvements, which tend to relate to infrastructure and be capital intensive, over lower-profile incremental improvements to systems and operations. Indeed, BRT projects in the United States, such as the Dulles Corridor in Virginia (which was not included in this analysis), have been designed for eventual conversion to LRT, which affects route alignment, station design, and many other features of the BRT system (*31*).

As a result, public subsidy of both new rail transit and BRT projects tends to emphasize highly visible projects on one or a few lines, over less-visible improvements to networks and systems. This is especially evident for BRT projects because many of the lower-cost BRT features can directly improve the quality of complementary transit services. For example, local and express buses operating on all or parts of BRT routes can take advantage of signal priority and queue-jump lanes at intersections, and local bus passengers waiting or transferring at stops served by BRT lines can benefit from next-bus information systems. Additionally, because the majority (59% of all unlinked passenger trips in 2002, and a much larger share if one excludes metropolitan New York) of transit patrons nationwide are bus passengers (*32*), the potential trickle-down benefits of widespread, low-cost BRT improvements to non-BRT bus services and passengers present a significant opportunity for public transit. This analysis suggests, however, that such relatively low-cost, big-bang-for-the-buck BRT improvements are not the focus of most current BRT proposals.

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