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Urban Transportation and the Benefits of Public Transit

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Introduction

The private automobile has had a significant impact on the layout of the city and the health of city residents. Driving, while fast and convenient on uncongested roads, is slow and frustrating in rush hour traffic. An over-dedication of space for vehicular parking leaves little space for more desirable and beneficial land uses. Driving, for even short trips, obviates use of other forms of transportation and the benefits that come along with alternative transportation. A gradual realization of these and numerous other issues is at the heart of the trends across the nation toward providing commuters with transportation choices other than using a private automobile.

This practice guide is a compilation of research and best practices for cities of all sizes working to improve their transportation system. It is organized into four components:

1. The fundamentals of transportation economics are addressed to help people understand the techniques used to make transportation decisions and present research related equity concerns that may not be well served by these traditional measures. This includes the Complete Streets planning paradigm as a framework for transportation decision-making processes involving government and residents.
2. How government can work with businesses and individuals to reduce the number of cars on city streets through car-sharing and arrangements such as providing a guaranteed ride home.
3. Public transit costs and benefits, as well as technologies often considered when deciding how to improve existing mass transit.
4. A discussion of bicycle and pedestrian improvements that potentially increase safety and provide health benefits to communities, along with increasing the chances that individuals decide to use alternative forms of transportation.

Costs and Benefits: A Primer on Transportation Economics

Transportation economics, the methodological background of transportation planning, starts with the assumption that the transportation user is a rational actor interested in promoting their best interest by avoiding time spent commuting. Transportation is a derived good for the transportation user because it is a means to an end and not generally a pleasant activity in and of itself. In other words, the standard commuter will change modes, for example from car to bus, when they find a quicker method that saves time or otherwise improves their commuting experience.

Models about transportation project many aspects of transportation decisions with varying degrees of predictive power. These may project mode, destination, vehicle ownership, and residential and industrial location. Predictions made by these models are instrumental in identifying problems and determining needed capacity. They are also helpful in cost benefit analysis as they relate the dollar-cost of infrastructure to the time cost that is hopefully saved by the commuter after infrastructure changes are made (Small and Winston, 1999).

Despite the widespread use of transportation-demand models to assist in important decisions, there are many factors not captured by current models that are the focus of current efforts to improve transportation (Beimborn, 2006). These issues include demand management, employer-based trip reduction programs, pedestrian and bicycle programs, time-of-day shifts, changing age structure of the population, and land use policies. Practitioners should be alert to the fact that transportation studies conducted by consultants leave out important information which planners, policy-makers, and the public need when making transportation planning decisions such as the needs of transit users, pedestrians, cyclists, as well as the disabled. This is due, in part, to ill-conceived, outdated, or simply misinformed assumptions about who commutes and how.

Cost and benefit analysis is important for infrastructure decisions. Cash-strapped governments may find funding alternative transportation a challenge when a motoring majority may be more interested in increasing road capacity and fixing potholes. Constituents may question the fairness of providing road space to users of alternative transportation, given a common (and mistaken) perception that roads are primarily funded by taxes and fees connected to automobile usage. In actuality, motor fuel taxes, automobile licensing tax, and tolls for highway usage amount to only 50 percent of revenue spent by state and local government for highway infrastructure (see U.S. Census Bureau, 2011).

Equity and Economic Efficiency

Observers may find it difficult to perceive how metropolitan transportation relates to equity – after all, vehicles travel at the same speed regardless of the socioeconomic status of the driver. However, inequality in transportation is a result of the inequalities in political power that impact urban planning (Grengs, 2005). Equity is part of the triple-bottom line of sustainability: economy, environment, and social goals.[1] This seems simple, but in practice often implicates contradictory influences of planning for environmental sustainability and social equity. Both access to the means of transportation and the destinations to which transportation systems connect are unevenly distributed within cities in both the developed and developing world (Levine, 2013). While there is no dominant frame for thinking of transportation planning from an equity perspective, there are three key ideas worth considering: mobility versus accessibility, how transportation need is measured, and urban sprawl.

Briefly, transportation planning in the United States has typically considered its chief criterion as one of mobility or ease of movement (Sanchez et al., 2003), which begs the question: how is equity operationalized, or measured, within transportation planning practice? Bearing in mind the general goal of transportation is to *reach* destinations, equity in transportation planning may be considered in three ways, of which mobility is only one part: mobility, proximity, and connectivity (Litman, 2013). If a destination is close to the point of origin on a given trip, mobility may be less important than proximity, because the destination may be easily reached by various methods of transportation. The equity perspective suggests that mobility is a necessary but

[1] The Transportation Equity Caucus provides a significant amount of resources and up-to-date information related to topics on equity in transportation planning (http://www.equitycaucus.org).

insufficient route to accessibility in that mobility is a means to the end goal of accessibility rather than the end goal itself. If mobility is the freedom for cars to move quickly and easily, accessibility then is the degree of difficulty or ease to which users of *all* forms of transportation can reach their destinations in a safe manner.

Economic efficiency in transportation planning is often at odds with social equity. That is, efficiency is measured via cost-benefit analysis; in this case travel time savings. The problem is that travel time is valued as a percentage of the prevailing wage rate; the fact that different income groups use transportation investments makes this difficult to conceive vis-à-vis equity because the implication is that some forms of travel – intercity buses and railway improvements to name two – are then considered less efficient (Levine, 2013). Therefore, planning priorities under this form of efficiency often reiterate socioeconomic differences across varied socioeconomic groups in a city where *willingness to pay* is used as an indicator of demand alone. Willingness to pay is a useful indicator, but larger socioeconomic dynamics should be also considered for planning with an eye on equity.

Changes in the employment and living patterns in the U.S. since the 1950s have rapidly changed the effectiveness of existing transit services. Individuals and families in poverty, in part because of the spatial mismatch between employment and residential location, risk increasing marginalization as they remain in areas with few viable employment opportunities. (Wilson, 1996). This problem is augmented by the failure to charge road users the real price of their road use. Instead of charging for congestion, people are instead charged through gas taxes, meaning with increased fuel efficiency people are both driving more and paying less per mile of driving. Transit networks tend to be configured for trips from the suburbs to the central city. A shift from manufacturing, which was located closer to the central city, to services, which follow wealthier individuals with a preference for lower density suburban living, means these networks are not adequate to carry individuals out from the central cities.

Empirical results measuring the frequency of trips between suburbs and central cities show there is a racial pattern, after controlling for income, consistent with discrimination in the ability of low-income non-white groups to move to the suburbs to be near better jobs. The working poor are four times more likely to lack access to cars. Caucasians, regardless of income, are more likely to make up for the spatial mismatch because they are more likely to have access to friends or others who themselves own a car. Non-white ethnic groups, in many cases, are more reliant on public transit.

Experience suggests attempts to solve the spatial mismatch by moving employment or low-income groups will not address the problem. Transit is one factor among many that play a role in whether people find a job. The most successful programs address education, transportation, and job skills at the same time to make sure people can find adequate employment.

Externalities of Transportation: Health, Civic, and Ecological/Environmental Concerns

Sprawling environments and urban forms are associated statistically with lower levels of physical activity, and subsequently, suboptimal health outcomes relative to more dense environments which promote other forms of commuting (Ewing et al., 2003). It should be noted that this evidence is not conclusive, although the statistical association itself has been found by multiple researchers in different studies (Ewing et al., 2003; U.S. Department of Health and Human Services, 1996). While existing research generally shows no relationships between *individual*-level measures of sprawl – such as density, residence within a central city, age of building stock, and transit pattern – and individual happiness and health, there is an exception: residents of newer neighborhoods tended to report higher levels of personal happiness (Williamson, 2010). However, and importantly for transportation planning practices, *commute time* is linked to a number of undesirable outcomes, including lower levels of health, happiness, some forms of social participation, and even community quality-of-life assessments.

Finally, even if health and civic engagement are not problematic in some areas – even if sprawl is *cost-efficient* on those dimensions, sprawl is highly problematic for long-term ecological sustainability. To wit, sprawl is associated with loss of usable agricultural land (Kahn, 2008); species loss (Ewing et al., 2005); wetlands destruction; runoff water pollution; and air pollution generated from automobiles (Pollard, 2007).

The Urban Imaginary: Design Qualities and "Place"-making

A common argument found in literature on urban design and planning makes the case that there are design properties across cities both of historic and contemporary importance which have bolstered their city's character and sense of place (*imageability*). Transportation planning focused on these qualities can play a part in making a place memorable and relatively easy to navigate. Kevin Lynch's *The Image of the City*, a canonical text in the urban design literature, makes the case for *imageability* as *legibility.* A legible place is precisely one where people understand a place in their interpretation of what is happening there as well has how to negotiate the area physically (Lynch, 1960). Other writers have added criteria to Lynch's *imageability* concept such as permeability – that a plethora of routes through an area and choices in terms of routes for navigation is desirable; that an area contains multiple uses and is flexible enough to adapt to changes in use, and, perhaps more subjectively, visual appropriateness (Kenworthy, 2006). These design criteria have been incorporated into New Urbanism as well as paradigms such as Complete Streets. Both New Urbanism and Complete Streets de-prioritize the automobile as the sole or main means of transportation for daily living. Creating or enhancing non-automotive means of transportation have as a potential consequence many spillover benefits, both economic and social. A city which is legible and permeable to pedestrians is, when combined with mixed-use and compact urban forms, more likely to be environmentally sustainable.

The above notwithstanding, there is often a tension between place-oriented policy and policies which aim more directly at social equity: that is, many community-building efforts have,

historically, been associated with social homogeneity and exclusion (Talen, 2003; 1996). While higher-density areas have been associated with relative ease of improving public transport and access to facilities relative to lower-density cities (Burton, 2000), it remains a vital concern. Equity and equality in transportation planning are discussed below in this practice guide in fuller detail.

Public Transportation and Municipal Economic Development

Transit-oriented development (TOD) is a planning and design practice which seeks to create compact, mixed-use communities, friendly to pedestrians and located around public transit stations. TOD draws support from diverse audiences such as smart growth advocates, community-based developers, and local business leaders. The idea is not new – TOD was a common planning tool prior to the 1950s and the onset of automobile-dependent planning. Since 1950, development patterns have become increasingly auto-centered (Williamson, 2010; Litman, 2014). New neighborhoods were located along highway routes, and transit systems catered to drivers, creating "park and ride" routes serving suburban commuters, and enclosing commuter and light rail stations with large parking lots. Decades of sprawling suburban development left many suburban residents with arduous, costly commutes and many low-income urban communities isolated from jobs, transit, and services.

TOD may be used to address numerous public issues. To wit, it can catalyze economic revitalization within a station area. The mixed-use component of TOD offers residents easy access to jobs, housing, and services and concomitantly lower transportation costs for households. The latter is no small feat: transportation costs are typically the second-largest expense for households after housing expenses (Bureau of Labor Statistics, 2012). Low-income families may spend as much as 30 percent of their budget on transportation alone (Lipman, 2006). TOD and mixed-use development can be equity-promoting in that the general *accessibility* of residents is promoted.

Complete Streets Policies and Practices

Complete streets policies are commitments made by cities to provide for the safe and efficient use of streets by all users, regardless of mode, age, or ability (Complete Streets Coalition, 2013). These policies are meant as correctives for decades of planning exclusively for the automobile. The policies are not in and of themselves a re-write of design manuals that public works departments will use to set regulation, though they often spur revision of design requirements. Instead, policies are formal statements of the intention of a community to change conceptions about what constitutes good transportation planning.

The purpose of complete streets policies is to coordinate the actions of a governmental unit to ensure that future decisions about streets and infrastructure are made in compliance with complete streets policy goals. Policies are designed to impact future street decisions, not current infrastructure, though some policies direct public works departments to restripe streets once it is time for resurfacing (Complete Streets Coalition, 2013). A Complete Streets policy addresses improved conditions for pedestrians (sidewalks and traffic signals calibrated for all road users) as well as people with disabilities (such as provisions for the needs of the vision-impaired or persons

who use wheelchairs). These policies are also designed to improve safety conditions for automobile drivers (i.e., slower driving speeds and fewer sharp turns).

A Complete Streets policy can take many forms. As of December 2012, 49 percent of 480 communities with complete streets ordinances enacted them through resolutions, 17 percent through legislation, 15 percent through city policies, nine percent through a city plan, six percent through internal policy revision, three percent through design guidance, and one percent through executive order (Complete Streets Coalition, 2013). Legislation is best, but if this is difficult to achieve, initial steps might include resolutions, issuing design guidance, writing a complete streets plan, altering existing policies, or executing complete streets through an executive resolution (Smart Growth America, 2012).

Complete Streets policies are likely to be palatable to a large percentage of the population, when correctly framed. Benefits include being inclusive to all street-users, and incorporating or going beyond the requirements of the Americans with Disabilities Act (ADA) requirements; this includes infrastructure for the disabled, policies for people who want to walk and bike, and in some cases infrastructure improvements to assist the elderly. In 2013, 83 cities adopted complete streets policies (Complete Streets Coalition, 2014), as well as over 610 regional and local jurisdictions, 27 states, Puerto Rico, and Washington, D.C. (Complete Streets Coalition, n.d.).

However, all policies are not created equal. It is important to understand the people who are served by the policy to properly include interests. Conducting a visioning process with the broadest possible stakeholder representation is a useful tool for public input (Dunham, 2011). This process allows for a dialogue between policy-makers and all stakeholders to discuss the benefits to automobile drivers (for example, decreased accident rates), bicyclists, and pedestrians. Public forums are also an opportunity to explain how Complete Streets policies are actually much more cost-effective than may be imagined; in fact, Complete Streets policies cost only three to five percent more than policies that do not incorporate all road users (Shapard, 2012).

The American Association for Retired Persons (AARP) is also an advocate for Complete Streets (2009); they support these policies as a means to guarantee adequate provisions for the needs of the elderly. As the Baby Boomer generation ages, the U.S. will face an unprecedented number of elderly drivers using the road. These drivers have slower reaction time due to age-related changes in vision, cognitive abilities, and muscular flexibility. AARP finds that most transportation and street plans do not explicitly consider the needs of aging populations. This is unfortunate considering that as of 2011 there were 41.4 million older Americans, or people 65 years or older, representing 13.3 percent of the U.S. (Administration on Aging, 2012). The population of people 65 and over is expected to grow, with a projection of 92 million in 2060 (Administration on Aging, 2012).

People over 65 years of age have needs that are different from those of the younger population. One report found that 42 percent of people over 65 report having a disability (Lynott et al., 2009); for those 85 years and older, 72 percent reported having a disability. Both men and women are

likely to live beyond the age where they can safely drive an automobile. Men are likely to live seven years beyond the age when they should drive an automobile; women are likely to live an additional 10 years. This will be a significant problem in the future. By 2025, automobiles will have been the primary means of transportation for a majority of older Americans throughout their lives; many will have based their housing choices on the assumption they will continue to be able to drive. Older Americans are especially likely to suffer from streets not designed for their needs in rural areas where they must navigate high speed roads for long distances. A transportation plan that does not account for the needs of the elderly is not a plan that is likely to succeed in meeting the future needs of a community.

An AARP survey suggests the current population of people over the age of 50 is already poorly served by current infrastructure (Lynott et al., 2009). Researchers found that 40 percent of those 50 years and older did not find the sidewalk provision in their neighborhood adequate. Worse, half of respondents felt it was not safe to cross streets close to their homes. Half of this group who reported problems with the infrastructure also said they would walk, bicycle, or take the bus if the problems with infrastructure were fixed.

One very important consideration for older Americans is the timing of traffic lights (Lynott et al., 2009). People with limited mobility will not find the crossing time designated by the Manual for Uniform Traffic Control Devices for Streets and Highways, the national standard published by the Federal Transportation Administration (FTA), adequate. A decreased ability to focus attention on the road means complex traffic situations such as temporary lanes, complex traffic signals, and certain bicycle infrastructure configurations may lead to dangerous confusion at intersections. While Complete Streets policies do not directly address engineering requirements, federal guidance on traffic engineering suitable for older people is available to communities making decisions about specific traffic engineering policies in the Federal Highway Administration's (FHWA) *Highway Design Handbook for Older Drivers and Pedestrians*.[2]

Guaranteed Ride Home Policies

"Guaranteed ride home" (GRH) is a program that provides security for people who are willing to divert some of their private automobile trips to alternative transportation. The programs provide users with a lot of security for a very small per person cost by guaranteeing a ride to participants in case there is an emergency that requires a ride home. Guaranteed ride home programs are widely used. As of 2007 they were in use in 63 of the largest 150 transit authorities. A study of data from the 63 transit authorities with complete statistics about program usage, totaling 43 agencies, found that only 4.57 percent of eligible participants actually used the service (Menczer, 2007).

GRH services come in many forms. Most programs require participants to walk, bus, bike, carpool, or vanpool at least once a week, but some require up to three times a week. Programs vary widely: 22 percent did not include walking or bicycling, while 20 percent only included public

[2] See http://www.fhwa.dot.gov/publications/research/safety/humanfac/01103

transportation and not any other form of commuting in the programs. Services are usually an agreement with taxi or car rental services. Some employees can use company cars, rent cars, or be driven by other employees. San Francisco allows people to use car sharing services for the ride home. Areas with well-established public transit often incorporate public transit into the GRH program to minimize the cost of a ride home. This may mean a user will be asked to take a bus or train to a distant stop where they will meet with a taxi for the last part of the trip. GRH users usually pay either with vouchers that may be redeemed with specific taxi companies or transportation agencies, through reimbursement for payment to a ride provider, or with direct payment to the transportation service provider (Menczer, 2007).

Controlling expenses and preventing abuse of the program is done with limits on the number of rides participants can use or with limits on the mileage or expense of rides. In Denver, participants can use the service to travel for 100 miles, and in San Francisco CarShare can be used for up to 200 miles. Most programs restrict taxi rides to 20 miles. Limits on the maximum number of trips range from two rides per year to no limits at all. Some programs require users to co-pay on transit services. This may be a nominal fee such as $3 for a ride, or a percentage of the cost of the ride. One agency provides three rides at no cost and then requires 50 percent co-pay for all future rides. Registration fees have been shown to greatly inhibit usage of the program. Despite a marketing campaign and an outreach effort only two commuters paid the $15 registration fee for San Antonio's service (Menczer, 2007).

Programs costs average $36.95 per claim, with a median cost per claim of $29.96. The range of cost per claim was from no cost to $114.08. Per average commuter registered, costs were $1.69 with a median cost of $.35. Costs did not stay constant as the size of the area covered increased because a larger coverage area means potentially longer rides. Data does not show an increase in the usage of the program with greater numbers of rides allowed. Studies on the effectiveness of GRH in encouraging people to commute range from showing a very small positive increase in the number of commuters to showing programs greatly increase usage of alternative transportation. Because of the low cost per participant and relative cost-effectiveness of programs, communities should likely consider supporting transit through the use of GRH programs. Communities, the FTA found, should also consider not being too restrictive with the limits since evidence shows little correlation between the parameters of the program and the actual rate of use (Menczer, 2007).

Cities interested in GRH programs should adopt policies supporting fast emergency travel options that spell out the eligibility of participants for the program, the cost, if any, maximum number of rides per year, limitations on mileage, and maximum trip cost. Keeping programs from being unduly restrictive is important to encourage the maximum number of participants to use the program. Involving potential participants in the design is important since it will build buy-in and allow designers to tailor the program to the needs of the actual end users (Menczer, 2007).

Public Transit

Public transit includes transport services available to the general public, including vanpools, buses, trains, ferries, streetcars, and variations thereof. In the U.S., public transit beyond local bus systems is sometimes thought of as far-fetched or politically undesirable. However, this view is mistaken: prior to the 1950s, inter-city passenger trains in the U.S. stood out as one of the most robust and complete public transit models available in the world at the time. By 1969, nearly 60,000 miles of track were decommissioned and less than one in five of the inter-city trains running in 1954 were still operating in 1971 (Renner and Gardner, 2010). Yet, ridership in 2012 set record highs with over 31 million inter-city train passengers in the U.S. The U.S. has only 5 percent of the transit rail cars on the planet (Europe has 35 percent for comparison). Buses carried the largest percentage of U.S. public transit users at 39 percent in 2010.

In general, there are four ways to consider transit improvement (Litman, 2014): increased service (e.g. increased transit vehicle-miles); improved service (e.g. increased comfort and/or reliability); transit use incentives (e.g. lower fares or commuter financial incentives); and finally, TOD, which, as previously stated, is land use patterns designed to support transit with mixed-use developments featured at transit stations and corridors. Public transportation is necessary, though not enough, to address traffic and parking congestion, ameliorate traffic accidents, energy consumption, and pollution, reduce the cost of infrastructure, roads, and parking, as well as issues arising from inequalities in car ownership. For growing cities, public transit represents a viable solution to reducing congestion and supporting more efficient land use patterns (Suzuki, Cervero, and Iuchi, 2013).

Levenger and McGhee (2008) discuss four factors to consider in developing and evaluating transit service: ease of use, effectiveness, comfort, and aesthetics. Lynch's *legibility* concept stresses the notion that if users find a transportation system difficult to understand, they are more likely to make mistakes in using the system or avoid use of the system in general. *Legibility* is a way to ask: what difficulties do new riders face? For example, are timetables easy to decipher? The system should be predictable, provide users with some degree of security and accommodation for users of different abilities and sizes, as well as appeal to the senses in a minimum fashion with clean facilities and vehicles.

Similarly, ease of use, legibility, price, the extent to which public transit is integrated with other modes of transportation (such as park and ride facilities), comfort, security, and even prestige are factors affecting levels of ridership in public transit. In economic terms, studies of transit ridership demonstrate an average elasticity of -0.4, meaning that each 1 percent increase in fare price will reduce ridership by 0.4 percent, everything else being equal. Research on the elasticity of other factors shows that the strongest drivers of public transit usage are the total size of the area the public transit system serves; a large central city population, and regional employment hubs, while travel time, fare price, and wait time all exhibited negative relationships with ridership levels (Kain and Liu, 1999).

Bus Rapid Transit (BRT)

Bus rapid transit (BRT) is a rapidly emerging mode of public transit, striving to achieve the speed and reliability associated with rail services in combination with the flexibility and lower cost of conventional bus service (Deng and Nelson, 2011). Unique elements of BRT systems include running ways (dedicated lanes on a street), prepaid fare collections, and a tendency for quiet, high-capacity vehicles using (relatively) "clean fuel." BRT systems are more efficient than standalone local or express buses, and less expensive than light and heavy rail systems (Cain et al., 2009). The latter are covered in the next section in more detail.

BRT is comparable to a surface metro or train system, with advanced stations and high rates of speed and frequency, but with notably lower costs than either light or heavy rail systems. One of the most well-known BRT systems in the world, in Curitiba, Brazil, is so successful and well-regarded that it has prompted a modal shift in the city, with estimates suggesting 25 percent of commuters were car users prior to the deployment of Curitiba's BRT system (Rabinovitch and Hoehn, 1995). In the U.S., Los Angeles' Orange Line is notable for outperforming its light rail local counterpart, the Gold Line in both cost and efficiency (Callaghan and Vincent, 2007). As with the Curitiba experience, Los Angeles' Orange Line was successful to the extent that 18 percent of BRT users were identified as car users prior to the Orange Line's deployment. In general, international and U.S. research suggests that BRT significantly increase transit use, with riders displaying higher levels of satisfaction relative to on-street conventional bus riders and rail corridors (Currie, 2006A).

Case studies demonstrate that BRT can be cost-efficient while offering high-quality service, as well as induce transit-oriented development (Levinson et al., 2003). The key to BRT projects is the quality and extent of busways (dedicated lanes) on local roads, often taking the place of a median. Some BRT systems can achieve average speeds over 50 mph with maximum speeds of over 60 mph (Currie, 2006B). Additional factors in improving average speed are the extent to which transit signal priority (TSP) is implemented – allowing BRT vehicles to minimize delays at intersections as well as minimize impact on car traffic – and use of fast boarding concepts such as electronic prepayment for fares, multiple door boarding, and multiple floor boarding in contexts where BRT vehicles are multi-leveled.

Relative Costs and Consequences of BRT

BRT systems typically require less capital and feature lower operating costs relative to rail systems. It is also thought of as a means to increase use of and favorable attitudes towards transit (Hensher, 2007). Indeed, BRT systems average costs four to 20 times lower than light rail systems and, even more strikingly, 10-100 times less than metro systems (Wright and Hook, 2007). Therefore, BRT can provide greater coverage than rail with a start-to-finish construction timeline, taking as few as three years in some cases (Deng and Nelson, 2011). A U.S. Government Accountability Office review of 20 existing BRT lines found that such systems are cost-effective (U.S. Government Accountability Office, 2001). In terms of environmental costs, pre- and post-implementation measures of environmental pollution suggest that BRT can improve air quality

as conventional bus lines are typically reduced after the advent of BRT (Wöhrnschimmel et al., 2008).

While BRT systems are relatively new and unexplored in research literature especially in terms of effects on land use and development (Deng and Nelson, 2011), the research does suggest BRT is a cost-effective way to move large numbers of people. The burden in the U.S. is that bus services are often perceived as slow, a source of pollution, unreliable – as well as class bias delineating norms about *who* rides buses. Therefore, design characteristics must be kept in mind. In cases where BRT systems have been well-designed, they often provide tangible benefits exceeding their cost, not the least of which is promoting transit *per se* and inviting potential users to utilize transit in a multi-modal manner.

BRT in San Francisco: Evaluation Standards and Program Goals

San Francisco was one of the first major cities in the U.S. to incorporate principles which are now part of Complete Streets policies through its adoption of a "transit first" policy in 1973. Decisions related to streets and sidewalks "shall encourage the use of public rights-of-way by pedestrians, bicyclists, and public transit." [3] However, the city's BRT implementation – originally slated for 2009 – is now scheduled to be finished by 2018.

Why the delay? Anti-bicycling (or pro-automobile) advocates sued the city on the grounds that BRT and other efforts to incorporate multi-modal transit onto roads currently used exclusively for automobiles are actually bad for the environment and dangerous to drivers. The opposition to BRT implementation resulted in a court battle between advocates and opponents. The main charges – that BRT would adversely affect congestion and the local environment – required five and nine years to investigate respectively. In particular, for San Francisco and many cities throughout the U.S., any change to roads or streets invokes the level of service (LOS) concept: how does this particular change affect auto traffic? Any increased delay on cars warrants further study. Reduced driving - reduced vehicle miles travelled (VMT) – is critical to sustainability efforts and a major facet of policy initiatives such as smart growth, compact cities, and complete streets (Henderson, 2011). Therein lies the tension: LOS is incumbent in most cities and, in its most common form, is part of the auto-dependent paradigm that prevailed in many older cities in the U.S. during their expansion.

LOS may appear to be an obscure transportation tool, but one reason it is heavily used is its ease of calculation. The chief function of LOS is to measure the delay a car experiences at a particular intersection. A delay of less than 10 seconds means a street has a "good" traffic flow and earns an LOS grade of "A." A grade of "F" is given when delays go over 80 seconds.

Let us say there are parties interested in adding bike lanes in San Francisco. The sponsor of this project must consider whether the change to the street will result in a downgrade of LOS. In San Francisco, generally speaking, the threshold for LOS acceptability is a grade of "E" – or a delay

[3] CityLab (http://www.citylab.com/commute/2014/07/transit-projects-are-about-to-get-much-much-easier-in-california/374049)

between 55 and 80 seconds (San Francisco County Transportation Authority, 2011). If our hypothetical bike lane eliminates a car lane, that could create enough congestion for each car's delay to exceed the 80-second mark. This doesn't prevent implementation, but it does exacerbate the process by mandating impact reports due to California environmental laws. If the additional analysis confirms the LOS failure, additional solutions for mitigating traffic are also required. These additional steps add to a project's fiscal and resource costs. "That takes that $20,000 or $40,000 bike lane and suddenly makes it a $200,000 project, and it takes a project that might have taken a month or two to go from design to implementation and it could make it into a 2- or 3-year project," according to Andy Thornley, policy director at the San Francisco Bicycle Coalition. "In many cases it's not so much that we take the bike lane or the crosswalk all the way through the research and reject it, it's that we don't even go into the environmental review because public agencies don't have the resources to spend the time and the money on these pretty cheap projects. So there is a hugely chilling effect to having to go through all of these hoops."[4]

The key, from a planning perspective, to resolving this problem is to utilize a more complicated multi-modal LOS metric. To provide a counterweight to the heuristic of automobile LOS, measures covering additional areas of sustainability such as measuring the quality of the pedestrian environment (for example, sidewalk width, connectivity, and curb cuts) or the transit system (frequency, crowding, service hours, and dwell times) should be utilized (McCann and Rynne, 2010). In this vein, the Transportation Research Board (TRB) has incorporated a new multimodal LOS in the fifth edition of the Highway Capacity Manual[5] (TRB, 2010).

Light Rail Transit

Urban rail transit may be generally divided into two groups: heavy and light rail systems. Heavy rail systems are characterized by "exclusive rights-of-way, multi-car trains, high speed and rapid acceleration, sophisticated signaling and high platform loading," and include subways, elevated rail systems, and metropolitan railways. Light rail systems are "an electric railway with a 'light volume' traffic capacity compared to heavy rail. Light rail may be use shared or exclusive rights-of-way, high or low platform loading and multi-car trains or single cars" (American Public Transportation Association [APTA], 2012) Light rail therefore includes streetcars, trolleys, and trams. Other general differences include a higher fixed-capital cost for heavy rail (a larger price tag for the initial implementation due to, for example, infrastructure costs); higher speeds and greater capacity for heavy rail; and perhaps most acutely, light rail typically does not need to be placed above or below city centers and other dense urban areas.

Evaluations of urban rail transit systems suggest these systems promote environmental, social, and economic conditions. For example, reduced car travel and subsequent reduction in green-house gas emission, related air pollution, and fuel consumption certainly are positive for environmental concerns (Shapiro, Hasset, and Arnold, 2002). Economic benefits may be realized in the form of increased land value, business development (such as TOD) at stations, and a higher

[4] CityLab (http://www.citylab.com/cityfixer/2011/12/transportation-planning-law-every-city-should-repeal/636)
[5] Available at: http://www.trb.org/Main/Blurbs/Highway_Capacity_Manual_2010_HCM2010_164718.aspx

tax revenue stream (Bhatta and Drennan, 2003). Perhaps more tentatively, social benefits may also follow from urban rail transit developments, such as increasing access beyond what bus systems may offer for transit-dependent individuals. Urban transit may also change the urban form itself as rail stations may become focal points with potential for diversity and increased walkability, higher levels of inter-personal interactions, and stronger attachments to community and a place itself (Besser and Dannenberg, 2005; Brown and Werner, 2007; Lachapelle and Noland, 2012; MacDonald, et.al., 2010; Stokes, McDonald, and Ridgeway, 2008).

Who uses public transit and for what purpose?

A meta-analysis which compiled data from 150 on-board vehicle passenger surveys conducted during 2000-2005 suggests that public transit riders are disproportionately adult women with a diverse range of household incomes (APTA, 2007). While 20 percent of riders surveyed indicated incomes less than $15,000, 9.5 percent report incomes higher than $100,000 annually. Interestingly, only 30.7 percent of public transit riders surveyed indicate they do not own a car. Indeed, more riders reported owning two or more cars (40.3 percent) than none at all. Work commutes account for nearly 60 percent of all rides, trips to school 10.6 percent, and all other purposes such as personal business, medical trips, and "social purposes" accounting for the remainder of riders' reported purposes (~30 percent). Surveys of the various reasons riders provide for using public transit suggest that personal convenience, saving money, avoiding driving-related stress, and environmental concern were among the top reasons for using public transit (Center for Urban Transportation Research, 1998).

However, there are important distinctions between kinds of public transit. For example, local bus riders are less likely to have other means of personal transportation than users of light-rail and express buses. Typically, local buses serve riders who live within a mile of the bus line whereas light rail is characterized by users who reside throughout the region in question, on average living more than three miles from the rail line (Center for Transportation Studies, 2009).

Table 1 highlights commonly experienced costs and benefits for various conceptions of improving transportation, along with indicators which provide a way to measure changes involved therein. For example, increasing public transit travel is likely, as previously discussed, to increase mobility of new users, to increase security of all users due to more populated transit stops and stations, and also positively impact the health and fitness of transit users as they walk or cycle more frequently. Transit-oriented development, while harder to quantify outside of analyzing plans and associated documents, is also associated with fewer vehicles on the road, a reduced crime risk, and preservation of farmland and other land uses, with the downside being compact development which may not be locally desirable.

Public Transit Costs, Benefits, and Related Indicators

Table 1

Category	Improved Transit Service	Increased Transit Travel	Reduced Automobile Travel	Transit-Oriented Development
Indicators	Service Quality (speed, reliability, comfort, safety, etc.)	Transit Ridership (passenger-miles or mode share)	Mode Shifts or Automobile travel reductions	Portion of Development with TOD Design Features
Benefits	Improved convenience and comfort for existing users. Equity benefits (since existing users tend to be disadvantaged). Option value (the value of having an option for possible future use). Improved operating efficiency (if service speed increases). Improved security (reduced crime risk)	Increased user security, as more users ride transit and wait at stops and stations. Mobility benefits to new users. Increased fare revenue. Increased public fitness and health (if transit travel stimulates more walking or cycling trips)	Reduced traffic congestion. Road and parking facility cost savings. Consumer savings. Reduced chauffeuring burdens. Increased traffic safety. Energy conservation. Air and noise pollution reductions.	Additional vehicle travel reductions ("leverage effects"). Improved accessibility, particularly for non-drivers. Reduced crime risk. More efficient development (reduced infrastructure costs). Farmland and habitat preservation.
Costs	Increased capital and operating costs, and therefore subsidies. Land and road space. Traffic congestion and accident risk imposed by transit vehicles.	Transit vehicle crowding.	Reduced automobile business activity.	Various problems associated with more compact development.

Source: Litman, 2014

Financing Public Transit

There are a number of financing mechanisms available to metropolitan transit agencies to increase access to capital. Federal support exists which may enable local agencies to leverage a variety of funding sources, reduce principal and interest costs on projects while minimizing risk for private investors (Yeager, 2014). This section briefly describes the broader structures that works within communities and provides case studies to show the variety of funding mechanisms that governments have used to locate funding for the advancement of transportation planning.

Community leaders attempting to improve transportation in their communities will likely need to work with a municipal planning organization (MPO) or a regional transportation planning organization (RTPO). MPOs have been required by federal law since the early 1970s to ensure comprehensive, continuing, and cooperative planning on an ongoing basis (Transportation Capacity Building Program, 2007). Some MPOs are located within regional planning organizations

or councils of government. Federal funds are funneled from FHWA through MPOs to local municipalities. Outside metropolitan areas, state Departments of Transportation are responsible for ensuring outreach and comprehensive transportation planning in rural areas of the state. This is frequently done with RTPOs, which are voluntary institutions that represent local governments (National Association of Development Organizations [NADO], n.d.).

Indianapolis, IN

Cities combine local, state, and federal funds to finance innovative infrastructure improvements that would have seemed far-fetched when the focus of transportation planning was squarely on the movement of automobiles. An example is the Indianapolis Cultural Trail. The 5-mile trail connects with seven "cultural districts." Pedestrians and cyclists take protected, separated paths directly to museums, landmarks, public art, restaurants and businesses. The trail also connects with White River State Park and the 15-mile Monon trail, a heavily used mixed use path (Partnership for Sustainable Communities, 2013).

Building the Cultural Trail has led to significant investment in Indianapolis. Developers began purchasing parcels of land adjacent to the trails before its completion both in stable neighborhoods and those with abandoned or vacant properties. Permits were issued for $17.5 million in new retail development and $36.4 million in new residential developments between 2007 and 2010. The city anticipates the trail will bring 11,000 new jobs to the city, and will yield an economic benefit of $863 million. The city has received international attention for the downtown's walkability when it hosted the Super Bowl in 2012 (Partnership for Sustainable Communities, 2013).

Planning the project took 12 years, while construction took six. The Cultural Trail is landscaped and showcases local artists' work along the way. Even the design of the paving was considered on the trail, with two-tone hexagonal and striped asphalt. The project is part of sweeping investments in the city's downtown focused on increasing livability, work that has earned the city recognition for having the best business climate in the Midwest (Simmons, 2014).

Funding for $62.5 million Cultural Trail came from the U.S. Department of Transportation (DOT), Environmental Protection Agency (EPA), and Department of Energy (DOE). Funding included $26.5 million in donations from private individuals, foundations, and local corporations. Once the city had invested the money donated by local sources and $15.5 million of federal transportation funding, the city was awarded a $20.5 million Transportation Investment Generating Economic Recovery (TIGER) grant (Partnership for Sustainable Communities, 2013).

Lexington, KY

Lexington, KY, is currently in the process of developing the fourth stage of their Legacy Trail. This 12-mile walking and biking trail, which opened in 2010 as the Cane Run Trail, connects downtown Lexington with the Kentucky Horse Park. Though some of the trail does align with streets, over 8.5 miles are off-street; this trail also integrates public art and interpretive signage. The plans for a multi-use separated path originated in the 2001 Greenways Master Plan before funding was

secured (Scott Thompson, Bicycle and Pedestrian Coordinator, Lexington-Fayette Urban County Government, personal conversation, September 24, 2014).

The community participated and generally supported the plan through a planning process that resulted in a report that identified multiple possible alignments for the trail. The community's goal was to have the trail completion coincide with the 2010 Alltech FEI World Equestrian Games that were to be held in Lexington. Equestrian Game events were slated to be held at various locations in Lexington and the surrounding area such as the Kentucky Horse Park and Keeneland Race Track. Without deliberate planning, it would have been impossible to complete the project in time for the Games.

There was excitement throughout the community and state surrounding this international event, and a big push came from the community, local government, and the state department of transportation to complete the project in a timely manner. The Lexington Area Metropolitan Planning Organization and the city pursued funds from the DOT for congestion mitigation, and transportation enhancements (now referred to as *alternative transportation*). The city also sold trail bonds, and provided some of the matching funds requirement out of the city funds. Because of the time constraint for the trail project, funds earmarked for other projects were used to pay for the trail project. Thompson said that not only is the Legacy Trail extremely popular and well-used, it is often cited as an example when other bicycle and pedestrian improvements are proposed.

Mayfield, KY

In Mayfield, KY, with a population of 10,024 people (U.S. Census Bureau, 2010), City Planner Brad Rodgers explained they have improved the pedestrian and bicycle experience by installing bicycle racks in several city parks and at city hall, and also by competing a one and one-fourth mile waking trail in Kess Creek Park (B. Rodgers, personal communication, September 30, 2014). The work was widely supported by Mayfield residents, and has proven popular. The bike racks were paid for using local funds. For the walking trail, the city used Kentucky Department for Local Government[6] grant money awarded to the city directly from the state.

Jeffersonville, IN

Downtown Jeffersonville, IN, is serving an unprecedented number of cyclists and pedestrians since the June 25, 2014 opening of the Big Four Bridge. This former railroad bridge has been transformed into a mile-long linear park that the spans the Ohio River. The extremely popular facility, which had been closed since the late 1960s, has attracted approximately 1.6 million users since it opened from the Louisville side in June 2013 while the Jeffersonville ramp was still under construction (K. Phillips, personal communication, 2014).

Previously, the Clark Memorial Bridge, with its narrow sidewalks, fast traffic, and tight lanes had been the only route for pedestrians and cyclists to cross the river. In recent years, there have

[6] Kentucky Department for Local Government provides financial and technical assistance to local governments. For more information visit https://kydlgweb.ky.gov.

been cyclist and pedestrian fatalities which involved involving vehicular traffic. The Big Four Bridge provides a significant improvement and safer travel across the river for cyclists and pedestrians.

While some called for the Big Four Bridge to be torn down when railroad operations on the bridge ended in 1968, proposals emerged to turn the bridge into a mixed-use development (Klayko, 2011). Plans for development of the bridge into a pedestrian facility began 30 years ago in the late 1980s and early 1990s (K. Phillips, Personal Communication, 2014). Plans became more viable in 2012 when a new source of money was found by redirecting pedestrian and bicycle facilities from a new bridge expansion project to the Big Four Bridge (K. Phillips, Personal Communication, 2014).

Jeffersonville and the Indiana Department of Transportation (INDOT) agreed to coordinate designing, funding, and building the Jeffersonville ramp of the bridge. Louisville Metro Government and several other organizations coordinated and paid for work on the bridge itself and the ramp that connects the bridge to the Kentucky side of the river. The cost for engineering, design, construction, and project management to complete the ramp from the bridge down to the Indiana side was approximately $11.2 million. Of this amount, Jeffersonville paid approximately $3.2 million and INDOT paid approximately $8 million. The funding was apportioned on an 80/20 basis.

Development of the bridge has opened up significant economic development opportunities for Jeffersonville. Restaurants and other businesses in downtown Jeffersonville, some of which were developed in anticipation of the opening of the Indiana side of the bridge, experienced overwhelming influxes immediately after the bridge opened. A map at the bottom of the Indiana ramp points bridge users to 58 local businesses within walking distance. While no economic study has yet been conducted, local business owners report record sales (White, 2014). The economic development impact of the bridge has earned Jeffersonville the Primacy of Place Award, the 2014 Indiana Association of Cities and Towns Community Achievement Award, and the International Economic Development Council Bronze Excellence in Economic Development Award for its part in developing the bridge (Gibson, 2014).

The bridge is part of a larger bicycle infrastructure in southern Indiana. It is integrated with southern Indiana's Ohio River Greenway project[7]. The greenway connects the Falls of the Ohio State park, the Big Four Bridge, Jeffersonville's marina, and neighboring Clarksville and New Albany. Funding for portions of the greenway comes from the MPO, Kentuckiana Regional Planning and Development Agency (KIPDA), from grant funding, and from Redevelopment.

[7] The Ohio River Greenway project's goal is to provide a common linkage between the communities of Jeffersonville, Clarksville, and New Albany, Indiana along the banks of the Ohio River and to promote a passive recreational environment for river access, while allowing each community to construct riverfront amenities to enhance the overall project, http://www.ohiorivergreenway.org/.

Opposition

However, despite the success of these and other programs, backlash against increased spending on bike lanes has become a common feature of the political landscape surrounding bicycling. In Indianapolis, some motorists are arguing they prefer their roads free from bikes (Madhani, 2014). City council members argue the money would be better spent fixing the city's infrastructure.

In Louisville, KY, Metro Council members have ordered a temporary stop on bicycle lane funding after the city installed 40 miles of bike lanes in 2014. Continued funding is contingent on the Mayor's office issuing a report on bicycle lane plans for the future (Madhani, 2014). This backlash suggests cities should work carefully to ensure programs are carefully presented to the public with a focus on the mutual benefits flowing from investment in complete streets.

Conclusion

Streets are a necessary and important part of U.S. communities. States, cities, and towns across the country have, over the last decade, increasingly sought to make their roads safer, more accessible, and easier to use for individuals of all backgrounds. In large cities, multi-modal transportation has also seen its own increase in both use and desirability. These projects also make financial sense and provide long-term benefits even with, in many cases, relatively cheap costs. Promoting walking and biking is known to positively affect levels of health, and remain a cornerstone of transportation policies that include equity as a key principle. In short, a well-balanced transportation system is one where individuals have multiple options for meeting their transportation needs. When local decision-makers and stakeholders do decide to plan such a system, they are, in a sense, freeing their residents and constituents to a great extent. Complete streets and multi-modal systems represent powerful, safe, and cost-effective steps towards a more accessible future.

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