Conceptual Model of the Fixed-Guideway Decision Process

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During the last two decades, a number of cities have developed or considered fixed-guideway systems. Because the actions of eight metropolitan areas have been involved in the fixed-guideway evaluation process, a conceptual decision model could be based on their experiences. The decision process for four of the areas—Portland, San Diego, Sacramento, and Santa Clara County—resulted in the construction of light-rail transit systems; two of the cities—Houston and Los Angeles—opted for a system of transitways, and two cities—Milwaukee and Columbus—chose not to develop a fixed-guideway system. The decision process for a fixed-guideway system is a complex interaction of various issues and actors. The principal issues affecting fixed-guideway decision making are social, systemic, and funding. Social issues are external system factors such as economic development, land use impacts, and energy issues. Systemic issues, which are the technical criteria used in alternatives analysis or comparable studies, include capital and operating costs and ridership estimates. Funding issues pertain to the availability of financial resources and their impact on decision making. Actors are categorized as the public (local citizens, including special-interest and community groups), local officials (persons or groups designated to evaluate fixed-guideway alternatives), and institutions (federal and state funding agencies and various state transportation departments and commissions). The case study analysis indicates that technical criteria are not critical factors in fixed-guideway decision making. Instead, the decision process is dominated by political interaction among local, state, and federal officials guided by social benefits, actual or perceived, and systemic issues that influence funding for transit alternatives.

As urban transportation problems continue to mount, cities will be forced to make major decisions affecting the economic and environmental well-being of their communities. During the 1980s, a number of cities constructed fixed-guideway transportation facilities. Currently, there are over 24 cities in various stages of planning and design of fixed-guideway systems (*1*).

The purpose of this paper is to identify key decision factors and issues used in selecting a fixed-guideway system. The findings are the result of a research study conducted by the Center for Transportation Research, University of Texas at Austin, for the Capital Metropolitan Transportation Authority (Capital Metro). The objective of the research was to identify critical evaluation criteria in the selection of fixed-guideway systems. Capital Metro officials anticipated a set of objective technical criteria that could be used for projecting the success or failure of a fixed-guideway system. Eight cities, representing three different decision outcomes, were selected for in-depth study. Four cities—Portland, Sacramento, San Diego, and San Jose—selected light-rail transit (LRT) as the preferred fixed-guideway alternative. Houston and Los Angeles opted for a system of transitways or high-occupancy vehicle (HOV) lanes. Milwaukee and Columbus studied fixed-guideway alternatives and chose not to construct a new system. These cities are identified as "no-build."

Following analysis of the case studies, it was concluded that technical issues did not determine the outcome of the fixed-guideway decision process. Consequently, it was not possible to identify a set of critical values for evaluating alternatives. What emerged, instead, was a conceptual model of the decision process. Within the model, it is possible to identify critical elements and factors affecting implementation of fixed-guideway systems. This model should assist decision makers in their review of fixed-guideway alternatives.

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SUMMARY OF CASE STUDIES

Portland

The Portland Standard Metropolitan Statistical Area has an estimated population of 1.25 million persons (1980 census) under the jurisdiction of more than 40 governmental entities. Formed as a municipal corporation in October 1969, the Tri-County Metropolitan Transportation District (Tri-Met) serves the transportation needs of the urban portions of Multnomah, Washington, and Clackamas counties. Tri-Met is supported by a payroll tax of 0.6 percent (60.2 percent of total revenues), operating revenues (27.2 percent of total revenues), federal operating assistance (4.8 percent of total revenues), and other miscellaneous sources (7.8 percent of total revenues). The district currently operates the regional bus system and the Metropolitan Area Express (MAX), Portland's LRT system.

The decision to construct the MAX was the product of a complex history. Beginning as a crusade to terminate construction of the proposed Mount Hood Freeway, the construction of the 15-mi MAX resulted in one of Oregon's largest public works endeavors (*2–5*). Although decision makers used traditional criteria for evaluating fixed-guideway alternatives, an analysis of the Tri-Met fixed-guideway evaluation process reveals that nontechnical issues were largely responsible for the selection of LRT as the preferred alternative.

Tri-Met officials cited reduced operating costs, based on projected ridership, as a critical issue in their support for LRT

(*3*). However, several factors inflated the ridership projection: (a) high growth, (b) expensive gasoline, and (c) a 10-percent mystique factor. (Not surprisingly, MAX ridership in 1988 was less than one-half of the 1990 projection.) In reality, the decision to implement an LRT system was based on issues other than operating and cost factors. These issues were inferred by the Tri-Met Board, when it indicated that there was strong public support for LRT.

Public support for LRT from the city of Portland was based on environmental and land-related issues. The city had recently completed a transit mall to enhance the redevelopment of the downtown area as well as provide a focal point for transit-pedestrian interaction. City support for the busway, one of the two principal alternatives, was substantially diminished when it was learned that the busway option would inundate the mall with over 500 buses per hour in 1990—the mall's peak-hour capacity is 260 buses per hour. The city was particularly disturbed about the potential noise and exhaust impacts of diesel buses. Another primary reason cited by the city for support of LRT was its ability to focus and enhance the city's development and redevelopment plans. Overall, the city believed LRT would have a positive impact on development. Other municipalities and county officials in the Tri-Met service area cited comparable reasons for supporting LRT.

Although projected operating costs and ridership pointed to LRT as the preferred alternative, in truth, other nontechnical issues were more significant. Strong public support and the availability of funding through reallocation of money from the Mount Hood Freeway, coupled with strategic political maneuvering by state and local officials, determined the fate of LRT in the Portland area.

Sacramento

The Sacramento Regional Transit District (RT) is charged with providing public transportation to over 900,000 persons in the Sacramento metropolitan area. The FY 1989 RT operating budget is $34.5 million. Operating revenues are expected to make up 26.8 percent of the $34.5 million, with passenger fares accounting for 97 percent of the operating revenue. Nonoperating revenues account for the remaining 73.2 percent of the FY 1989 budget; federal and state sources supply 9.3 and 63.3 percent, respectively, and the remaining 0.6 percent is scheduled from other sources.

RT operates two LRT lines in corridors extending northeast (I-80 corridor) and east (Folsom corridor) from the central business district. The combined area of the two corridors was studied for Sacramento's alternatives analysis process conducted during the early 1980s.

A primary factor behind Sacramento's selection of LRT was the broad public support that LRT enjoyed throughout the decision process. The local community, including public officials, believed that the ability of rail transit to focus and guide urban development is an important characteristic of rail transit that is not considered in the technical evaluation. Local officials argue that because of the permanence of rail, LRT has a tendency to attract developers and potential employers to the LRT line and station locations. HOV lanes and buses, which are not necessarily a fixed service, do not have the same ability to attract. Additionally, because the system was primarily constructed within abandoned Interstate and railroad rights-of-way, the effects of construction on businesses and housing were minimal—only eight residential dwellings and three businesses were removed (*6*).

Especially instrumental in bringing LRT to Sacramento was the Modern Transit Society (MTS), which conducted planning studies, remained active on various committees and study teams, and lobbied individual decision makers and groups. Before the draft environmental impact statement was released, the MTS and an RT-sponsored Community Task Force for LRT launched a major campaign to build broad community support for LRT. The community was nearly unanimous in its support for LRT along the two proposed corridors. Overall, 46 different community organizations and the 80,000-member Central Labor Council rallied to the cause of LRT. Indicative of the broad support was a comment by the president of the Sacramento Board of Realtors that support for the LRT option was probably the first issue that his organization and the Sierra Club ever agreed on (*7*). The RT Board and Sacramento Area Council of Governments unanimously supported the LRT alternative, as did 10 of 11 members of the study's policy committee and 8 of 9 City Council members.

Sacramento wanted LRT from the beginning and continued its support throughout the decision process. It was a uniform belief among local decision makers that LRT was technically comparable to HOV (*6*). Key local decision makers believed that the UMTA technical evaluation process and state and federal transportation agency staffs were biased against LRT. Local officials argued that the technical evaluation did not give adequate weight to the less quantifiable positive effects of rail transit, such as improved environmental quality (reduction in noise and diesel exhaust), the superior ridership-generating qualities of LRT, and the ability of LRT to focus and guide urban growth (*6*). The perceived lower operating costs were cited by local officials as an important reason to select LRT.

In conclusion, Sacramento desired an LRT system throughout the study process. The technical analyses did not generally support LRT as the best alternative; however, this alternative was selected because of a strong political and public preference.

San Diego

Between 1970 and 1980, San Diego County was the fifth fastest growing county in the United States. Growing concern over transportation problems culminated in the creation of the Metropolitan Transit Development Board (MTDB) in 1975 to study the feasibility and implementation of a fixed-guideway transit system and to coordinate transit service in the San Diego metropolitan area. Made operational in January 1976, MTDB began the Guideway Planning Study, the beginning of the planning process for the San Diego Trolley, in December 1976 (*8–10*).

Between 1970 and 1975, several planning studies concluded that rail transit should be considered in the San Diego area. Coupled with these studies were state initiatives freeing gas tax revenues and 0.25 percent of the state sales tax for transit. These factors were instrumental in the legislation authorizing the creation of MTDB. The legislation mandated the plan-

ning, design, and construction of a guideway (rail) transit system in the San Diego metropolitan area, thereby precluding the study of other fixed-guideway alternatives. Funding for LRT was provided entirely through state and local sources. (Federal funds, particularly UMTA assistance, were not actively sought because local officials believed the San Diego area could not qualify because of low densities, uncongested highways, and undefined corridors.) MTDB's enabling legislation was initiated by the influential state senator James Mills, a strong transit advocate, who also played a key role in the transit funding legislation.

The acquisition of the San Diego and Arizona Eastern Railway Company (SD&AE) rail line was a key factor in the decision to implement LRT and was also an important factor in the selection of the South Bay Corridor. Once the corridor was selected, rail became a highly viable alternative because the infrastructure was basically in place in two major corridors of the region. The relatively inexpensive SD&AE acquisition (108 mi of rail line for $18.1 million) was important, because the MTDB enabling legislation and the policies later adopted by the MTDB required that the selected guideway technology be low cost.

According to the June 1978 *Final Report: Guideway Planning Project* (*11*), capital costs for the preferred alternative, a baseline bus system with a guideway, were expected to total $116.8 million between 1978 and 1995 ($48.3 million for bus facilities and vehicles; $45.3 million for single-track rail facilities and vehicles; and $23.2 million for land acquisition). Actual Phase I construction costs (including single-track facility, 14 rail vehicles, and land) totaled $85.8 million in 1981, nearly 25 percent more than the $68.5 million estimate. After completion of Phase II construction in 1983 (double-tracking and 10 additional rail vehicles), the total cost of the project had come to $116.6 million. Although the planning estimate of $116.8 million and the final cost of $116.6 million appear very close, the initial planning estimate included all capital costs for bus and rail facilities constructed between the initiation of construction and 1995, whereas the actual total of $116.6 million was the cost of the rail facility when construction was complete in 1983.

With the MTDB restricted to developing a rail system, the primary decisions made during the Guideway Planning Project were the selection of the rail transit technology to be tested (LRT, heavy rail, or automated small vehicle transit), the identification of the corridor in which the alternatives (i.e., the various all-bus networks to be combined with LRT) would be evaluated and eventually implemented, and the selection of the preferred alternative. Within the context of this report, the ultimate choice of an LRT system in San Diego was not a choice of LRT versus busway but a choice between LRT and other rail technologies (as well as LRT in combination with various all-bus alternatives). The choice to implement rail was, in effect, made when the legislature created the MTDB, an agency charged with implementing a rail system.

San Jose (Santa Clara County)

Located at the southern tip of the San Francisco Bay, Santa Clara County had a 1988 population of approximately 1.4 million. The city of San Jose (population 637,000) is in the northern part of the county, known as Silicon Valley, a major electronics and high-technology area. Santa Clara County is currently constructing a 20.3-mi LRT line extending from the sprawling industrial parks of Silicon Valley, through the San Jose central business district, to the populated residential areas south of the central business district.

A large portion of the transportation needs of Santa Clara County are provided by the county. The Santa Clara County Transportation Agency (SCCTA) consists of 10 divisions with responsibilities ranging from planning, operating, and maintaining the countywide bus system to managing and operating the county's three general aviation airports. The county is also responsible for the administration and operation of the area's LRT system. The SCCTA transit service area covers 326 mi^2 and serves a population of over 1.4 million. The primary operating revenue for the transit system is supplied through a ½¢ local transit sales tax. Additional funding is provided by state gas tax money and federal formula money (*12*).

When transportation alternatives for the San Jose area were studied in the late 1970s and early 1980s, the area was experiencing major growth from the evolution of Silicon Valley. Experiencing the heaviest growth was the 16-mi-long, 5-mi-wide Guadalupe Corridor, which will accommodate San Jose's LRT system on completion in 1991.

Implementing LRT in San Jose was primarily a local political decision made, in effect, before the results of the technical study. The study served a secondary function—justifying LRT over a busway on the basis of the opinion that LRT was comparable to a busway, not superior. In the eyes of many local officials, LRT represented an investment in the future of the city.

The LRT alternative was superior to the busway alternative in only 3 of 10 cost-effectiveness measures, all relating to operations and maintenance costs: average 1990 operations and maintenance cost per passenger, annualized operations and maintenance cost per passenger, and incremental operations and maintenance cost per incremental passenger. Additionally, according to local sources, the rising costs and uncertain future availability of petroleum were important factors in the decision to support LRT. It was estimated at the time of the draft environmental impact statement that the local electricity supplier generated approximately 40 percent of its electricity by hydroelectric means (*13*).

It was the local opinion that both alternatives were economically comparable. A statement from the *Guadalupe Corridor Preferred Alternative Report* (*13*), however, emphasized the superiority of LRT by implying that future LRT operations and maintenance costs might decrease beyond the 1990 estimate: "these cost-per-passenger (amounts) . . . are only for a single point in time, 1990, and do not consider any future growth in transit ridership and resulting operating and maintenance costs beyond 1990."

LRT received broad local political and public support throughout the decision process. Several protransit members of the County Board of Supervisors also served on the County Transit District Board of Supervisors and the Board of Control for the Guadalupe Corridor Alternatives Analysis, creating a strong base of political support for LRT. Several groups, including the MTS, were very vocal in support of LRT alternatives, whereas community support for busways was virtually

nonexistent (although there was substantial support for the construction of new highways). Because of the somewhat universal support among the local constituency, congressional support of the project was strong and the project was funded against the wishes of UMTA staff. This strong base of public support and the local politicians' prorail philosophy were the key factors in the decision to implement LRT.

The local prorail political position was bolstered when results of the technical analysis were made public. Although capital costs for the LRT system were substantially higher, the total costs, which included operations and maintenance costs, indicated that both alternatives were "good investment choices." Also, ridership estimates for the two alternatives were essentially equal; however, the fact that the estimates were said to be high tended to favor LRT over busway because of potentially lower operations and maintenance costs per person. This comparability of modes tended to support the ultimate decision for LRT, because the political and community support was present.

The LRT decision would probably have been more difficult if the results of the technical report tended to overwhelmingly support busway. The ridership estimates were made under the inaccurate assumption that fuel prices would continue to increase and that growth would continue at a high rate. Also, as a result of a state appropriation, the expressway segment of the preferred alternative was later upgraded to freeway standards, dramatically increasing the capacity of an overcrowded highway system. If these new trends and the additional capacity of the highway system had been taken into consideration, anticipated LRT ridership would have been lower and, as a result, the ultimate selection of LRT would have been much more difficult to obtain. A statement made by a local official best sums up the San Jose decision process:

> Certainly, our decision to build a light rail system could not be justified on an immediate economic payback requirement. It was by far the most expensive alternative in terms of capital costs. Its initial ridership expectations were marginal at best. But local political leaders were convinced, rightfully or wrongfully, that only light rail would give them the kind of future quality environment and land use pattern they wanted to see happen. And there was a realization that we're probably building this system for our children and grandchildren. But future generations would look back and thank us for the foresight and vision we had.

Houston

The development of the transitway system was a result of the need to improve mobility in the rapidly growing Houston area. With population increasing by 50 percent between 1970 and 1983, Houston grew more rapidly than any city in the United States. Associated with this growth and increasing mobility problems were a 100-percent increase in the number of dwelling units, a 107-percent increase in employment, a 348-percent increase in office space, a 104-percent increase in the number of vehicle registrations, and a 141-percent increase in freeway vehicle miles traveled (*14*). Generally, the transitway was perceived as a cost-effective way to increase the people-carrying capacity of the congested Houston freeways.

The Houston Metropolitan Transit Authority of Harris County (METRO) is the transportation provider for the city of Houston and 14 neighboring cities and towns. The jurisdiction covers a 1,275-mi^2 area, including most of Harris County. The total revenue for METRO in Fiscal Year 1988 was $277.9 million. The operating revenue was $35.1 million, with passenger revenue making up $33.4 million, or 95 percent. Approximately 14 percent of METRO's total expenses were covered by passenger revenue.

When METRO took over operation of the transit system in 1979, METRO staff envisioned a heavy rail system as a means of reducing Houston's growing congestion problems. In June 1983, however, voters soundly rejected the building of a heavy rail line along the Southwest Freeway. The citizens were unwilling to support heavy rail because it was perceived that few people would be served by the costly system. Also, the public generally had a low opinion of METRO. The agency was perceived as spending money unwisely by hiring an excessive number of consultants, and as uncaring and unresponsive in following up on promises made during the agency's formation in the late 1970s.

Prior to the formation of METRO, UMTA agreed to fund the construction of a contraflow demonstration project in the North Freeway corridor in 1978. The North Freeway contraflow lane was considered a success; bus and vanpool patrons achieved an average daily travel time savings of 15 minutes, and passenger use grew from 1,450 person-trips to 4,600 person-trips per peak period during the first year of operation (*15*). Daily ridership increased from 2,900 to 16,500 passengers between September 1979 and September 1983. The contraflow lane, however, was only an interim solution. Several studies indicated that by 1985 or earlier, off-peak travel demand would increase to the point that the contraflow lane would detrimentally affect off-peak traffic operations. Study findings offered the following options: (a) continue the contraflow lane for an indefinite period, (b) discontinue the contraflow lane without replacement, or (c) replace the contraflow lane with a transitway (*15*). Benefit-cost analyses indicated that construction of a transitway was the best of the three alternatives. Finally, in 1982, the state and METRO agreed to develop a transitway within the median of the North Freeway as a portion of a State Department of Highways and Public Transportation (SDHPT) project to rehabilitate the North Freeway.

The failure of the 1983 rail referendum had a direct effect on the development of transitways within the Northwest and Southwest freeway corridors. With the overwhelming defeat of the rail project, the agency was left without a transit project. As congestion grew worse and the agency's poor image deteriorated even further, METRO had to devise a quick solution. A quick solution was also necessary because METRO was about to lose federal discretionary funds earmarked for the rail project. The Northwest and Southwest freeway transitways evolved as an alternative transit project rather naturally because Houston was heavily involved in developing transitways along the Gulf, Katy, and North freeways and had developed a strong working relationship with SDHPT. The Northwest and Southwest projects were similar to the other projects in that construction of the transitways would coincide with the rehabilitation of the freeways and additional rights-of-way would not be needed.

The decision to construct the Gulf, Katy, and North freeway transitways was made during the economic boom of the late

1970s and early 1980s. The decision to develop the Northwest and Southwest transitways, however, was made during the economic downturn of 1984–1985. During the boom periods, the transitways were touted as effective methods for reducing congestion problems along the freeways; however, during the economic downturn, a major selling point for transitways was their cost-effectiveness.

The development of transitways along the Gulf and Katy freeways, as well as the other transitways, was a result of the need to increase the capacity of the corridor within restricted rights-of-way. An important selling point for the initial transitways approved for the Gulf and Katy freeways (as well as for the North, Northwest, and Southwest transitways) was that the transitways would be constructed in conjunction with the scheduled rehabilitation of the freeways. A lower transitway construction cost could, therefore, be realized. The support and cooperation of the Texas SDHPT was instrumental in development of the transitways.

Congressional and UMTA support for the program has been excellent—the Northwest and Southwest freeway transitway projects have been funded approximately 60 percent with federal discretionary grants involving congressional appropriations. Although federal support has been excellent, it was not pivotal in the decision to construct transitways. In the opinion of one key local official, if METRO had been denied federal funding, either METRO or SDHPT would have discovered another method for continuing the building program.

After approval of the Gulf and Katy transitways, the other transitways evolved rather naturally because of SDHPT and METRO's new transitway philosophy. Additionally, after Houston voters rejected METRO's proposed heavy-rail project in 1983, transitways remained the only viable alternative for increasing capacity within the remaining corridors. Bob Lanier, Chairman of the Board for Houston METRO, has been instrumental in the development of transitways. As chairman of the Texas State Highways and Public Transportation Commission, Lanier strongly advocated the development of transitways as a cost-effective means for increasing corridor capacity. Support for METRO's efforts was enhanced through the formation of an ad-hoc "Super-Group" consisting of the mayor, a county judge, and members of the Texas State Highway and Public Transportation Commission, the chamber of commerce, and METRO.

Los Angeles

Transportation service to the 7.5 million people in Los Angeles and the 81 surrounding communities is provided by the Southern California Rapid Transit District (SCRTD). SCRTD, the third largest transit authority in the United States, operates a bus fleet of 2,577 buses over 240 bus routes and a 10.9-mi transitway for a total route mileage of 2,630 mi (*16*). The total Fiscal Year 1987 revenue for the transit district was $490.1 million, less than the reported expenses of $500.5 million (excluding depreciation and loss on disposition of buses). The overall net loss when including bus depreciation and a June 29, 1986, change in the method of accounting for insurance liability claims was $42.3 million. Its operating revenue of $200.9 million made up 41 percent of the total Fiscal Year 1987 revenue, with passenger revenue ($189.3 million) accounting for 94 percent of the operating revenue. Passenger revenue covered 38 percent of the total SCRTD revenue in Fiscal Year 1987.

The El Monte Busway is a 10.9-mi, two-way transitway operating along I-10 (the San Bernardino Freeway) between the community of El Monte to east of downtown Los Angeles. The $60 million facility (in 1972 dollars) opened to buses in January 1973 and to carpools of three or more persons in October 1976 (*17*).

In the 1950s, the private transportation carriers of the Los Angeles region amalgamated into public ownership under the Metropolitan Transportation Authority, later becoming SCRTD. The conversion to SCRTD in 1964 was conditioned by a mandate to develop a rapid transit system for the Los Angeles area (*18*).

It was not until the late 1960s that SCRTD planners and engineers considered constructing an exclusive express bus facility in the congested San Bernardino Freeway corridor (*19*). This corridor was selected as the busway site primarily because improved transportation was needed in the corridor and an infrequently used Southern Pacific Rail Company line was operating just north of the freeway in the wide median. The railway right-of-way was made available after 18 months of negotiation between SCRTD, Southern Pacific, the Public Utilities Commission, and other affected governmental entities.

The project was funded by the Federal Highway Administration (FHWA), UMTA, California Department of Transportation, SCRTD, and the Southern Pacific Rail Company. It became the first project of its kind to be granted federal highway funds. Prior to the funding agreement, FHWA Administrator Frank Turner personally visited the site. (FHWA provided approximately 65 percent of the funds.) This high-level involvement was instrumental in making federal Interstate funds available for transitways within a basically completed stretch of Interstate highway.

The decision to construct a busway in the San Bernardino corridor was based almost entirely on the availability of federal funding and adequate right-of-way, rather than being the result of the type of transportation planning studies or analyses that have been required in recent years. In the words of a knowledgeable participant in the development of this project, "The El Monte Busway was not the result of an in-depth study, addressing a broad range of policy issues. Rather, the project was a response to an opportunity created by the availability of right-of-way. Admittedly, the San Bernardino Freeway has long been congested during peak periods of travel and was a reasonable candidate for a busway." Also, ". . . the availability of funding and real estate (right-of-way) were the determining factors in the implementation of the El Monte Busway."

Milwaukee

The city of Milwaukee, Wisconsin, had a 1980 population of 636,000, accounting for 66 percent of the population of Milwaukee County. Transportation service for the Milwaukee metropolitan area is provided by the Milwaukee County Transit System, operated and managed through contract with Mil-

waukee Transport Services, Inc. The transit system boarded over 68.6 million riders during 1987, with total revenue and expenses amounting to $64.52 million. Its operating revenue of $30.14 million accounted for 47 percent of the transit system's total revenue. Passenger revenue ($29.41 million) accounted for 45 percent of the system's total budget in 1987.

Beginning in March 1979, the Southeastern Wisconsin Regional Planning Commission (SEWRPC) conducted an areawide study of transportation needs in Milwaukee County and the surrounding area. The project was jointly funded by Milwaukee County, the Wisconsin Department of Transportation, and UMTA and guided by a 21-member advisory committee.

Initial work involved the development and analysis of maximum extent system plans for bus-on-freeway (express bus), exclusive busway, LRT, heavy rail, and commuter rail technologies. System plans were also developed for four alternative futures—moderate growth, centralized land use (most optimistic); moderate growth, decentralized land use; stable or declining growth, centralized land use; and stable or declining growth, decentralized land use (most pessimistic).

First-stage analysis produced cost-effectiveness revisions to the system plans and an initial screening of transit alternatives. The initial analysis determined that a commuter rail system was only viable under the most optimistic future and also found that a heavy rail system could not be supported in the Milwaukee area because of high capital costs and underuse of the system's potential capacity.

The final analysis involved an evaluation of the remaining technologies—bus-on-freeway, busway, LRT, and commuter rail (analyzed under moderate growth, centralized land use only)—using final system plans under each of the four alternative futures. The advisory committee concluded that, under each of the four future scenarios, the bus-on-freeway, busway, and LRT alternatives were very similar in terms of ridership (each within a range of 2 percent), potential levels of service, operating and maintenance subsidy requirements, environmental impacts, and systemwide energy consumption (LRT petroleum consumption 5 to 8 percent less than the busway plan and 8 to 11 percent less than the bus-on-freeway plan). The only measurable difference between the three alternatives was the cost required for system implementation. The annual net public cost for the bus-on-freeway system in each future scenario, including capital costs and operation and maintenance costs, was 14 to 21 percent lower than the busway plan. The LRT plan was 7 to 10 percent more costly than the busway plan and 25 to 30 percent more costly than the bus-on-freeway plan (*20*).

On the basis of these study results, the bus-on-freeway plan was judged superior because of the lower costs associated with it. The advisory committee, however, believed that the LRT plan would defeat the bus-on-freeway plan if the intangible benefits of LRT (especially the potential to influence land development and redevelopment) were considered. Consequently, the Milwaukee County Executive and Board of Supervisors requested a study to determine how express bus or LRT improvements would address transportation, land development, and redevelopment needs of northern Milwaukee County.

Initiated in September 1984, the Milwaukee Northwest Corridor Rapid Transit Study evaluated six alternatives—three express bus alternatives and three LRT alternatives. Under Step 1 of the evaluation, the three express bus alternatives and the three LRT alternatives were studied individually to determine the best alternative from each of the two technologies. Step 2 involved a comparative analysis of the best bus and best LRT alternatives.

An alignment using an existing rail line was selected as the best LRT alternative. A primary factor in its selection was a capital cost expected to be $3 to $4 million less expensive than an alignment along West Fond du Lac Avenue and $13 to $14 million less expensive than an alignment along North Sherman Boulevard (*21*). Although less costly and less controversial, however, the railway alignment would be less accessible to patrons.

Public outcry against construction of an LRT line along Sherman Boulevard or West Fond du Lac Avenue was also a factor in the decision to select the North 33rd Street railway corridor as the best LRT alignment. In areas near the North Sherman Boulevard alignment, a division of the neighborhood near the proposed LRT line prompted strong opposition. Similarly, the business community strongly objected to the West Fond du Lac Avenue alignment, primarily because of anticipated problems (such as construction inconveniences and loss of onstreet parking) related to the roadway widening.

In comparing the best LRT and express bus alternatives, express bus was determined to be superior with respect to direct costs and benefits. Compared with LRT, the express bus alternative was expected to provide annual operating cost savings of $2.1 million, an annual reduction in the operating deficit of $2.8 million, and a total capital cost savings of $166.7 million (*21*). Throughout the process, UMTA maintained that the LRT system was not cost-effective and could not be justified over the express bus option. Both alternatives, however, were similar with respect to levels of service and transit ridership.

It was determined that LRT would have a substantial effect on development along the LRT corridor. Corridor area development, however, would primarily involve relocation of existing business rather than attraction of new businesses.

On October 1, 1987, the Milwaukee County Board of Supervisors, as recommended by the advisory committee, endorsed the planning report and the best LRT and best express bus alternatives. The board also endorsed implementation of the express bus alternative. Key to the board's decision to select the best express bus alternative (rather than the best LRT alternative) was federal support for a low-capital project and the noncontroversial nature of the express bus alternative. The lack of a current state program to provide transit system capital assistance was also a local reason against implementation of the LRT alternative. Overall, community support for the LRT option was neutral. The implementation of the best LRT alternative remains an option for the future.

Columbus

The Central Ohio Transit Authority (COTA) provides public transportation service to 895,000 people in the Columbus metropolitan area. In FY 1987, the total COTA revenue was $19.3 million, and expenses totaled $34.8 million (excluding depreciation on assets). Passenger revenue ($6.0 million) covered

approximately 17 percent of COTA's $34.8 million expenses. With depreciation ($5.4 million) included in the total expenses, the district ended FY 1987 with a $20.9 million deficit. (Because of striking vehicle operators and other union employees, COTA experienced a work stoppage between January 1 and February 9, 1987.)

Since the mid-1970s, the Columbus metropolitan region has conducted several transportation studies examining the feasibility of a fixed-guideway system in the North Corridor, an area experiencing rapid development and increasing congestion problems. Two such studies, *A Long-Range Plan for Transit* (*22*) and *Mid-Range Transit Development Concept for Central Ohio* (*23*), recommended the construction of a busway along an existing railroad right-of-way in the North Corridor. In response to the recommendations of *Mid-Range Transit Development Concept for Central Ohio* (*23*), as well as earlier studies recommending similar solutions, UMTA agreed in 1977 that additional study of the North Corridor was warranted. The report was accepted in fulfillment of the systems planning stage of the alternatives analysis process.

Four alternatives for the corridor [no action, transportation systems management (TSM), busway, and LRT] were ultimately studied. Early in the study process, however, UMTA disallowed continued analysis of LRT with federal money because the alternative was not considered cost-effective (*24*). It was argued locally that LRT should be included so that all available alternatives could be compared. As a result, the Mid-Ohio Regional Planning Commission (MORPC) and COTA, with the assistance of a consultant, continued to evaluate LRT with local funding. UMTA continued to disallow the inclusion of the LRT alternative, contending that a number of incorrect and inconsistent study assumptions meant that the LRT alternative could not even be accurately compared with the other alternatives. Later in the study process, the busway alternative also failed to pass UMTA's cost-effectiveness threshold criteria. Neither fixed-guideway alternative was cost-effective, because ridership estimates were too low in comparison to the anticipated capital expenditure. Related to high capital costs was a decision early in the study process to minimize neighborhood disruption and housing relocation. As a result, railroad alignments were considered the most likely alignments for the fixed-guideway facilities; however, the lack of high-density residential areas within walking distance of the railroad alignments translated into low ridership. An additional barrier hindering ridership was created by an Interstate highway paralleling the selected railroad alignment. The busway alternative (53,200 daily linked riders) generated only a 1-percent increase in ridership as compared with the TSM alternative (52,800 daily linked riders). Although the LRT alternative (58,800 daily linked riders) generated a ridership 11 percent higher than the TSM alternative, local officials felt that the capital spent on the LRT system would be disproportionately high compared to the ridership produced.

In December 1985, MORPC and COTA released *North Corridor Transit: Solutions for the Future*, which documented the results of the alternatives analysis. The report, however, did not recommend a specific alternative. During the months before and after its release, support for the entire project was waning. Local political support began to falter because federal funding did not appear to be forthcoming because of UMTA's dissatisfaction with both fixed-guideway alternatives. Also, unlike residents of cities of similar size in the Northeast, citizens of Columbus did not view transit as a primary need. As a result, no official action on a fixed-guideway system was taken, and applications for federal funding assistance were discontinued. In the words of one locally involved individual, the project "went out with a whimper."

Fixed-guideway alternatives were again studied in the *COTA 2000 Long-Range Plan*, completed in January 1988. During this study, each of the region's eight travel corridors were screened for transit compatibility. Using a generic fixed-guideway system operating under ideal conditions, each corridor was tested and evaluated against a standard set of criteria. The results of the initial screening indicated four corridors warranted additional study.

The next step of the study involved identification of fixed-guideway technologies and their applicability to the Columbus region. Using subjective judgment based on the general characteristics of the technologies and the Columbus region, the following guideway technologies were screened: rapid rail, LRT, monorail, automated ground transport (AGT), intermediate capacity transit, suspended rail transit, exclusive busway, and HOV freeway lanes. The guideway technology screening process indicated that LRT and AGT warranted further study.

The LRT technology was tested in two corridors where railroad right-of-way may be available. It was determined, however, that the LRT options were not feasible because of low patronage estimates. A conclusion of the report states that the existing rail lines hold little use as public transit guideways because of the lack of nearby high-density residential areas and employment centers necessary to generate sufficient ridership. Similar conclusions were found for the AGT alternative.

MODEL OF DECISION-MAKING PROCESS

Overview

The case study analysis of these eight cities indicated that the decision to proceed, or not proceed, with a fixed-guideway system was not dependent on a set of technical criteria like those used in the UMTA alternatives analysis. In fact, the selection and development of a fixed-guideway system was the result of a multifaceted decision process. Consequently, attempts to identify critical values for such criteria as operating and construction costs or ridership forecasts, provide little useful information into the decision process for fixed-guideway systems. The case studies indicate that critical values or specific criteria cannot be accurately contrived from the planning or operation data of a facility, because the decision is so heavily affected by issues other than the findings of the alternatives analysis or related technical studies. Also, upon preliminary engineering or after several years of facility operation, the findings of the initial planning studies are frequently found to be inaccurate. Table 1 presents capital cost and ridership planning estimates of LRT systems in comparison with actual values incurred after construction or after several years of operation. Without adjusting for the effects of inflation, LRT capital costs were underestimated between 26 and 174 percent. Similar results are found for ridership. The San

TABLE 1 LIGHT-RAIL CAPITAL COSTS AND RIDERSHIP

LRT System	Forecast Capital Cost ($ millions)	Actual Capital Cost[a] ($ millions)	Forecast Ridership	1988 Ridership
Portland[b]	143.0	214.0	42,500 (in 1990)	20,000
Sacramento[c]	87.7	176.0	50,000 (in 2000)	14,000
San Diego (South Line)[d]	68.4	86.0	28,000 (in 1995)	23,000
Santa Clara County[e]	187.0	511.5	45,000 (in 1990)	6,200

[a]Cost is at opening of project.
[b]Estimates are from the August 1980 Final Environmental Impact Statement (FEIS).
[c]Estimates are from the Draft Environmental Impact Statement (DEIS). The Preferred Alternative Report estimated capital cost at $112.7 million. The 1988 FEIS estimated ridership at 20,500.
[d]Cost estimate represents capital expenses between 1978 and 1985 in constant 1978 dollars. Cost estimate is from the Preferred Alternative Report. Actual cost is based on Phase I construction (SD&AE acquisition, single track, 14 rail vehicles, and construction).
[e]Actual capital cost is the November 1988 estimate to complete the light rail project. Cost estimate is from the Preferred Alternative Report (*12*). Only one-half of the system was operational in 1988.

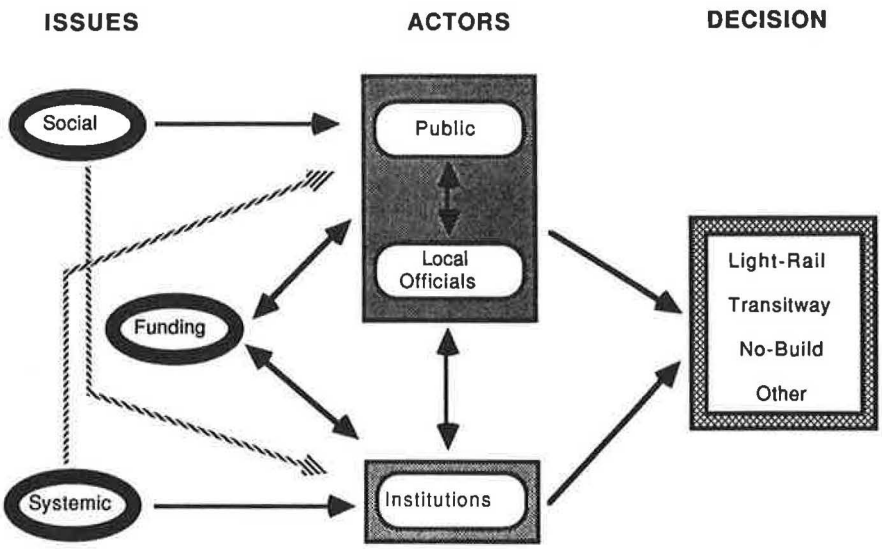

FIGURE 1 Model of fixed-guideway decision process.

Diego South Line, with a planning estimate of 28,000 riders per day in 1995 and an actual ridership of 23,000 riders per day in 1988, appears to be on line in terms of ridership; however, the South Line LRT facility is now a double-track line offering a much higher capacity and level of service than the single-track facility that was originally planned and operated.

There are a number of factors common to the case studies from which to derive a conceptual model of decision making. The model, shown in Figure 1, describes the interaction of various issues and actors in their decision making. Issues generally set the stage or the context for decision making. Actors, who are strongly influenced by these issues, are those persons, individually or collectively, in a position to influence the decision to implement (or not implement) an LRT system, transitway, or transit facility improvement. It is the interaction of these components that determines the outcome of the fixed-guideway evaluation process.

Issues are categorized as social, systemic, or funding related. Social issues are primarily external to the planning and direct operation of the fixed-guideway facility. The potential for economic development, land-use impacts (e.g., removal of housing or businesses), energy issues, and the current or anticipated state of the regional economy are typical social issues. Systemic issues are the traditional technical criteria used in the alternatives analysis or other technical evaluations and include capital and operating cost estimates and ridership forecasts. Funding issues pertain to the availability of financial resources and their resulting impact on the fixed-guideway decision.

Actors are categorized as the public, local officials, and institutions. The public is the general population or constituency of a governmental jurisdiction as well as special-interest groups, community groups, and other organizations. Local officials, principal persons involved in the selection of the locally preferred alternative, are usually elected officials at the city and county level as well as transit board members. Institutions are the federal and state funding agencies, typically UMTA and FHWA, and the various transportation departments and commissions.

The various issues affect actors differently. Social issues primarily influence the desires and perceptions of the public and local officials who would directly benefit (or not benefit) from the implementation of a fixed-guideway system; institutions, however, which are seldom guided by social issues, base their decision to support a project on systemic issues. In each of the three federally funded LRT case study projects as well as the two no-build cities, UMTA did not support the construction of a fixed-guideway facility; the capital costs, operating costs, or ridership estimates, or some combination of these systemic issues, along with other technical factors, did not justify LRT over other alternatives.

The availability of funding affects the local level (public and local officials) as well as the institutional actors that control or make recommendations concerning the allotment of funds. Although the availability of funding is important in the local decision to commit to a major investment, local decision makers have frequently pursued LRT without UMTA financial support. Federal funding, in some instances, was obtained later through congressional appropriations.

Interaction among actors is especially strong at the local level. Seldom have local officials made a decision to support or not support a major capital investment without the support of their constituency. This was particularly true in Milwaukee and Columbus, where there was not active support for a fixed-guideway system. On the other hand, local officials can also be effective in molding public opinion through the news media and community meetings. Interaction among institutions and local officials (and their agents or staff) is common throughout the project planning stages.

Issues

Systemic issues generally pertain to the results of technical evaluation and review studies. Primary systemic issues are ridership, capital costs, and operating costs.

For each LRT case study, actual patronage lagged behind the ridership forecasts (see Table 1). These higher planning estimates usually favored LRT over other alternatives in one or both of the following ways: outright superiority in terms of ridership and lower operating costs. In Portland, a high ridership estimate was strongly influenced by the 10-percent rail mystique factor, anticipated high gasoline prices (which did not come about), and an unexpected recession that severely lowered anticipated population levels. Similar economic conditions in other cities resulted in high ridership estimates for LRT alternatives.

In San Jose, the ridership estimates both for the busway and LRT alternatives were similar; however, the fact that the number was high tended to justify LRT over busway in terms of lower operating costs. Lower operating costs result from the need for fewer train operators, as compared with the number of bus operators, to handle higher loads. Also, the LRT alternative was judged superior to the busway alternative in only 3 of 10 cost-effective measurements presented. All three measurements involved various operating and maintenance costs on a per-passenger basis. In Sacramento, operating cost was the only criteria in which LRT was judged superior, and this factor was promoted heavily by local officials. The results, however, were based on study assumptions that, in conjunction with high ridership estimates, yielded overly optimistic values.

In each of the LRT cities, the capital cost of the completed facility was underestimated (see Table 1). The busway alternative was less expensive than the LRT alternative in both Sacramento and San Jose; however, San Jose promoted LRT by indicating that both alternatives were good investment choices. LRT capital costs were also higher than the other alternatives in Columbus and Milwaukee. The availability of right-of-way was an important factor in lowering capital cost estimates as well as promoting the feasibility of a fixed-guideway facility, even though right-of-way availability did not necessarily promote the implementation of one form of fixed guideway over another.

Social issues affect the decision process but are primarily external to the planning and evaluation studies. These issues are commonly related to the economy, environment, or overall identity of the region.

The ability of LRT to focus and guide urban development was an issue touted by several cities, including Portland and Sacramento. The potential development impacts of LRT in Milwaukee was a primary reason for continued study of LRT feasibility in the Northwest Corridor, even though initial studies indicated that it was not feasible due to excessive capital costs. In all cases, UMTA did not support these local contentions.

Potential impact on properties was also a significant issue. In Portland, public revolt against the construction of the Mount Hood Freeway, which would have removed 1 percent of the housing stock, was a major impetus in mobilizing the search for alternative forms of transportation. Milwaukee business and neighborhood group objections to two proposed LRT alignments that would either remove on-street parking or divide established neighborhoods led to the selection of an LRT alignment that was inferior to other alternatives in generating ridership.

Similarly, the detrimental environmental impacts of buses was an important issue in several instances. City support for the busway in Portland declined when it was determined that the downtown transit mall would be inundated by nearly twice the number of peak-hour buses than the facility was designed to handle and with excessive noise and air pollution. Local supporters in Sacramento felt the superior environmental effects of LRT were given inadequate consideration.

Energy questions were particularly significant for the four LRT systems. Decisions to implement LRT were made during the late 1970s and early 1980s, a period when the future availability and price of fossil fuels were questionable. Because of this uncertainty, electrically powered LRT systems were more attractive to local decision makers and the general public.

The current and anticipated areawide economy has an effect on the local desire to invest in a fixed-guideway system. In San Jose, for example, Silicon Valley was growing at a high rate in the late 1970s and was expected to continue to expand during the 1990s. As a result of the expected growth, high ridership estimates tended to justify LRT over buses because of the potential savings due to lower expected operating costs.

The model identifies funding as another important issue in the decision process. In truth, availability of funding ultimately determines whether or not a fixed-guideway system will be built. The funding can come from a variety of sources,

but it has traditionally involved about 80-percent federal money and 20-percent state and local money. However, there are many examples of local transit authorities using other funding approaches. San Diego, for example, wanting to avoid certain regulations and requirements, did not pursue UMTA funding support. The funding issue and its interplay with the different actors is clearly demonstrated in the Sacramento case study. During and following the evaluation process, UMTA voiced opposition to the LRT alternative, arguing that the high costs and low ridership could not justify its implementation. Local officials, however, backed by tremendous community involvement, overcame UMTA objections by generating congressional support. Local and state officials lobbied Capitol Hill to support funding of their LRT. Resulting legislation bypassed UMTA objections, forcing UMTA to relinquish funds for the LRT project.

Unquestionably, there are a variety of issues that initiate or affect the development of fixed-guideway systems, and it matters little whether the impacts are real or perceived. If the public desires a fixed-guideway system, every effort will be used to effect a favorable outcome. The intangible benefits of rail have frequently been touted as an issue that should be considered when conducting a study of transit alternatives.

Actors

The second part of the model focuses on the actors involved in the decision process. Generally speaking, the public are the citizens, individually and collectively, of a community or jurisdiction. Their importance as actors is demonstrated in a number of the case studies. In Houston, propositions for heavy rail were soundly rejected by voters, forcing Metro to consider less expensive alternatives. Included in the public category are business, special-interest, and community groups. The impetus for LRT in Sacramento began with the MTS, a protransit organization. This special-interest group was formed from a number of community groups opposed to construction of new freeway routes in Sacramento. MTS effectively pressured the Sacramento County Board of Supervisors to abandon new freeway construction in several areas and assisted in the North-East Transportation Task Force efforts, culminating in a recommendation to examine the feasibility of LRT. At the other extreme, neighborhood groups along the North Sherman Boulevard in Milwaukee effectively voiced strong opposition to a proposed rail line. Business groups, fearing patron inconveniences due to construction and loss of on-street parking, similarly opposed a rail alignment along West Fond du Lac Avenue. The public is a critical actor in the decision process for fixed-guideway systems. The case study analysis indicates that when public support was lacking, a fixed-guideway system was not developed, and where support was strong, a system was implemented.

The second group of actors, local officials, are the persons, boards, or other entities responsible for activities such as conducting or coordinating transit planning and alternatives studies, approving or disapproving transit plans, and determining funding sources. Public officials are the elected or appointed agents of the community. In each of the case studies, local officials significantly influenced the fixed-guideway decision process. State Senator Mills played a pivotal role in molding legislation to approve the study and implementation of a fixed-guideway system in San Diego. Neil Goldschmidt, first as Mayor of Portland and later as Secretary of the U.S. Department of Transportation, was instrumental in the development of the MAX. Without his efforts it is unlikely that the MAX would be in operation today. Similarly, Chairman Bob Lanier influenced the development of transitways in Houston.

The final group of actors important in the decision model is institutions. This group consists of federal and state officials, including UMTA, FHWA, Congress, state transportation commissions and departments, and governors. UMTA is an important actor in that it controls distribution of important financial resources for transit systems. In nearly every case study, UMTA played a role, positive or negative, in the decision to build or not build a fixed-guideway system. Likewise, state officials affect the decision process. California Governor Jerry Brown's protransit views were instrumental in making state transit funds available for Sacramento's LRT system. The support of Governor Straub of Oregon and his decision to support the withdrawal of freeway funds and their transfer to a fixed-guideway project was critical to the development of the MAX.

The model indicates that in addition to being influenced by issues, the actors also are influenced by each other. This is to say, the public can influence public officials and institutions, local officials can influence institutions and the public, and institutions can likewise influence the public and local officials. None of the actors operate separately, but instead operate in a complex interrelationship. As noted earlier, the decision to move forward with LRT in Sacramento was influenced significantly by the MTS. Local officials were motivated by the activities of this public group and their perception of strong community support for rail transit. Likewise local officials were influenced by Governor Brown's office and his decision to offer funding for an LRT feasibility study.

CONCLUSION

The model reveals that the activities and interaction of the actors, particularly the public and the local officials, occur during a critical stage in the evaluation of fixed-guideway systems. The interplay of these groups is political. In fact, the interaction between the different groups is the nature of the political process. Before the decision of commitment or rejection is made, these groups are guided by a range of social and systemic issues, either perceived or actual.

At some point, the principal advocates of a fixed-guideway system—one of the three actors, generally the public or the local officials—perceive significant social or community benefits from a fixed-guideway system. In some instances the benefits are seen as answers to immediate needs, such as traffic congestion, and in other instances the benefits are believed to be for the future. In either case, particular actors become motivated to support a fixed-guideway system. This motivation is generally translated into action, such as transit studies, mobility plans, or corridor impact studies. During this process, systemic issues assume greater importance. Capital and operating costs and projected ridership values influence to a large degree the availability of funding, especially federal funds.

Systemic issues guide primarily the institutions in their decision making. The dotted line in the model indicates that systemic issues impact local officials and the public to some degree. Local officials recognize that the systemic issues determine, in large part, the availability of funding. This is particularly true in the Portland example, where original ridership estimates were overly optimistic and were re-estimated at a more realistic and much lower level after receiving funding. After the first year of operation, actual ridership exceeded projections, though it was far below the original estimates used in the analysis of fixed-guideway alternatives. Generally, local decision makers consider systemic issues important when they relate to social benefits. The local decision to support a fixed-guideway system is generally made before estimates of ridership and system costs.

Likewise, social issues influence the institutions, although they are not generally viewed by UMTA as important decision criteria. UMTA focuses on the systemic issues, principally capital costs and ridership.

On the basis of this conceptual model and the analysis of case studies, several important conclusions have been drawn about the fixed-guideway decision-making process:

1. The local decision to commit to fixed-guideway systems is often determined by perceived social benefits that may or may not occur, and it is frequently not the product of an objective analysis of alternatives.
2. Public support for a fixed-guideway system is critical. This support is generally developed during the process of analyzing fixed-guideway alternatives. Lack of support or strong opposition generally results in a no-build decision.
3. Funding availability ultimately determines whether the fixed-guideway system is approved. Where local support is strong, barriers to federal support are overcome, and where funding is readily available, the public is inclined to support.
4. There is not a set of critical threshold values that officials use in selecting among transit alternatives, including no-build scenarios. Instead, the decision process is dominated by political interaction among local, state, and federal officials guided by social benefits, actual or perceived, and systemic issues that influence funding for transit alternatives.

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