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Comparing Modes in Urban Transportation

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Modal comparisons are defined as those studies in which an analyst compares urban transport modes with each other in a generalized framework, attempting to assess relative advantages and disadvantages of modes under a variety of conditions. This paper establishes a link between comparative analyses of transport modes and urban planning processes and generates a basis both for a normative theory of modal comparisons and for a critique of existing works in this field.

An ongoing debate in the field of urban transportation planning revolves around comparative advantages and disadvantages of various transportation modes. It often takes the form of polemics, such as bus versus rail. Considering the variety of conflicting positions and the potential impact of the conflict on policies and investment decisions, a methodological study of this debate is long overdue. The main purpose of this paper, which is a summary of a larger report (1), is to establish a link between comparative analyses of transportation modes and urban planning processes and thus generate a basis both for a normative theory of modal comparisons and for a critique of existing works in this field.

A transportation mode is initially defined as a particular combination of transportation-related structures, vehicles, and strategies of operation. Within the broad setting of urban transportation planning, modes are usually compared in the following specific contexts:

1. When a planner deliberates which modes to include as components of alternative plans for a given urban area (this context will be called a site-specific design of alternatives);
2. When a decision-making body evaluates a set of alternative transportation plans for a given urban area (this activity is expected to end up with a decision or at least a recommendation and will be called site-specific evaluation); and
3. When an analyst compares modes with each other in a general fashion, attempting to determine conditions under which a particular mode is in some sense better than others or to arrive at rankings of several modes under a variety of conditions (studies of this type, which will be called modal comparisons, are usually not site specific although they sometimes make use of data from a single site).

It is customary to analyze decision processes by breaking them down into activities such as clarification of goals, design of alternatives, evaluation, and action. Such activities take place both in the site-specific, urban planning context and in the context of modal comparison; in fact, alternatives considered in these two contexts are similar. Both exercises involve evaluations using similar criteria, and both end with expressions of preference. Nevertheless, they differ in scale and in depth and should not be confused with each other. They also serve different purposes, by answering similar questions from different questioners. Perhaps the most significant difference between them is that modal comparisons arrive at expressions of preference for transportation modes through a technical process and site-specific evaluations arrive at these preferences through a political process.

Modes are what transport plans are made of. The site-specific planner faces numerous possible combinations of transportation structures, vehicles, and operational strategies and, because of time and money limitations, can consider only a few of these combinations in depth. The task will be made easier if he or she is provided with modal descriptions that enable the planner to screen many alternatives quickly and select the few that are promising in a specific context. Comparisons, or descriptions that bring out similarities and differences between the things compared, are well suited for this purpose.

Although the site-specific planner cannot evaluate all modes, somebody must. The design of alternatives for a modal comparison should therefore be based on a structured, exhaustive classification of modes. No single exercise can be expected to compare all, or even many, modes, but it should sample the set of modes in a systematic manner.

Alternatives in transportation planning are evaluated on the basis of their service characteristics, costs, and external (nontransport) effects. There are many ways to select and organize this type of information, including making judgments about which parameters to include, exclude, stress, or deemphasize; choosing between aggregate measures or distributions; and exercising a preference for quantitative or qualitative information. If evaluation criteria used in modal comparisons are to be useful, they should broadly correspond to criteria used in the site-specific decision process.

Evaluation criteria in urban transportation planning have changed substantially in the past 20 years in both theory and practice, reflecting changes in planners' perceptions of what constitutes the transportation problem. Until the mid-1960s, the prevalent view of urban transportation was that of a closed, functional system designed to achieve narrow but precise objectives. Then, as a result of the revolt against freeways and the general increased awareness of environmental ills, urban transportation was recognized as an open system with far-reaching economic and political consequences. Transportation planners became involved with external effects of their alternatives in the areas of distribution and environment. The role of technicians, who (by virtue of recommending the "best" plan) were once the sole planners and decision makers, was diminished by legal requirements for citizen participation in all activities of the planning process. In the emerging planning process, technicians would be producers of facts and alternatives and spokespersons for the unrepresented public interest, but they "must not be the focus of making recommendations" (2). Having come far from its early concern with benefit-cost ratios, evaluation theory now recognized the importance not only of decision outcomes but also of decision processes (3).

The new planning process, here called the open process, differs from the old engineering-economic model of decision making in the following major ways:

1. Functions of the planner and the decision maker are vested in different people.
2. The decision-making body consists of a number of groups that may espouse different value sets and thus different evaluation criteria.
3. Fragmentation of the role of the decision maker rules out any attempt by the planner to propose an optimal solution. The evaluation process is political, and the decision that is eventually reached is a political compromise.
4. Engineering-economic decisions were based on aggregate impacts; open evaluation is based on trade-offs.
5. There is no unified set of goals to guide the planner in the design of alternatives. The final goal set is the product of the evaluation process.
6. To inform and broaden the political debate, the planner deliberately designs alternatives to suit competing goal sets and presents them in a fashion that makes diverse trade-offs explicit.
7. It is understood that transportation projects can be used to achieve nontransportation—i.e., developmental, economic, political, environmental—ends.
8. Engineering-economic decision models required that evaluation criteria be quantifiable and commensurate. These conditions are dropped in the open processes, and the result is fuller descriptions of alternatives (and the risk of overloading decision makers with information).

These characteristics of open decision-making processes are significant for evaluation criteria used in modal comparisons. When site-specific criteria are complex in number and kind, modal-comparison criteria must also be complex. If there is no best alternative in a site-specific context, there is even less chance of one in a generalized comparison. Therefore, the goal of modal comparisons is describing modes in a manner that illuminates the functional, economic, environmental, and aesthetic trade-offs they offer.

EXISTING MODAL COMPARISONS

The archetype of all modal comparisons is that of Meyer, Kain, and Wohl in their study of urban transport (4). The main features of this generalized comparison of automobile with bus and rail rapid transit are as follows:

1. The environment studied is a single suburb-to-downtown corridor during peak hours. Passenger volumes are given and uniformly distributed along the corridors, and almost all traffic is assumed to be downtown oriented.
2. Service standards are developed based on walking distance, waiting time, in-vehicle travel speed, and seating area in the vehicle (substituted for comfort). Because the aim of the study was to examine the case for transit versus the automobile, values for each element are based on what suburban drivers are presumed to expect of transportation services.
3. An automobile system and two classes of transit alternatives—bus transit, including local and other express buses, and rail rapid transit—are designed for the corridor to satisfy the adopted service standards.
4. Conclusions about the relative worth of modes are based on average origin-to-destination cost per seat trip, agency costs for transit modes, and agency plus automobile ownership and operating costs for the automobile alternative.
5. It is concluded that the economic case for transit can be made at one-way, peak-hour design volumes greater than 5000 passengers (at the maximum load point).
6. The comparison between bus-based and rail-based transit alternatives is favorable to the bus. At medium residential densities, bus transit is significantly cheaper than rail for all design passenger volumes. At high densities, the lowest cost curves for bus and rail coincide for all practical purposes.

Several events in the early 1970s made modal comparisons an important field of study. The first new regional rail system in the United States since World War II—the San Francisco Bay Area Rapid Transit System (BART)—was completed after a decade of troubled efforts. A similar system in Washington, D.C. (Metro) was experiencing similar difficulties. During the same period significant federal funds in the form of capital grants became available to urban public transportation projects. Cities such as Atlanta, Buffalo, and Baltimore, which proposed to build rail rapid transit systems, applied for the largest capital grants. Even sprawling Los Angeles had a brief, unsuccessful encounter with rail rapid transit. Significantly, many new modal comparisons coincided with or followed these events. Three large, recent studies are discussed here.

A study by Boyd, Asher, and Wetzler (5) compares three alternatives: (a) rail rapid transit, (b) express buses operating on arterial streets only, and (c) express buses operating on arterial streets during collection and distribution and using an exclusive busway for line-haul. The third alternative is referred to as integrated bus.

The Boyd, Asher, and Wetzler study follows the method of Meyer, Kain, and Wohl but with the following important differences.

1. The restrictive assumption of equal service is dropped. Alternatives are designed to provide different types of service, and these differences are reflected in door-to-door travel times.
2. Alternatives are compared in terms of generalized costs, which consist of agency costs plus time costs of travelers.

The overall conclusion is that, under the study conditions, bus systems have lower generalized costs than rail rapid transit systems.

A study by Bhatt (6) compares 16 modal alternatives, 14 of which are bus and rail systems. The alternatives differ mainly in their method of collection and distribution. The general method of Meyer, Kain, and Wohl is followed but the assumption of equal service is dropped. Bhatt does not follow the Boyd, Asher, and Wetzler method of converting time into equivalent doller costs; instead, results are presented in both cost and time dimensions. The study findings favor bus-based alternatives.

The most technically ambitious effort to date to develop intermodal cost comparisons and draw policy implications was made by Keeler and others (7). [Pozdena's study (8) was done as part of the same project.] Most of their data are site specific and are taken from BART, bus properties, and the highway system in the San Francisco Bay Area. Marginal cost pricing is explicitly introduced (e.g., by charging drivers the marginal congestion costs). The work will be of special significance in transit cost modeling.

In their modal comparison Keeler and others follow in the footsteps of Boyd, Asher, and Wetzler. But they differ in the greater econometric sophistication and the local origin of their data, as well as in the close scrutiny they give to the automobile mode. Their results show that the bus-based system has lower generalized costs than rail rapid transit for all study conditions and lower costs than the private automobile for all but the lowest design volumes. The study concludes, among other things, that BART should never have been built.

All four studies, but especially the last three, appear to prove that urban rail transit has no future. These findings contradict those of a number of site-specific studies in which consultants or local planners recommend rail transit. The four studies reviewed here and similar studies will be referred to in the following methodological analysis as economic modal comparisons because the majority of their authors are economists who emphasize cost analyses while assuming a given demand.

METHODOLOGICAL ANALYSIS

As stated above, the nature of site-specific decision processes in urban transportation determines the nature of the modal comparisons that attempt to inform these processes. If modal comparisons are to inform open transport planning, they should underscore the many differences and similarities (trade-offs) among modes. This analysis of economic modal comparisons focuses on (a) perception of the problem (or goal clarification), (b) approach to evaluation of modal comparisons, and (c) design of alternatives.

Perception of the Problem

The conclusions of modal-comparison studies reveal a tendency to structure comparisons toward picking a winner among modes. For example, Bhatt (6) states: "High performance exclusive busways require substantial investment but are less costly and faster than rail rapid transit in almost all environments and volume levels." This implies that the role of modal comparisons is to help the site-specific planner by eliminating some alternatives. The site-specific design of alternatives would be greatly simplified if such conclusions were considered to be true. The planner could eliminate rail rapid transit and turn all attention to the various bus-based alternatives. Uncertainties facing vehicle manufacturers would disappear, bus producers would enjoy sizable economies of scale, and so on.

What the planner actually needs is information on trade-offs; the above findings offer none (none, at least, between bus and rail rapid transit). It appears that economic modal comparisons attempt to preempt the roles of site-specific planners and decision makers by decreasing rather than enriching their decision agendas. In other words, they solve the wrong problem.

Approach to Evaluation

The belief that such large issues as the elimination of rail transit can be resolved in a generalized study is apparently based on authors' certainty about the correctness of their decision model (9): "The techniques used in this report can be applied in different communities to evaluate economic cost of proposed transportation alternatives, thus providing a basic economic foundation for recommendations." In effect, this is a variant of the site-specific decision-making process, but the site is a flat, featureless plain peopled by commuters who make modal choices with textbook rationality. The community is so homogeneous that there exists a well-defined welfare function. The transport system is an exact replica of a single suburb-to-downtown corridor. The costs are cross-sectional averages, or very particular site-specific cases. Of course the result of these efforts is the best solution, determined under monolithic conditions. The features of the engineering-economic model of decision making are easily recognizable here.

Meyer, Kain, and Wohl wrote their book at the time when these concerns were yet to be strongly articulated among transport professionals. Their decision model is very simple. The client body communicates its uniform service standards to the planner, who then designs to meet the specified standards and selects the design that minimizes total cost. That is, the planner is also the decision maker. The environment of the system enters the model through the description of the corridor (e.g., length, population density) and through the assumption of given demand (presumably derived from a land-use forecast). All cost estimates are cast in a deterministic form requiring literally dozens of assumptions. Transport alternatives are unchanging, as are values. Obviously, this model, which is a prime example of an early engineering-economic model, imposes iron restraints on the design of alternatives. By adopting a service standard for speed, for example, it biases the outcome against a mode that, all other things being equal, could offer a higher speed.

The new wave of economic modal comparisons recognized this difficulty and achieved an improvement by designing alternatives for different service characteristics. But those characteristics must still be translated into travel-time scores. Although the client body may now trade time for money in the model, all travelers must value time at a uniform rate of X dollars per hour where X is taken from studies of current modal choices. By using this rate the aggregate time score of an alternative is converted into dollars and added to capital and operating costs to obtain a generalized cost figure—"a single, comparable datum" (8).

The concept of generalized costs suffers from a number of problems, among them the problem of completeness. Generalized costs are supposed to measure both costs and service characteristics of an alternative but, as long as the average components of travel time are the only aspects of service represented, generalized costs would systematically underrate those alternatives whose advantages lie in other service areas. In other words, the technique is blind to such service measures as safety, reliability, and comfort. This bias would be particularly strong against alternatives that operate on an exclusive right-of-way (rapid transit) or that have elaborate, costly safety devices and practices (rail rapid transit). All service characteristics important to individual modal choice and to the needs of society should be incorporated into generalized costs if this technique is to be a useful tool for modal comparisons. Of course, there are difficulties in measurement and interpretation of measurements, e.g., whether to measure characteristics or perceptions of characteristics. Some concepts are too complex to be captured by a single quantitative measure; this includes even valuation of time, the area in which measurement has progressed the farthest. There is and always ought to be a place and a need for qualitative statements.

Generalized Cost and Individual Modal Choice

In some of the later economic modal comparisons the assumption of equal service (4) was replaced by "equal shadow price of travel time." Both assumptions imply, the second one more weakly, that there is a direct correspondence between group standards, which are represented by the shadow price, and individual preferences for transportation services. Thus, if the client body communicated to the planner that a shadow price of X dollars per hour of travel time should be assumed, then when a system was actually built travelers would be observed using that travel-time value as if they indeed valued time at that rate. It is known from many studies of travelers' preferences that a value put on a service characteristic is not a unique number but a distribution that depends on such things as taste, income, and trip purpose. The assumption of equal valuation is convenient in that it seems to circumvent the need for an explicit model of modal choice; that is, passenger attraction need not be estimated in a modal comparison. Thus, the concept of given demand is implicitly endorsed.

Relation Between Individual and Social Choice

In some aspects of decision making a group may purposely choose a standard different from that of many (or any) of its individual members. For example, empirical research may show that safety plays no role in travelers' choice of mode, that it is implicitly valued at zero, and yet a decision-making body may choose to place a high value on safety and invest accordingly. On the other hand, a group may value some characteristic less than individuals do. Standard practice in economic modal comparison has been to value walking and waiting time three times higher than in-vehicle time (this 3:1 ratio has frequently been observed in actual modal choices). This implies that the opportunity cost to society of waiting time is three times the cost of in-vehicle time. Some modal comparisons are particularly sensitive to this assumption, especially comparisons between systems requiring feeders, transfers, or integrated lines.

Generalized cost, as it is used in economic modal comparisons, is therefore an incomplete and limited measure of service. It neither adequately replaces an analysis of passenger attraction nor reflects group valuation when that valuation differs from individual valuations. Individual transit users, interest groups, local government, and transit operators all have their distinct points of view, and modes cannot be meaningfully compared unless the point of view is specified. Unfortunately, that is not possible in a generalized modal comparison, at least not by means of an analytical approach.

Design of Alternatives

Modal comparisons have paid surprisingly little attention to what constitutes a mode and have not attempted to disentangle relations between the input and output (cost and service) characteristics of alternatives. Indeed, because modal comparisons identify a mode with a particular vehicle technology, as represented by some typical design arrangements, it appears that vehicle technologies, and not modes, are being compared (e.g., rail and bus).

There is some diversity in bus-technology alternatives, particularly in Meyer, Kain, and Wohl, but the typical system based on rail technology is almost always rail rapid transit. Costs for this typical system are usually borrowed from BART or Metro. The impression is given, in fact, that rail transit equals BART or Metro and vice versa. If a study shows that BART is more expensive than a number of bus-based alternatives, a subtle cost generalization is made over all rail-based designs.

Important issues are implicit in the way in which economic modal comparisons select and characterize alternatives and in the conclusions they draw. These issues are discussed below. (BART is frequently used as an example only because it is the best-known, new, large-scale transit system in this country.)

Mode Concept

There is substantial agreement among transportation engineers and planners that a mode should not be defined according to its vehicle technology. A morphological concept of mode connects the portions of service (output) space with pertinent characteristics of inputs such as way, vehicles, and rules of operation (10). Whether these connections (mode classifications) are made coarse or fine grained depends on the purpose of the exercise. For example, by using the following three-way classification a mode could be conceived as a large subsystem of an urban transport system:

1. Degree of exclusivity of right-of-way (e.g., entirely exclusive, partially shared, fully shared);
2. Technology class (type of guidance, vehicle size, dynamic properties, fuel consumptions); and
3. Operational strategy (express, local, or skid-stop; single-unit or train operation; strategy for fare collection; safety procedures).

The virtues of a morphological approach for the systematic exploration of all alternatives in a specific context are well known (11). Detailed accounts of its application to transportation modes are also available (10, 12). What is important here is that the degree of exclusivity of right-of-way, and not the technology class, is the most important determinant of service output. An exclusive right-of-way offers designers and managers the potential to maximize the overall efficiency of transit while emphasizing reliability and safety. This characteristic largely determines the cost of a mode. As discussed above, economic modal comparisons note the high costs but not the corresponding benefits.

In the morphological view of urban transport modes, BART is a regional transit system that operates on a fully exclusive right-of-way and uses rail technology. This same technology can be used for a whole range of modes, some considerably cheaper (light rail, for example) and others conceivably more expensive. A BART-type system could also be less expensive depending on site-specific conditions. It is possible, with numerous advantages and disadvantages, to use bus technology for such a system. Unfortunately, economic modal comparisons do not note these trade-offs. In drawing conclusions, modal comparisons emphasize vehicle technologies, and yet technological aspects are almost totally absent from the analyses. The absence of a clear concept of mode prevents them from making a systematic selection of alternatives. An example is the mismatch that results when BART is compared with freeway flyers.

Technology and Cost

BART is expensive only partly because it uses rail technology. The major share of BART capital expenses can be attributed to such factors as exclusive right-of-way, extensive tunneling, elevated structures, the underwater tube, and lengthy delays in construction. Problems with rolling stock have partly resulted from trying to introduce too many innovations simultaneously. Labor agreements have also had a complicated impact on BART operating costs.

The historic correlation between rail and underground operation is strong. But, in modal comparisons, the expense of the so-called rail alternatives is in great part due to an erroneous identification of rail technology with tunnels. When Keeler and others (7) say it makes no economic sense to build another BART, they are actually saying that it makes no economic sense to dig tunnels and construct underwater tubes. Authors of all recent modal comparisons follow this practice, in spite of a clarifying study by Deen and James (13).

Dealing with costs and other historical data is a complicated matter, especially when cross-sectional data are used to derive averages. One reason is that designs for systems with similar functional characteristics can run from the spartan to the luxurious (e.g., the cost of stations). Another reason is the potential for a learning-curve effect in constructing successive versions of a system or a vehicle.

It is one of the purposes of modal comparisons to inform the site-specific planner about the consequences of choices. To achieve this purpose, historical correlations between right-of-way and costs, technologies and costs, or operational strategies and costs should be examined for causal chains. The subject is a sensitive one requiring substantial research (14).

Another controversial topic is that of the propriety of assigning all costs of a given system to its functional purpose. During the construction of BART, citizens of Berkeley went to court and forced a section of the system that was to pass through the city to be located underground (14). As a result, BART registered a cost increase attributed to environmental considerations. Keeler and others included this item and many like it in their total generalized costs (7). This type of expense ultimately became a part of the cost per passenger.

Some BART stations appear, at least to some people, to be quite lavish. Many rapid transit systems around the world share this characteristic. Although costs may sharply increase because of these embellishments, there is no corresponding increase in performance, especially none measured by generalized costs.

Keeler and others compare freeway-flyer buses with BART on the basis of generalized costs. Historically, the former alternative could have been gradually introduced in the San Francisco Bay Area without any new construction, new route by new route, by purchasing new buses as the patronage increased or by attempting to modestly stimulate patronage. An engineering-economic model could have been used to design and evaluate the additions. If the whole project or some part of it did not work well, one would at worst have some buses to sell. BART, however, is an alternative of a different nature. It is primarily supposed to carry people within the region, but it is supposed to do much more. Correctly or not, it is expected to stimulate a change of activity patterns, even life-styles, in the whole region. The former alternative is an incremental one designed to follow land-use development and observed user preferences. BART is a "big leap," designed to shape activity patterns and change user preferences for transport, and more.

It is clear from these examples that the major tool of economic modal comparisons, generalized costs, is particularly inadequate in the presence of externalities and multiple purposes, especially when such impacts are so large that they overshadow the functional impact of an alternative.

Comparison of Alternatives

On the basis of the previous discussion, comparisons of dissimilar alternatives appear to be full of pitfalls when a single, limited criterion of evaluation is used. The troubles start, however, when an analyst is not deductively aware of the difference in the alternatives. This creates distortions both in the selection and characterization of alternatives and in the choice of evaluation criteria.

The morphological approach to the concept of mode would help in such cases by systematically organizing all alternatives on the basis of a selected set of parameters and the associated scales. Nearness in morphological space (or planes) indicates similarity between alternatives and suggests the proper evaluation criteria. For example, given a fully exclusive way and bus technology, an effective comparison could be made among all operating strategies. Given the current debate about technologies, it might be a good strategy to make many comparisons within the same vehicle-technology groups. Lehner (15) gives an example of this strategy in his comparison of light rail and rail rapid transit.

Comparisons based on the morphological approach would not be global but partial and significantly deeper. Drawing samples from the entire population of modes would aid in the design of coherent research programs that avoid excessive overlapping.

Other Issues

It was pointed out earlier that modal comparisons tend to (a) concentrate on a single downtown-oriented corridor having an insignificant amount of local travel, and (b) treat only peak journeys to work and charge most (or all) capital costs of alternatives to peak use. A few brief comments are warranted.

1. Downtown-oriented corridors that serve no local travel are not the only situation encountered in our cities; neither do they have a special claim on the future. Of course, in comparing modes in an environment of heavy local travel, technological details such as the width of doors, prepayment of tickets, and overloading potential become especially important.

2. To the best of my knowledge, not one economic modal comparison has examined the integration of corridors into a system, especially in the context of transit [although Pozdena (8) did make a start]. This has resulted, among other things, in transfers being treated as an inconvenience rather than an efficient way of connecting zones that lack a direct corridor.

3. The concentration on peak travel to work, including charging capital costs mostly to peak use, and the almost complete absence of references to off-peak travel reveal an underlying assumption that transit exists only for peak journeys to work. Meyer, Kain, and Wohl (4) argue that off-peak volumes are so low that the automobile's advantages multiply "because the avoidance of discomfort, inconvenience, and other travel conditions seem to be more important to off-peak than peak travelers." This is a common way to look at transit, especially if one assumes multiple-car families, fixed values, and short-range planning. Meyer, Kain, and Wohl are quick to point out that new ways of operating old technologies

should be considered; yet they stop short of applying the same wisdom to new values and differently organized cities. Their concepts of equal service and the bedroom corridor are unquestioningly projected into the future. Nevertheless, values change and cities change. Alternative philosophies of transit, assuming different values and transformed cities, should find their way into modal comparisons.

SUMMARY AND RECOMMENDATIONS

The main problems with economic modal comparisons can be summarized as follows:

1. Modal comparisons are not based on a clear understanding of the decision processes in urban transportation but, by implication, on an outdated, engineering-economic model of decision making having well-defined, commensurate goals and guided by criteria of aggregate efficiency.
2. They are oriented toward single-answer, global comparisons that emulate site-specific planning based on the engineering-economic model.
3. When comparisons are global but the site is not specific, there is a need to make numerous assumptions (including idealized environments) and to use average data. These factors frequently affect findings more than do the characteristics of the alternatives studied.
4. Modal comparisons make static, undifferentiated assumptions about individual and social travel preferences and future urban patterns. Their assumption of given demand eliminates the essential aspect of transportation alternatives, which is the comparative ability to attract passengers.
5. The criterion of evaluation, generalized cost, cannot account for some important service characteristics of alternatives nor reflect important externalities. It does not allow for the fact that site-specific evaluation deals with multipurpose projects involving the client, the planner, and the decision maker and that these entities frequently differ about goals and evaluation criteria.
6. Because the selection of alternatives is not based on a clear concept of mode, it is not systematic. Alternatives are often dissimilar in a manner that cannot be measured by the adopted technique; some differences are purely functional, others stem from external effects. Some alternatives represent incremental changes to the current transportation system, and others represent drastic departures.
7. Conclusions of economic modal comparisons are stated in terms of vehicle-technology groups, such as bus and rail. Such conclusions stir unproductive controversy and divert the attention of site-specific planners from more important questions.

It is recommended that economic modal comparisons of the type discussed in this paper be abandoned. To be useful, modal comparisons should

1. Recognize the multiplicity of interests and values among urban residents and that planning requires both projection and vision,
2. Recognize the difference between incremental and large-scale changes in urban transportation and the corresponding difference in evaluation criteria,
3. Recognize that modal comparisons serve to inform site-specific planners about service and cost tradeoffs related to alternative transport designs,
4. Use the morphological concept of mode as a basis for selecting the alternatives to be compared and the evaluation criteria,
5. Allow greater depth of analysis by comparing alternatives with incremental differences in characteristics and costs and thus require the analyst to scrutinize the data and build detailed causal chains between input characteristics, costs, services, and travelers' reactions to these factors, and
6. Leave global, single-answer studies behind and instead perform many partial comparisons (if there is no best plan under site-specific conditions, there can hardly be one under generalized conditions).

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