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Location and Transportation Strategies in Public Facility Planning

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IN PUBLIC FACILITY PLANNING

ABSTRACT

Public facility planning is currently viewed in terms of structuring a service delivery system for optimal provision. Because the spatial process of delivery has been neglected, however, the means of improving service utilization have been narrowly construed as locational in nature. Consequently, facility systems have been modeled and evaluated in terms of supply rather than use, and decentralization has been advocated to the exclusion of alternative spatial patterns. An expanded planning framework regards service delivery as a spatial interaction system and identifies location and transportation as complementary spatial strategies which enhance service utilization and widen the choice of facility pattern. Transportation strategies are more flexible, though, since they directly enhance travel behavior and service accessibility. Moreover, given present planning constraints, transportation strategies have a much wider role to play in improving the effectiveness of future public facility planning and spatial policy.

INTRODUCTION

Growing concern with the performance of public services has fostered a search for alternate ways of improving service delivery. While traditional emphasis has been placed on operations internal to the service organization, more recent attention has been focused on the spatial context of delivery. The importance of this context has surfaced in debate over the relationship between a delivery system and its service environment, and the role of service decentralization (Rein, 1972; Kristol, 1968). A central issue is whether or not the benefits derived from small, locally provided services outweigh those of larger, centrally provided services. Consequently, the planner's task has been defined as identifying the ways in which the spatial orientation of service units influences the delivery of services to users. The problem of service delivery in a spatial context has thereby been rendered as the task of planning a system of public facilities.

The analytical approach to public facility planning that has emerged over the past decade involves modeling the benefits and costs of alternative location patterns for service centers (ReVelle, Marks and Liebman, 1970). Indeed, most of the models pose the planning problem as one of determining how potential service users evaluate the attractiveness of service opportunities with respect to spatial impedances. Thus, at the heart of the present planning approach lies the geographical paradigm of spatial interaction.

But this paradigm has been distorted. A largely structural interpretation has been given to public facility planning and modeling, and consequently the range of spatial solutions to service delivery problems has been unduly restricted. The chief source of distortion is the neglect of the spatial process underlying service delivery. A distinction can therefore be made between current emphasis on location strategies, which identify a spatial form for service opportunities, and transportation strategies, which focus on the means and ability to obtain services provided, but which have been largely ignored.

This paper examines the means by which transportation strategies expand the spatial framework for public facility planning. The argument entails recognition of the role of transportation in shaping the behavioral response to service opportunities; in widening the range of alternative facility patterns; and in contributing to greater spatial effectiveness and equity. The discussion proceeds from consideration of the bases for service delivery and ways to model and evaluate facility configurations, to analysis of alternative location and transportation solutions, framed by facility planning goals. Finally, modeling procedures and the constraints introduced by present planning circumstances are assessed in order to indicate the central role that transportation strategies may assume in future public facility planning.

A FRAMEWORK FOR PUBLIC FACILITY PLANNING

Bases for Service Delivery

Service delivery consists not only of provision or supply, but also of utilization. This conclusion implies that the ultimate purpose of delivery is not to allocate services to facilities but to provide benefits to potential users. For services such as fire and police protection, or parks and libraries, utilization is not as important to the facility planner as supply. The normative principle underlying these public goods is equal availability. This principle implies that, since no one can be excluded, any individual can be assumed as likely to demand and consume the service and to derive the same benefits as any other individual. In sum, basic public services largely emphasize general social welfare without differential impact (Margolis, 1968).

Some services, however, are targeted to particular groups in order to compensate for disadvantages or inadequate levels of resources to meet basic needs. Such targeted services are merit goods, which seek a redistribution of resources in order to reduce disparities in social welfare (cf. Musgrave, 1969; Bernard, 1971). It is therefore essential for the public facility planner to determine not only the spatial distribution of services, such as vocational rehabilitation, senior citizen or mental health care, but also the extent to which the disadvantaged utilize and consequently benefit from their availability.

Spatial Interaction and Service Utilization

The spatial interaction paradigm provides a general framework for considering both provision and utilization of services in a spatial context. The paradigm poses the level of interaction between service opportunities at particular locations, on the one hand, and a spatial distribution of potential users, on the other, as dependent upon how the benefits of service opportunities are evaluated with respect to the costs associated with overcoming spatial separation (cf. Olsson, 1965). The principles underlying interaction for any user-opportunity pair are: (1) complementarity: demand is congruent with supply; (2) transferability: spatial impedances can be overcome; and (3) absence of intervening opportunities; no equally attractive opportunity lies closer to the user (Ullman, 1957).

A model of service facility utilization can be constructed along the lines of this spatial interaction paradigm, in terms of characteristics of the planning problem. These characteristics will index the benefits or attractiveness of opportunities and the costs or the nature of impedances to obtaining services, along with the form of the evaluation procedure as construed by particular user groups. In the context of comparative urban services evaluation, the model will characterize the level of aggregate utilization (U) as a function of characteristics of facilities in a service system (F), travel effort (T), and characteristics of users that identify differential response or differential evaluation of opportunities and effort (C):

$$U = f(F; T; C).$$

For analysis of individual services, dimension F (characteristics of a single facility) is treated as a parameter and does not enter the analysis directly.

The model is a way of estimating levels of service utilization based on the likelihood that a given person will choose a service opportunity. It also provides a behavioral view of service delivery. By reflecting the manner in which potential users evaluate the net benefits of services provided, the planner's model captures the interaction that takes place between service providers and service clients. The nature of the interaction is a response to what is offered, given the balance between the attractiveness of services and the spatial impedances to obtaining them.[1]

Evaluating Service Delivery

The spatial interaction paradigm and the resulting spatial utilization model also yield a procedure and a criterion for evaluating alternative facility plans. The procedure consists of identifying the level and distribution of interaction with the delivery system; i.e., the number and distribution of disadvantaged individuals obtaining particular services. The criterion, in turn, measures the system's accessibility. The concept of accessibility defines the ease of spatial interaction (service utilization), and indexes the effort or cost involved in obtaining service opportunities, where the latter reflect the level and pattern of potential benefits associated with the facility configuration under study (Hansen, 1959; Harris, 1966).

Accessibility is thus a means of indexing the spatial effectiveness of service delivery. By examining alternative public facility configurations in terms of actual or potential levels of utilization, determined by the interaction model, the facility planner can compare spatial strategies on the basis of outcomes rather than outputs.[2] What remains to be determined is the operational form that accessibility should take and what its contribution might be in a practical planning context. Since the concept is quite general, it is apparent that different planning strategies may generate alternative operational specifications, which could lead to different assessments. Indeed, this difficulty is precisely what has occurred in current public facility planning with its emphasis on locational solutions.

LOCATION STRATEGIES

Orientation

Location strategies for public facility planning are structural in nature. They focus on the organization of service opportunities for given demands or needs, and consequently yield a spatial ordering of service facilities. In essence, the facility configuration (number, location, and attributes of facilities) is construed as the policy instrument for determining outcomes of the delivery system model. Locational strategies, therefore, seek to enhance the attractiveness of service facilities to potential users by manipulating facility variables, while treating spatial impedances to utilization as the contingent result of the location solution selected.

Evaluation of public facility plans is framed by alternative location patterns, and the criterion of accessibility is employed to measure the impedances to user interaction within these patterns. Conceptually, the impedance measure is associated with travel to services and represents a generalized cost of travel. Operationally, this generalized cost is assumed to be a univariate function of travel distance, travel time, or an estimated opportunity cost of travel. Any facility location plan can thus be evaluated by a single, aggregate value of impedance (Massam, 1975).[3]

Locational strategies for public facility planning are clearly reflected in current facility models. For example, in Scott's (1970) location-allocation models, the evaluation criterion is implicitly physical accessibility, and optimal solutions are achieved by minimizing overall distance or cost separating facilities and demands. The models for central facilities location presented by ReVelle and Swain (1970) and Rojeski and ReVelle (1970) similarly attempt to establish optimal public facility locations which "minimize the average distance or time that the users take to reach the facilities [....] equivalent to minimizing the total population-time or population-distance" (Rojeski and ReVelle, 1970, p. 343). Even in welfare-oriented approaches, such as Wagner and Falkson's (1975) model, the solution is derived in terms of location pattern and the number of users, both of which depend upon how users evaluate travel cost relative to their "willingness-to-pay" for services. In sum, current facility models emphasize locational strategies and choose particular plans by measuring the level of impedance resulting from given locational solutions.

Alternative Solutions

The full range of potential location solutions is not represented by public facility models, however. The majority of these models are concerned with specifying entire facility system configuations; they seek <u>equilibrium</u> location patterns. A more complete set of solutions considers locational options for individual facilities as well as for the entire facility system.

Indeed, the planning context will more often consist of an existing system of service facilities which requires adjustment. The motivation for adjustment may be an expansion or redistribution of service demand, the desire for improved service effectiveness, or an increase (or reduction) in the service budget.

1. Individual Facility Options. In situations where the areal distribution of service need or demand shifts in relation to an exisiting pattern of services, or where the service budget is revised, location strategies will likely be addressed to individual facilities. There are three basic options. (i) Creation: a new facility can be added to the system and located with respect to an area of unmet need or demand. (ii) Elimination: an existing facility might be closed when local demand no longer supports it, or when the service budget is cut. Or, (iii) Re-location: an existing facility may simply be re-located to cover a shift in the demand distribution. Clearly, then, all of these location options represent short-term adjustments to facilities within a delivery system and offer a flexible response to changing local circumstances regarding supply or demand.

2. Facility Pattern Options. In cases where service policy or the philosophy of service delivery is revised, longer-term and more fundamental changes in the service facility pattern may be called for. The impetus may be a drastic change in the service budget, adoption of a new service delivery or benefit model, or allocation of resources to a new kind of service to be delivered. Thus, rather than pursuing local adjustments, location strategies will be concerned with changing the entire spatial organization of service delivery.

Considering the current assumptions of additivity and disaggregation in facility benefits,[4] the rationale for a decentralization strategy appears to be well-founded. Organizational patterns that make individual services more available and convenient, by locating more facilities at closer distances to user groups, promise greater accessibility to services by increasing their individual attractiveness and by reducing the overall level of travel cost involved. Such a strategy is purportedly more responsive, to the extent that service programs can be tailored to local service needs and circumstances.

By emphasizing the benefits to be gained from service facility dispersal, public facility models argue for this kind of strategy. Indeed, the models have been criticized for not going far enough in this direction, by ignoring variations in social disadvantage and thus ignoring spatial equity. D. Hodge and A. Gatrell (1976) have argued that facility patterns should be dispersed not just with respect to estimated demand or need but with respect to the "size, shape, and arrangement of residential areas of social groups" (e.g., income classes) seeking services, in order to achieve both spatial effectiveness and spatial equity. Despite the value of disaggregating service demands to capture welfare differences, this added criterion for distributing public facilities still displays the same structural orientation to service delivery as other facility models. Thus it can be considered a sophisticated form of decentralization and a logical extension of the locational approach to facility planning.

Critique

Locational approaches seek to reduce impedance in the aggregate in order to increase physical accessibility. The assumptions underlying this objective is that facility configurations and their attractiveness attributes are more variable and that travel costs are not directly manipulable. But in thus emphasizing appropriate delivery structures, location strategies have contributed very little to delivery process. The spatial interaction model has been narrowly interpreted: utilization has been construed as simply a response to provision, rather than as a form of interaction between provider and user and something the planner is able to directly influence. In short, location strategies, by themselves, are more provider-oriented than fully delivery-oriented.

The locational models suggest the nature of the problem. Most of them lack a specific utilization function, particular the kind that might be subject to policy manipulation. In seeking equilibrium solutions for the entire facility system, the incremental and often disjoint nature of many facility planning problems is not addressed. The model format itself, with its emphasis on generality without accompanying identification of the complete service process or impact, can hardly specify the full range of delivery contingencies that lie within the service environment as well as within the service system.

It is precisely the interpretation of impedance and travel cost which must be revised. In its univariate functional form (generalized or not), current measurement of spatial impedance assumes a behavioral response and accompanying level of travel effort that apply equally to all potential users.[5] Variations in travel resources and travel effort are thereby assumed away. Moreover, while impedances due to travel may be (partially) represented, alternative means of conveyance, modal options, and travel behavior are not. The immediate conclusion is that an expanded set of spatial strategies must seek to clarify the variety of transportation impacts and establish the linkages between impedances, accessibility, and mobility.

But the use of spatial strategies also must be clarified. If a disaggregated and differentiated approach to facility planning is adopted, then both assessment and implementation of design proposals must be addressed. This expanded planning purview includes how services are to be delivered through a facility system in a practical context; how facility plans are to be more responsive to service needs and service users; and how delivery systems can adapt to changing service conditions.

The immediate issue, therefore, is not what utilization of services might occur, but how facility planning can promote utilization of the fullest extent. This problem is especially pertinent for welfare-oriented services and human services. The choice is to view the delivery system and its accompanying spatial policy as a "passive" structure that relies on people to evaluate its benefits relative to their own abilities to overcome impedances which are differentially borne, or to assume an "activist" orientation in which strategies that improve the ability to overcome impedances are coordinated with locational alternatives. Both approaches are spatial, but the transportation option may be able to enhance service effectiveness over and above what the location option has thus far achieved.

TRANSPORTATION STRATEGIES

Orientation

Transportation is accurately regarded as a means to an end, rather than an end in itself (U.S. DOT, 1977, p. 5). The true ends are activities and opportunities, and transportation strategies are concerned with the process of obtaining them. In facility planning, transportation strategies complement location strategies. While the latter are designed to improve overall attractiveness by adjusting the spatial organization of facilities, transportation strategies are designed to directly reduce the differential impedances to utilization. The intent of transportation strategies is to address the heterogeneity of the transportation domain and to evaluate transportation resources and travel behavior in addition to travel costs. Not only is the spatial structure of service delivery thereby altered, but service utilization is identified as a process that can be manipulated.

The rationale for any transportation strategy is the principle: *the ability to use available services presupposes the mobility of the user.* Mobility is a descriptive characteristic of user groups identifying their potential for travel (Stanley, 1975; Burkhardt and Eby, 1973). This potential is a reflection of patterns of travel behavior based upon: (1) individuals' preferences for pursuing various activities; (2) their options for, and the availability of, various travel modes; and (3) their travel resources (Paaswell and Recker et al., 1975).

Because a large part of individual travel behavior appears to be constrained by existing aggregate travel patterns, trip-making actually consists of a discrete rather than continuous set of alternatives. Whether due to preferences based on convenience or to constrained resources or simply to behavioral inertia, substitution possibilities between different travel modes are quite limited (Paaswell and Recker et al., 1975; Paaswell and Berechman, 1976). The implications of this "lumpiness" of trip-making is that mobility may attach less to particular activities or spatial opportunities than to the general travel behavior of different groups in the population.

Planning Tasks

In developing transportation strategies, the first task is to identify mobility differentials. Thus, the service population is sub-categorized based on a determination of relative advantages in travel ability, and those individuals for whom inadequate mobility exists are consequently classes as travel disadvantaged (cf. Revis, 1975; Kinley, 1973).

Attention to travel disadvantage has two implications for facility planning. First, with the use of an index of travel disadvantage, the service population is disaggregated not only by social disadvantage or service need, but also by specific mobility conditions, such as the availability of alternative travel modes and of resources permitting interaction with service opportunities.[6] Secondly, inclusion of travel disadvantage and mobility differentials in facility planning forces the nature of spatial impedance to be redefined. In the face of alternative evaluations of impedance implied by heterogeneous travel behavior, a single travel cost.function is no longer tenable. By noting the multi-modal character of mobility and the multiple options for dealing with impedances, this analysis makes clear that facility plans will have to be oriented not only to a tableau of travel costs but also to particular forms of travel to services.

A second planning task is therefore to detail the impacts of transportation networks, whether recognizing a dominant mode (e.g., automobile) or multi-modal travel. Analysis of transportation networks stresses public facility planning in a discrete space, where facilities are oriented to the transport links, junctions, and route configurations for particular travel modes. The first implication of this more realistic view of the spatial context, already acknowledged by some researchers, is that travel costs must be calculated with respect to particular street metrics and to their capacity and congestability (Perreur and Thisse, 1974). More importantly, though, this view implies that the process of service delivery itself will have to be redefined in terms of the mobility restrictions that travel networks impose on potential service users.

Route configurations have a double influence on the spatial context of facility planning. First, they redefine spatial impedance in terms of particular travel mode/travel network combinations that can be readily used by individuals in particular mobility circumstances. Second, route configurations re-orient location solutions towards the discrete spatial structure and orientation of these networks as they are shape by aggregate travel behavior and mode choice (cf. Taafe and Gauthier, 1973, Chpts. 4 and 5). For example, in the majority of urban areas, the major auto routes and the total pattern of mass transit converge on downtown districts

(Thompson, 1977). Thus, while facilities located in central city areas may appear to be biased when examined in pure distance or locational terms, they may be suitable when considered as an accommodation to transportation networks and travel behavior.

Evaluation

When transportation process and structure are included in a planning framework formerly governed by locational considerations, the analytical problem of whether or not a given public facility configuration is appropriately situated requires a different calculus. The same evaluation criterion is relevant, but inclusion of new planning elements forces a reinterpretation of accessibility.

Whereas in a purely locational approach to service delivery the accessibility measure was taken to be travel cost, an expanded approach evaluates both the cost and the means of travel. It has also been suggested that ability to use services implies mobility of users. The logical extension of this dependence in an evaluation scheme is the principle: *accessibility to services presupposes accessibility to transportation.* In other words, the ease of interaction with services is dependent upon mobility and the ease of obtaining and using appropriate means of travel (Mouchahoir, 1974).

A transportation approach to facility planning implies that, because mobility is essentially a judgement regarding relative travel advantages, and because mobility underlies the expanded sense of accessibility, an index of accessibility can never be objective. Any index of accessibility will be open-ended and more appropriately considered with respect to a specific context of evaluation. For locational solutions--which may be suitable in certain circumstances and for certain categories of service delivery--an accessibility measure that indexes travel cost may indeed be sufficient. For transportation or joint solutions--which appear more appropriate for human services delivery--an expanded index is in order. The facility planner must recognize, however, that in either case such indices require greater justification and discretion for their use.

Alternative Solutions

Depending upon judgements made concerning the extent to which service utilization will be directly facilitated, three sets of alternative transportation strategies can be isolated for consideration.

1. Network Solutions. Strategies that fall within this category seek to enhance service utilization by more closely coordinating service provision with existing travel patterns and prevailing route configurations. For example, in recognition of the dependence on public transit of potential service users, delivery systems may be able to alter transit routes, stops, and/or scheduling in certain service areas (for example, central city districts) in order to accommodate established service facility locations (Hoel, 1968). Such an option is particularly relevant for public bus systems.

More often, the location solutions outlined previously can be modified with respect to existing route configurations (public or private), and can thereby create facility systems that are adapted to the transport structure of urban areas. Two options are implied by this approach. One option involves identifying the dominant travel mode (or travel constraint) in a given service area and locating service facilities with respect to its configuration. In large urban areas, the dominant network may be mass transit (rail or bus), and facilities would therefore seek transfer points between transit modes, or sites where several major route patterns converge. In suburban areas, on the other hand, the dominant network will often be automobile oriented. Consequently, facilities would be located with respect to major thoroughfares or highway junctions.

The second option involves accounting for aggregate travel patterns, the purposes of traveling, and clusters of trip-ends. The aim of this transportation strategy is to locate service facilities with respect to areas that are focal points for activities and route configurations. And because networks largely reflect activity focii, the strategy actually implies concentrating services in transport-central areas, such as downtown or major shopping districts (cf. Hoover, 1968).

In fact, this second option challenges the appropriateness of any service decentralization strategy that ignores activity patterns. Because most people, disadvantaged or not, have a variety of trip-purposes to satisfy, it may prove beneficial to locate public or social services in areas of high consumer activity which are served by various transportation networks, in order to take advantage of multi-purpose trip behavior on the part of potential users (Virirakis, 1972). Indeed, a dominant pattern of clustered service facilities can be observed in many central urban areas, suggesting an application of this "shopping center" principle to service delivery (White 1977, 1976).

2. Behavioral Solutions. These solutions emphasize how individuals reconcile the desire for services with the ability to use transportation. While such solutions include promoting carpooling of service users and teaching individuals (such as the retarded and handicapped) to use transit, the chief option is to alter travel preferences and choices by reducing the monetary costs of travel. Here, utilization is directly facilitated by "subsidy". A special subsidy program would pay or reimburse service users on the basis of travel disadvantage, and specific transit systems might be favored by arranging for reduced-fare vouchers or full-cost passes (U.S. DOT, 1976). The planning assumption would be that many potential service users are dissuaded from traveling to services due to the monetary costs of travel (especially for public transit). Consequently, service utilization could be increased by the prospect of monetary compensation.

3. Paratransit. There are two issues which may not be addressed by the above transportation strategies. First, efforts to reduce the monetary costs of travel for particular users based on their immobility or their limited travel resources may still leave high convenience or opportunity costs to dissuade utilization. Second, the assumption that potential service users have some mobility options or advantages independently of their social (service) disadvantages is disputable given available data. All too often, the presence of service needs is linked with transportation disadvantage (Falcocchio and Cantilli, 1974). In a transportation context, the notion of multiple and interacting disadvantages implies that existing transit systems are inadequate (even when directly subsidized) as a means of facilitating service use. The alternative is to create an independent system.

The purpose of special transit systems, or paratransit, is to provide a limited capacity, "demand-responsive" transportation service to meet specific travel requests. In a few cases, it may be a generalist service, providing door-to-door transportation for any individual within a given area. More often, the intent of paratransit is to serve the special travel purposes of disadvantaged groups, such as the poor, the elderly, and the handicapped (Kirby et al., 1975; Higgins, 1976). The planning effort, therefore, involves not only identifying who among the population of service need is transportation disadvantaged, but also who will be responsive to paratransit.[7]

Two basic planning options are available. Because many cities already have one or more paratransit operations, there may be an opportunity to "subscribe" to one operation and have its coverage extended to include the service system being planned. Alternatively, special service agencies might pool their resources and create a common, special transportation system that delivers clients to one or more facilities. Such coordinated, multi-agency use of paratransit promises economies of operation and efficient use of equipment and personnel.

However, there are admittedly few examples of current inter-agency coordination (Brooks, 1976; U.S. HEW, 1975). The alternative is therefore to establish an independent, agency-operated paratransit system that serves only a particular service delivery system. Such an approach runs the risk of creating overlapping but mutually exclusive transportation services in areas of multiple service delivery. But it also has the advantage of being tailored to the particular service system's and its users' own travel and scheduling requirements.

The paratransit strategy offers advantages that other transportation strategies cannot match. On the one hand, paratransit is a transportation approach that frees up the choice of facility location strategies. Either impedance costs can be reduced to a minimum by using paratransit in conjunction with "optimal" dispersal of service facilities, or impedance can be traded off against alternative patterns that take full advantage of all factors contributing to service attractiveness. On the other hand, by linking the distribution of service needs with the distribution of travel needs, and by matching these needs with available services, the paratransit option is capable of addressing the issue of spatial equity (Hodge and Gatrell, 1976; Morrill, 1974; Mumphrey and Wolpert, 1973). What remains to be seen is whether this option or any expanded spatial strategy can help public facility planning move beyond current idealized models towards practical spatial settings and solutions for service delivery problems.

SPATIAL MODELS AND SPATIAL REALITIES

Given the way alternative spatial strategies have been framed with respect to a common delivery model (spatial interaction) and a common evaluation criterion (accessibility), it is obvious that location and transportation strategies are interdependent. Transportation solutions would make little sense without a facility location patterns, and location solutions cannot be considered apart from their orientation towards networks and travel costs. Furthermore, the spatial context of service delivery implies some means of transportation, realistic or not, with respect to which impedance is evaluated. In turn, evaluation cannot proceed--and travel costs cannot be measured--without some method of selecting and testing alternative facility configurations.

But in either a modeling or a planning sense, the simultaneous and interdependent view of the delivery problem must be exchanged for a more analytic relationship in which the two sides of the problem can be treated iteratively or sequentially. The decentralization principle itself argues for incremental single-facility location determination by emphasizing exclusive service systems and service areas. Thus, issues of appropriate "grand-model" form and the evaluation procedure required for comprehensive study of spatial effectiveness, are relevant only to long-range facility planning. The more pressing questions are: what facility model format is suitable for practical, short-term planning, and what specific spatial strategies should be emphasized in today's planning circumstances?

Expanding a Simple Location Model

The first question can be attacked by considering what analytical elements relevant to short-term planning need to be represented in a facility model. Two planning situations are envisaged. A service system in place is the usual situation encountered, and the minimum elements include: (1) the spatial distribution of need and of utilization (both identified at a sufficiently small spatial scale, such as by census tracts);[8] (2) the current pattern and capacity of public facilities; and (3) the spatial arrangement of service areas (collection of census tracts) for each facility. Only in a few instances will targeted services not follow some "catchmenting" scheme (Huffine and Craig, 1973). (This approach, of course, reflects the principle of decentralization.) The second, more infrequent planning situation is where an entirely new service is being established, but the planning problem will also be structured by prior delineating of service areas within which one or two service units will be located. Here the data will consist of the spatial distribution of needs, and the service "technology" or organizational form which indicates, for a given budget level, what alternative combinations of (limited) number and scale (capacity) of facilities are feasible.

The means available to guide the location procedure comprise the next set of planning elements, and consist of: (1) the organization of data, and (2) the criterion adopted to evaluate alternative locations. In its simplest form, the criterion will still correspond to the spatial interaction model for service delivery. But in light of practical planning circumstances, this criterion indexes the accessibility of individual public facilities. Thus, a simple location model can be initially assumed and subsequently modified by the planner.

For an incremental approach, a simple location model identifies the "best" facility location with respect to a given distribution of need, by determining the mean or median facility location indicated by some measure of accessibility. Where service area census tracts are indexed by i, and possible facility locations are indexed by j, the model seeks the nodal location (e.g., census tract centroid) to which service users can travel with minimum aggregate (or average) effort. Assigning a weight to each origin tract associated with the number of persons estimated (or known) to be users, w_i, and calculating the individual accessibility of a facility tract for a users' tract as a function of simple spatial impedance, $a_{ij}=w_i\, f(d_{ij})$, where d_{ij} is distance, that location i sought which maximizes accessibility, i.e., minimizes aggregate, weighted distance:[9]

$$\underset{j}{\text{MIN}} \sum_i a_{ij} = \sum_i w_i \cdot f(d_{ij})$$

This model provides the simplest basis for evaluating present or proposed, individual public facility locations. With regard to present locations, moreover, it is possible to measure the deviation from an optimal location and thus assess the "accessibility loss" or additional impedance imposed by a non-optimal location (White and Berger, 1974).

But the previous discussion of spatial strategies has indicated the drawbacks of such a purely locational approach and of a reliance on simple accessibility measures. For one, the delivery basis for merit goods and human services argue for establishing both the numbers in need of service and the intensity of accompanying disadvantage. Thus the model's user weights will be supplemented by welfare weights, which might index socio-economic conditons correlated with service and social disadvantage. These weight would sensitize facility locations to heterogeneity within the service area and would prioritize service needs to be addressed.

The further implication of an expanded service delivery context is that accessibility can no longer be equated with simple impedance. Consideration of travel distances for actual travel modes over transportation networks is the first improvement. Another improvement would be to use travel time within networks. The more general and more difficult measure, however, would be mode and network-related travel costs.

Ideally, though, measures of spatial impedance should reflect both direct costs, which index what must be paid to reach services by alternative means (modes), and indirect costs which reflect what individuals, differentially disadvantaged, are able to pay. The problem is thus not one of efficient location and pricing. In the face of travel disadvantages, spatial equity (i.e., equalizing the opportunity and the ability to pay for service) and spatial effectiveness (maximizing utilization) are to be sought by incorporating both available resources for transportation (e.g., income) and differential mobility (e.g., automobile ownership and availability of convenient transit) in the facility location criterion, namely the index of accessibility.

The above expansion of a simple facility location model suggests some of the ways in which the facility planner can represent the social and spatial complexities left out of current models. But given the level of improvement represented by this simple scheme the limitations of it should be acknowledged. Even an expanded facility location model cannot substitute for independent analysis of the delivery process and alternative "active" transportation strategies, such as paratransit. Indeed, it may be useful only as an evaluation procedure rather than as a facility configuration-determining tool, given present planning circumstances.

Obstacles to Current Facility Planning

Once the spatial context and the planning methods required for particular service delivery problems are understood, the remaining task is to identify the specific spatial strategies suited to particular circumstances. It is increasingly clear, however, that there are several obstacles to current facility planning which narrow the choice of spatial strategies. In fact, the constrained sense of spatial reality that results implies that "pure" location options and the rationale behind them (i.e., decentralization) may not address the essence of the service delivery problem.

1. Fiscal Instability. The present decade has witnessed a clash between expectations for increased output and performance from the public sector on the one hand and severe limitations or reductions in public resource allocation and distribution on the other (Yarmolinsky, 1968; Palley and Palley, 1977, Chpts. 3, 5, and 11). As a result, many service programs now confront fiscal uncertainty or retrenchment; few still face open or expanding budget levels. Consequently, few facility planners have sufficient funds at their disposal to permit facility re-organization. Individual service facilities may be shifted but only at a sizeable cost which must be entirely borne by the service agency.

2. Dynamics of Service Need. Largely ignored in current planning approaches is the problem of accommodating a service population whose spatial distribution of need changes over time. Insufficient attention has been given to modeling the combined demographics <u>and</u> socioeconomics of intra-urban mobility of the disadvantaged; thus planners have few means upon which to predict future spatial distributions. As a consequence, rather than <u>anticipating</u> shifts in need, service delivery must respond to them. While no time series data has been collected or analyzed to indicate the

rate or magnitude of such shifts, it is reasonable to assume that frequent facility re-location would be a costly strategy to adopt.

3. Locational Insensitivities. Studies of variations in facility location have indicated that optimal locations do not differ very much from random locations (Larson and Stevenson, 1972; Toft, 1970). It thus appears that service utilization may not be highly elastic with respect to actual or perceived travel costs. If this conjecture is verified, facility location strategies that indicate specific locations or patterns are not required. Indeed, the structure of dispersed provision may be shown to be far less important than the process of utilization and its enhancement.

4. Location Conflicts. Accompanying the increasing importance of the public sector in the past two decades has been a sensitivity on the part of various groups to the local impacts of public investments. Studies of locational conflicts have indicated that benefits and costs are imposed not only on service recipients but also on neighborhood groups in proximity to service facilities (cf. Wolpert, 1971-72; Wolpert, 1976; and Seley, 1973). While important issues, such as how all impact groups are to be represented in the planning process or how such impacts are to be measured, remain to be analyzed, the dilemma left for the facility planner to resolve is that service facilities, while clearly demanded or needed, are severely constrained in terms of locational options by the potential for costly locational opposition (Austin, 1974; Dear, Fincher and Currie, 1977).

5. Emerging Service Issues. Frequent references has been made to several of the assumptions underlying service delivery in a spatial context. However, questions are now being raised, which have a clear bearing on facility planning, over appropriate principles to guide service delivery (Kahn, 1973; Rosenberg and Brody, 1974). Two emerging issues are: (1) the extent to which different service facilities as well as different service programs interact or co-locate with respect to each other, and (2) the manner in which functional integration of service delivery systems should be achieved. While there exists scant documentation of components or measurement of interaction, even in non-spatial terms, there has been a healthy debate over services integration (Gans and Horton, 1975; Kahn, 1973, pp. 155-57, 171-74). Combining the two arguments, moreover, suggests that the spatial context of service delivery may be radically altered when <u>complexes</u> of services rather than individual services are considered (White, 1977).

The import of current obstacles confronting practical public facility planning is that, in the short term, locational approaches to service facility planning will have a diminishing impact on service delivery relative to broader utilization and transportation approaches. Both location and transportation strategies are clearly required, but practical emphasis must now shift away from siting towards transportation. In other words, having identified location options that improve the structure of service provision, facility planners must now consider the means for improving service utilization by facility systems integrated with transportation systems. Moreover, these obstacles, taken together, point up the need for re-thinking the rationale for services delivery in a more comprehensive spatial framework. Such a framework would necessarily question current assumptions about the benefits derived from current public facility configurations, and may lead to a more thorough comprehension of the principles and spatial strategies appropriate to interactive and integrated service delivery.

SPATIAL POLICY FOR PUBLIC FACILITY PLANNING

In summarizing this discussion of public facility planning, attention should be drawn back, first, to the service delivery model that has been outlined and, second, to the manner in which spatial planning alternatives are devised to meet the goal of delivery. The delivery model clearly emphasizes utilization as the key variable to analyze and thereby influence. While it might be viewed as simply the constrained response of individuals to a given structure of service provision, such a view inhibits both the planner, by excluding key spatial options, and the potential user, by neglecting the mobility conditions he or she faces. While Teitz (1968) originally posed the facility planning problem in terms of maximizing utilization, and while it has been "reinstated" as an objective (after much neglect) by ReVelle and Church (1976), a comprehensive spatial policy to implement it has yet to be devised.

Service facility decentralization has been the sustaining principle for current approaches to public facility planning. Decentralization is based on a view of spatial interaction in which: (i) attractiveness of services is assumed to derive from individual and independent service units; and (ii) spatial impedance is assumed to be a parameter rather than a policy variable. Because the benefits of utilization have been equated with an accessibility criterion that indexes the (absence of) spatial impedances to utilization, only those facility patterns which achieve maximum dispersal with respect to the population of service need are currently considered optimal. The whole sense of a locational approach as the principal spatial policy for service delivery rests on this narrow set of assumptions.

The point is that no convincing research on the benefits of alternative service facility configurations has been undertaken. But a range of facility patterns are clearly implied by an expanded model of spatial interaction. Once it is recognized that attractiveness may accrue as much from interacting, interdependent, or integrated services as from individual services, and once transportation is considered manipulable, alternative spatial patterns, including concentrated and dispersed facilities, must be evaluated.

The expanded and integrated set of spatial strategies have an obvious role to play here. Whereas a narrow set of location options may have biased spatial policy towards decentralization, integrated location-transportation strategies permit service agglomeration to be equally assessed.[10] Transportation strategies, particularly reduced-fare schemes or paratransit, allow the benefits and economies of facility concentrations to be explored for their ability to increase services attractiveness while maintaining low levels of spatial impedance.[11]

A further contribution of integrating location and transportation strategies is to provide an impetus for closer attention by service providers to the dynamics of community-oriented service. In essence, by fine-tuning service delivery to social, spatial, and behavioral contingencies at the local level, providers are better able to maximize service utilization and the benefits thereby derived. Moreover, when spatial strategies permit alternatives to decentralization to be implemented, these objectives are pursued without automatically raising the spectre of diffuse local impacts generating locational conflicts. Hence, consideration of both location and transportation strategies may suggest more effective or equitable ways of integrating services delivery and service facility systems with their community environments.

What is clear from this wider view of spatial policy for public facility planning is that the manner in which costs and benefits of alternative facility configurations are calculated must be revised. Spatial impedances indexed by a larger notion of accessibility must access travel costs which are weighted for differential mobility and travel disadvantage. But more importantly, the benefits of various facility arrangements must be incorporated: ways must be found not only to reliably measure the attractiveness of facility aggregates as well as individual service facilities, but also to evaluate impedance and attractiveness together. Optimal planning models that determine ideal configurations may provide only benchmark data against which to measure planning solutions. An evaluation model that could assess the impact of both spatial interaction components on the spatial effectiveness of service delivery would be an appropriate advance in analytical capability tailored to practical circumstances. And by clarifying the role of spatial policy as a means of improving service delivery, such a model would provide a broader foundation for a theory of public facility planning.

NOTES

1. This utilization model does not claim to be a complete behavioral specification. Attitudes and other psychological variables also will influence the decision to utilize services (cf. Veeder, 1975). Moreover, institutional barriers to utilization, such as eligibility requirements or waiting time and appointment scheduling, are impedances which are presently represented in the model. These factors could be treated as negative attractions of service facilities. Note, however, that proper evaluation of facility attractiveness requires a comparative methodology in which systems of public facilities are examined with respect to common and dissimilar attributes as they relate to service utilization levels.

2. The distinction is important since current evaluation efforts often treat output (or supply) as a measure of effective delivery, when the more appropriate indicator is outcome or result of service use.

3. This approach will actually indicate the spatial efficiency of a location strategy (i.e., the cost associated with a given level of output or service supply), more than its spatial effectiveness. The latter criterion depends on what level of service utilization can be achieved for a given level of travel cost.

4. Benefits are considered disaggregable in the sense of attaching to individual facilities considered independently of each other; no benefits derive from the facility configuration as a whole.

5. Indeed, it has been argued that the specification of a generalized travel cost function smoothes out differences in the evaluation of travel by different groups. The implication is that the more heterogeneous the population of interactors, the more concave will be the distance decay curve or impedance function (Haynes, 1974).

6. The most clear-cut norm of assessing travel disadvantage is the individual availability and use of the automobile. Numerous studies of travel behavior have reported the overwhelming preference given to this mode of travel for all kinds of trip purpose, and

the corresponding limited preference for any other mode. These preferences are not arbitrary, but are based on the flexibility, convenience, and cost associated with the use and enjoyment of modal options (Paaswell and Recker, 1975; Owen, 1976).

7. Such a determination may require a complex planning framework of its own (cf. Mouchahoir, 1974; Paaswell, 1971).

8. A dilemma exists here because no adequate estimation procedure for determining the pattern of service needs has been devised. But see Briggs et al. (1975).

9. The illustrative model calculates the median distance using a simple algorithm. A model to calculate the mean distance, which gives more weight and "locates" a facility with respect to more distant users, involves a complex algorithm. The two terms are reviewed in Neft (1966).

10. The notion of agglomeration has been treated in industrial location theory by Weber (1929) and Isard (1956), and has been neglected in a service context. But see Coughlin (1965).

11. The spatial scale (urban or intra-urban) at which service agglomerations might be promoted is another, as yet unexamined issue.

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