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An Isolation-Usage Index for Rational Allocation of Air Service to Small Communities

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ABSTRACT

SMALL communities in the United States have experienced over the last decade a marked decline and change in the supply and quality of air transportation, a trend that has been accelerated by recent airline deregulation.

A quantitative methodology is developed as a tool for planning and policy-making for short-haul air service and is applied to a case study of New York State in order to demonstrate its efficacy. The tool takes the form of an Isolation-Usage Index for characterizing a community regarding its access to air service and incorporates a benefit-cost criterion for establishing the minimum ridership required to justify the provision of local air service.

The criterion takes into account two main factors: (a) the spatial separation of the community from a major air hub and the nearest airport and (b) the level of service offered at the nearest airport and, if implemented, at the local airport. It equates the monetarized time savings of local air service and the incremental costs of implementing the service. A principal element of the criterion is an original conceptualization of a delay disutility function associated with inconvenient flight scheduling.

The product of the analysis is an optimal configuration of local air service in terms of (a) link to be served, (b) airport investment, (c) type of flight equipment and (d) flight frequency.

INTRODUCTION

The supply of air transportation services to small communities has seriously diminished and changed in character over the past decade. These changes have been accelerated by passage of the Airline Deregulation Act of 1978 which has made it easier for airlines to trim out unprofitable operations, typically service to small communities with marginal air travel demand.

A necessary element of planning and design of short-haul air service networks is some sort of analytical criterion with which to determine the minimum level of demand required from a community in order to justify provision of local air service of a given type and level. This paper formulates such a criterion as the basis for an Isolation-Usage Index by which communities can be characterized. As a policy tool, the criterion is useful not only for selecting the communities to be incorporated in the air service network, but also provides a uniform basis for equitable treatment among those that should be included and those excluded.

The degree of isolation of a small community with respect to air transportation depends upon two major factors, namely (a) the spatial separation from a trunkline air system (requiring ground transport for access) and (b) the level of service offered at the nearest available airport. In the present analysis, the level of service (LOS) component incorporates an original concept of traveler disutility associated with delay to flight scheduling (or headway) and accounting for two distinct characteristics:

- a tolerable limit of inconvenience under normal schedule
- an unbearable level of inconvenience beyond a certain low level of service.

The methodology essentially equates the monetarized net time savings of local direct air service relative to alternative indirect service and the incremental costs of implementing the local service. The resulting benefit-cost criterion is the basis for constructing the Isolation-Usage Index into which all the elements of the analysis are condensed.

Finally, the usefulness of the method is illustrated by application to New York State.

LEVEL OF SERVICE

It will be recognized that an important ingredient of level of service pro-

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vided to travelers is the wait time or delay associated with flight scheduling and that the inconvenience of disutility due to delay increases as flights become less frequent. Because disutility is a concept difficult to quantify, the present analysis adopts as its surrogate the actual amount of wait time (e.g., hours) as an operational measure of inconvenience associated with scheduling delay. Thus, disutility is taken here to be synonymous with frequency delay (T_f).

The proposed form of the disutility function is presented in Figure 1 as a relationship between frequency delay and headway. Conceptually, the function combines three main elements, namely (a) a concave portion at low headways, (b) a maximum wait time that travellers will tolerate under normal service conditions, and to which the concave part tends, and (c) a convex portion at high headways.

For very low headways, corresponding with excellent service, any delay is looked upon as a high level of inconvenience, especially to travellers who closely time their airport arrival in expectation of frequent and reliable air service. Consequently, the curve rises steeply at first and the wait time is about equal to the headway. As headway increases, travellers adjust their expectations to less frequent service, they become somewhat more tolerant of delay and willing to accept rather long waits. However, it is reasonable to suppose that there is a maximum wait, say as long as two hours, that travellers will tolerate under normal service conditions, a limit determined by the difference between flight time and the time required for the same trip by the next best travel alternative (e.g., automobile). Thus, the marginal disutility of wait time (slope of T_f) gradually tends to zero and the early part of the curve is therefore concave. Beyond a certain level of service, say 15-hour headway or one flight per day, disutility can be expected to increase sharply and convexly, reflecting severe loss of attractiveness and convenience as the traveller is forced to postpone his departure to another day. It is conceivable, of course, that local air service of one flight every other day, or even one a week, may be preferable to no service at all.

DISUTILITY OF SCHEDULE — FUNCTIONAL FORM

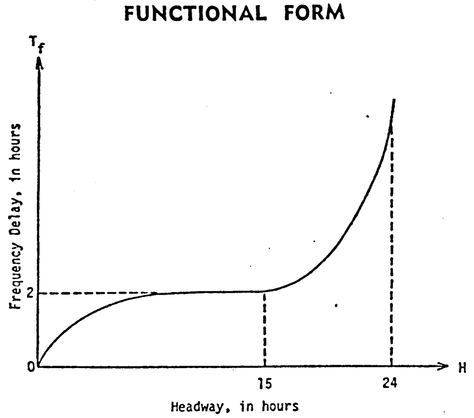

FIGURE 1

For simplicity and mathematical tractability, the subsequent analysis adopts a disutility function of the polynominal form:

$$T_f = H^3/600 - H^2/30 + H/4$$

where

T_f = Frequency delay, in hours

H = Headway, in hours.

This curve approximates the one shown in Figure 1, with convexity beginning at a headway of about 15 hours (one flight per day) and a maximum acceptable wait time under more frequent scheduling of about two hours. Although other forms might be adopted, Equation 1 is quite satisfactory for illustration of the methodology.

To relate service quality to levels of delay incurred by passengers, Douglas and Miller[1] have used the concept of schedule delay as comprised of two components:

- Frequency delay—the mean absolute difference between the traveller's desired departure time and the scheduled departure time, and
- Stochastic delay—time lost when the traveller cannot board his preferred flight and takes an alternate, less desirable flight, due for example, to airline overbooking practice.

The present analysis omits the stochastic component on the supposition that it can be minimized by adjustment of the load factor. The use of a deterministic load factor ignoring statistical variation, namely an average load factor over the operating period, may result in some imprecision of the analysis, but it is the authors' contention that it is likely to be small for low-density markets with infrequent flights. Moreover, the lack of data in these markets precludes reliable estimation of stochastic variation of demand.

BENEFIT-COST CRITERION

A basic formulation of the time savings—cost tradeoff—has been presented by Dick[2] in the context of establishing rational eligibility criteria for entry of general aviation airports into the National Airport System Plan (NASP). The present analysis follows Dick, but differs principally in the inclusion of the disutility concept.

The spatial setting of the problem, shown in Figure 2, comprises the local airport L as trip origin, trip destination D, and a nearby alternate airport A. Travellers desiring to go from L to D, but not offered direct air service, would have to drive to A, the alternate airport which is served by trunklines and gives access to the national domestic air network. The problem then is the economic justification of providing direct air service from L to D in terms of a tradeoff between travel time and money cost associated with the two alternatives of:

(a) Construction (or upgrading) and maintenance of an airport at L and the operating costs of flight $\overline{LD}$

(b) Drive to alternate airport A and the operating costs of flight $\overline{AD}$.

The provision of direct air service is optimized by equating the net time savings and the incremental costs to implement the service, computed on a yearly basis. The notation used in the analysis is summarized in Table 1.

The benefits are the net time savings of a direct trip $\overline{LD}$ over the indirect trip $\overline{LAD}$. The time of trip $\overline{LAD}$ is the sum of three components: $\overline{LA}$ driving time, $\overline{AD}$ flight time, and the frequency delay (disutility) T_f at A as described by Equation 1. Noting that the headway at the local airport, H_L, is a function of yearly traffic X (specifically $H_L = 15 \times 365\ L/X$), the annual time savings are:

$$TS = PX[(D_{LA} - D_{HL})/V_1 + (D_{AD} - D_{LD})/V_2 + H_A{}^3/600 - H_A{}^2/30 + H_A/4 - (2.73 \times 10^8)(L/X)^3 + (9.99 \times 10^5)(L/X)^2 - (1.37) \times 10^3)(L/X)] \quad (2)$$

The annual incremental costs of the airport at L comprise the direct operating costs to fly the $\overline{LD}$ segment, less the avoided costs of the trip $\overline{LAD}$, plus the annualized costs of building and maintaining the airport at L. These costs are:

$$IC = X[C_1(D_{HL} - D_{LA}) + (C_2/L)(D_{LD} - D_{AD})] + I_2 + M \quad (3)$$

The provision of direct air service to $\overline{LD}$ and its associated airport costs are justified when the annual time savings are at least as great as the incremental costs, that is, when $TS \geqslant IC$. This condition, combining Equations 2 and 3, becomes:

$$PX[(D_{LA} - D_{HL})/V_1 + (D_{AD} - D_{LD})V_2 + H_A{}^3/600 - H_A{}^2/30 + H_A/4 - (2.73 \times 10^8)(L/X)^3 + (9.99 \times 10^5)(L/X)^2 - (1.37 \times 10^3)(L/X)] - X[C_1(D_{HL} - D_{LA}) + C_2(D_{LD} - D_{AD})/L] - I_2 - M \geqslant 0 \quad (4)$$

The unknown X satisfying Equation 4 is the minimum ridership required to justify direct $\overline{LD}$ air service and the cost of an airport of size I_2, within the assumptions and parameter values embedded in the formulation.

The frequency of air service at the local airport is obtained by dividing the yearly ridership by the capacity of the selected flight equipment.

GEOGRAPHICAL SETTING OF PROBLEM

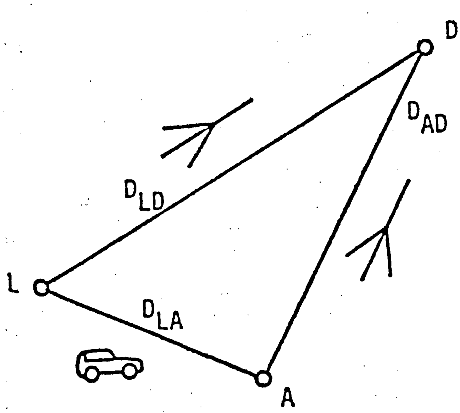

FIGURE 2

TABLE 1

NOTATION

Symbol	Definition
X	Total number of passengers to travel from L to D, per year, to justify building an airport at L.
D_{LD}	Distance (air) $\overline{LD}$ (miles).
D_{AD}	Distance (air) $\overline{AD}$ (miles).
D_{LA}	Distance (surface) $\overline{LA}$ (miles).
D_{HL}	Distance from center of city L to local airport (miles).
L	Number of passengers per flight = seating capacity of plane times the planned load factor (say, 65%).
P	Passenger Time Value (e.g. 10 $/hr.)
V_1	Car Speed (e.g. 45 mph)
V_2	Aircraft Speed (mph).
C_1	Car Costs, including amortization of original cost (e.g. 30¢/mi.)
C_2	Aircraft Costs, including amortization of original cost ($/mi.)
I_1	Initial airport capital investment ($).
I_2	Annualized airport capital investment ($). $I_2 = I_1 \cdot CRF$.
CRF	Capital Recovery Factor $= i(1+i)^n/[(1+i)^n - 1]$.
i	Annual rate of interest (e.g. 10%).
n	Economic life of airport (e.g. 20 years).
M	Operating and Maintenance (O&M) costs of airport ($/year).
F_A, F_L	Frequency of alternate airport A, at local airport L (no. flights/day).
T_{f_A}, T_{f_L}	Frequency delay at A, L = disutility associated with schedule at A,L (hours).
H_A, H_L	Headway at airport, A,L (hours).

ISOLATION-USAGE INDEX

The concept of the Isolation-Usage Index is now introduced and defined as

$$I = 1 - (X/Y) \qquad (5)$$

where

X = theoretical ridership per unit time, as predicted by the criterion

Y = actual, estimated or forecast future ridership per unit time.

Since X is related to supply, the index is effectively a measure of the balance between supply and demand.

In the case that local air service already exists, the Index is based on actually observed air travel demand and tells whether present air services are too much or too little. In the case when there is no local air service from the community and the possibility of providing it is being examined, the variable Y is taken as the best estimate of demand and the Index tells whether the proposed direct service is economically justified in relation to the use to be made of it. Similarly, for a future planning horizon, a reliable air travel demand forecast is required for each community on the proposed future air network.

The ideal Index value is $I = 0$, representing the situation in which actual use of the air service exactly balances the theoretically required market, that is, where the supply of air service of a given type and level matches the demand. It follows that a community with $I > 0$ may be regarded as relatively isolated and deserving of better service than it has. A community with $I < 0$ is not only well served, but oversupplied. It should be kept in mind that the costs embedded in the criterion, and hence in the Index, are tied to a particular quality of airport facility and flight equipment and that, consequently, a market not justifying service by regional carriers with jet equipment may be entirely adequate for commuter airlines using smaller, less sophisticated aircraft. Any student of recent air service patterns will have recognized that such a shift has indeed occurred at most small communities.

In general, then, the planner or policymaker should aim to bring communities towards the ideal Index value. In the case of undersupply, some options worth consideration are:

- construction of an airport where none exists or upgrading of an inferior existing facility
- increase in flight frequency
- increase in type and capacity of aircraft
- temporary subsidy or similar incentives to carriers until they are satisfied that an adequate market exists and the service is self-supporting.

In the case of oversupply, the ability of the policymaker to effect adjustments in the Index is rather limited, since most of the decisions about service lie with the carriers. Carrier willingness to supply apparently excess service is surely based on business rationale and likely accounts for factors not included in the foregoing analysis. For example, a community providing little demand may receive service simply because it is a convenient intermediate stop on a multiple-leg flight and offers enough revenue to balance the marginal cost of stopping. The present analysis does not account for such network interlinkage. Other factors not included in the criterion, such as commercial growth or wealth, geographic location and political decision, may very well explain the apparently oversized service. Nevertheless, the potential for waste implied by oversupply of air service warrants close examination, especially if subsidies are considered justified for particular social reasons.

The Index, as a tool available to the policymaker, is a definite asset in the decision-making process and allows a great deal of sensitivity analysis. It allows consideration of various CAB policies regarding minimum air service quality requirements, e.g., flight frequency, equipment capacity, load factor and so forth. It may be used also to establish the necessity and level of subsidy and moreover can tie subsidy to particular cost categories. Moreover, it can be used in consideration of the optimal allocation of public funds for airport facilities, as in the National Airport System Plan.

CASE STUDY—NEW YORK STATE

An overall decline in the quality of air service to many small and medium-sized communities in New York State has been experienced over the past several years. The New York State Department of Transportation (NYSDOT), in a 1978 Request for Proposal for a comprehensive study of intrastate air service, stated among its objectives (a) identification of the type and level of scheduled air service required for each community included in the investigation and a determination of whether such service is economically feasible and (b) identification of those markets in which air service is considered essential to community viability, but which do not appear capable of supporting the required level of service on a profitable basis.[3] These objectives are adopted for the case study.

The methodology is applied to a number of small communities (under 50,000 population) in New York State listed in the NYSDOT document. The results of the analysis for sixteen communities presently served by air are summarized in Table 2. Similar results for twenty-four other communities not presently served by air are shown in Table 3. For each location, the most likely alternate airport, usually the nearest, is given. The dominant (maximum demand) destination, for communities with service, is according to 1978 CAB traffic data. For communities without service, an educated guess is made about the most likely trip destination by looking at travel patterns of similar neighboring communities.

In some cases, because of the proximity of the community to the destination airport, only a direct local air connection to the destination was considered with the alternative travel choice of all driving. Examples of such situations are the communities nearby New York City (NYC) for which the nearest alternate airport as well as the final destination is New York City itself. In such coincident cases, the level of service at the alternate airport, which is one of the parameters of the model, is taken as the total number of direct flights available at the destination airport, whereas in the normal spatial setting (Figure 2) it is taken as the number of direct flights from the alternate airport to the specific destination.

Different combinations of airport investment and associated aircraft operating costs are arbitrarily defined in Ta-

TABLE 2

TEST RESULTS — NEW YORK STATE EXISTING SERVICE

City	Alternate Airport	Trip Destination	AIR D_{LD}	AIR D_{AD} (mi)	SURFACE D_{LA}	SURFACE D_{HL}	Frequency F_A (#day)	Airport & A/C Type (N-n)	X Theoretical (# pass/day)	Y Actual (# pass/day)	I Isolation -Usage
Catskill	ALB	NYC	106	144	47	5	18	I-1	16	4	- 3
East Hampton	ISP	NYC	92	42	53	5	2	I-1	19	4	- 3.75
Elmira	BGM	NYC	190	155	57	8	8	III-4	125	65	- 0.92
Fisher's Island	NONE	NYC	103	-	-	-	300		-	1	
Islip	NYC	ALB	151	144	45	8	21	II-1	43	40	- 0.075
Ithaca	SYR	NYC	192	206	60	5	15	IV-4	90	94	0.04
Jamestown	BUF	BUF	65	0	71	5	95	II-2	42	59	0.29
Massena	SYR	SYR	149	0	158	4	68	I-2	17	15	- 0.13
Montauk	ISP	NYC	105	43	68	3	2	I-1	16	1	-15.
Monticello	NYC	NYC	77	0	88	3	300	I-1	15	1	-14.
Ogdensburg	SYR	SYR	120	0	130	4	68	I-1	12	13	0.07
Plattsburgh	ALB	ALB	141	0	169	7	81	II-2	19	31	0.39
Poughkeepsie	NYC	NYC	67	0	77	5	300	II-2	37	46	0.20
Saranac Lake	ALB	ALB	120	0	159	8	81	I-1	11	14	0.21
Watertown	SYR	SYR	64	0	73	9	68	I-1	20	16	- 0.25
White Plains	NYC	SYR	197	206	25	3	15	I-1	34	24	- 0.42

TABLE 3

TEST RESULTS — NEW YORK STATE PROPOSED SERVICE

City	Alternate Airport	Trip Destination	AIR D_{LD}	AIR D_{AD} (mi)	SURFACE D_{LA}	SURFACE D_{HL}	Frequency F_A (#day)	Airport & A/C Type (N-n)	X Theoretical (# pass/day)	Y Forecast (# pass/day)	I Isolation -Usage
Auburn	SYR	NYC	188	206	30	5	15	II-2	48	117	0.59
Batavia	BUF	NYC	281	305	35	5	15	II-2	38	52	0.27
Bath	ELM	NYC	217	194	33	5	1	I-1	16	0	--
Cortland	ITH	NYC	183	192	24	5	4	II-2	45	57	0.21
Dunkirk-Fredonia	BUF	NYC	319	305	48	5	15	II-2	41	84	0.51
Farmingdale	NYC	NYC	25	0	35	3	300	I-1	45	13	-2.46
Geneva	SYR	NYC	202	206	51	5	15	II-2	31	40	0.22
Glen Falls	ALB	NYC	185	144	45	3	18	I-1	29	42	0.31
Gloversville	ALB	NYC	165	144	45	3	18	II-2	47	53	0.11
Hornell	ELM	NYC	233	194	57	3	1	II-2	23	23	0
Johnstown	ALB	NYC	161	144	40	3	18	I-1	26	15	-0.73
Little Falls	UCA	NYC	172	.189	35	3	7	I-1	20	5	-3
Malone	UCA	NYC	292	189	190	3	7	I-1	10	6	-0.67
Middletown	NYC	NYC	55	0	70	3	300	II-2	37	70	0.47
Montgomery	NYC	NYC	59	0	80	3	300	I-1	16	0	--
Newburgh	NYC	NYC	55	0	61	3	300	II-2	50	82	0.39
Norwich	BGM	NYC	155	155	47	3	8	I-1	18	11	-0.64
Olean	BUF	BUF	55	0	69	10	95	II-2	47	50	0.06
Oneonta	BGM	NYC	137	155	62	5	8	II-2	24	40	0.40
Owego	BGM	NYC	160	155	25	3	8	I-1	38	0	--
Salamanca	JHW	BUF	55.	64	35	3	4	I-1	19	7	-1.71
Seneca Falls	SYR	NYC	218	206	47	4	15	I-1	20	6	-2.33
Wellsville	ELM	NYC	238	194	66	7	1	I-1	13	0	--
Westhampton	ISP	NYC	62	42	22	3	2	I-1	51	0	--

bles 4 and 5 by the symbol N-n, where N is the airport classification and n the aircraft type. These classifications are entirely adequate for demonstration of the methodology, but truly reliable model results require more definitive and realistic cost estimates for specific locations and equipment.

In construction Tables 2 and 3, the model employs the disutility curve previously introduced and based on a minimum local air service standard of one flight per day.

The application of the methodology to communities with existing service is straightforward. The variable Y is the actual number of daily passenger enplanements taken from 1978 CAB traffic data. The airport-aircraft configuration is selected so that the Isolation-Usage Index comes as close as possible to the ideal value $I = 0$.

For communities without air service—the potential markets—the value of Y cannot be had from traffic data and therefore is taken as an estimate of demand based upon a simple regression of known demand data (for the cities served by air) with respect to population size. An attempt was made to regress on a combination of population and two additional explanatory variables, namely average household income (as an indicator of socioeconomic base) and the level of air service provided (to reflect demand generation), but the scarcity of travel demand data in short-haul, low-density interurban markets of New York State prevented the authors from establishing convincing multivariate regression equations. Consequently, the potential demand was estimated from the linear equation:

$$Y = 0.43 \times 10^{-2} Z - 27.42 \quad (r^2 = 0.78) \qquad (6)$$

where

Y = predicted travel demand, passengers per day

Z = population size.

The use of Equation 6 is another instance in which the approximation does not damage the demonstration of the methodology, but where the availability of a strict analysis for policymaking purposes requires reliable demand data. The results of the case study therefore must be viewed in the context of the various approximations made in the analysis.

The air service configuration for the presently unserved cities was taken first as the minimum Class I-1 ($500,000 airport investment and small commuter aircraft) to test if they were eligible even for this minimum service. A community showing a positive Index value with the minimum configuration was then upgraded to whatever service configuration would yield a positive Index as close as possible to the ideal $I = 0$. Any further upgrading would move the Index into the negative range, implying oversupply of service.

Table 2 reveals, in the light of negative Index values, that air service presently supplied should be diminished or abandoned at Catskill, East Hampton, Elmira, Massena, Montauk, Monticello,

TABLE 4

AIRPORT CLASSES BY TYPE AND COST RANGE

Airport Class (N)	Airport Description	Annualized Airport Construction + O&M Costs, I_2 ($i = 10\%$)
I	Small-General Aviation & Commuter	$0 < I_2 \leq \$150,000$
II	Medium-Turboprop a/c	$\$150,000 < I_2 \leq \$300,000$
III	Medium-Jet a/c	$\$300,000 < I_2 \leq \$1$ M.
IV	Small International Jet a/c	$\$1$ M $< I_2$

TABLE 5

CHARACTERISTICS OF REPRESENTATIVE AIRCRAFT

Aircraft Type (n)	Max. Take Off Weight[a] (lb.)	Seating Capacity[b] (pass.)	Max. Cruise Speed (mph)	Required Runway[c] (ft.)	Total Operating Costs[d] ($/mi.)
1. Swearingen Metro II	12,500	20	294	3,600	1.65
2. Shorts SD3-30	21,100	30	228	3,700	3.30
3. Fairchild-Hiller FH-227	43,000	50	276	3,300	4.50
4. Douglas DC-9-30	121,000	105	564	7,500	7.10

a. Aircraft specifications from Jane [4].
b. Representative configurations adopted for illustrative purposes only. Exact configurations should be used in specific applications of the analysis.
c. At sea level, standard day, no wind, level runway.
d. Actual costs (1979 $) for a 250-mile haul. CAB data [5].

Watertown and White Plains, unless continuation is considered justified by subsidies or carrier decisions. Service at cities with high positive indices, like Jamestown, Plattsburgh, Poughkeepsie and Saranac Lake, should be improved. Since the Index is not likely to be exact, even under the best analytical circumstances, a range of, say, $-0.1 \leqslant I \leqslant 0.1$ might be adopted as a guideline for judging service to be about right and maintaining the **status quo**.

The results in Table 3, for the presently unserved communities, indicate that:

(a) twelve communities with negative Index should not be included in the air service network, at least on grounds of economic efficiency.
(b) twelve other communities with positive Index deserve more service than provided by the given service configuration. How much more is moot, given the approximations of the costs.

Once the optimal service configuration is selected (to produce an Index close to zero), finer adjustment of the air service is possible by changing to another aircraft type compatible with the optimal configuration. Now, flight frequency—a function of the aircraft capacity—becomes the final instrument in matching supply with demand. The flight frequency is determined by dividing the optimal ridership X by the aircraft capacity, taking into account the expected load factor.

CONCLUSIONS

An Isolation-Usage Index, based upon a quantitative benefit-cost criterion for establishing the minimum ridership to justify the provision of air service, has been presented as a tool for characterizing a community regarding its access to air service. It is particularly useful in planning and policymaking for short-haul air service and moreover gives the decision-maker an objective and uniform basis for judging which communities shall have air service and which shall do without.

If local air service from a community proves to be economically unjustified on an objective basis such as that proposed and yet is deemed to be "essential" for subjective reasons, subsidy or similar incentive for a temporary or prolonged period would seem to be called for. The proposed methodology has the advantage of making more visible both the need for and level of subsidy as well as the cost categories to which subsidy should be directed, whether to airport investment or operating costs. It thus may be helpful in the optimal allocation of Federal funds for airport facilities, as embraced by the National Airport System Plan.

Since the methodology specified an optimal configuration of local air service in terms of flight link, airport investment, type of aircraft and flight frequency, it follows that the decision-maker is provided with a means to study a variety of options for matching supply and demand: changes in flight frequency, airport and aircraft, as well as estimates of the financial commitment, for each course of action. Similarly, the suitability of the model to parametric variation allows study of the impact of various CAB policies regarding minimum standards of air service pertaining, for example, to flight frequency, aircraft capacity, and load factor.

Finally, it needs to be remarked that reliable and realistic application of the proposed methodology, as revealed in part by the New York State study, hinges on perfection of the concept of disutility associated with flight scheduling, on improvement of demand forecasting methods for short-haul air markets, and on strict cost estimation. In spite of its imperfections, however, the methodology provides a credible and promising approach to the rational allocation of air service to small communities.

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