Data Requirements for an Analysis of Intercity Passenger Travel by Bus

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Transportation planners in Iowa have initiated efforts to enhance the attractiveness of passenger travel by intercity bus to exploit more fully the inherent advantages of that travel mode. However, insufficient data have been available to provide a firm basis for such planning. Data traditionally provided to regulatory agencies are aggregated so as to afford little information on patronage for specific cities or specific route segments. Data from a 100 percent sample of ticket sales for a summer month from 23 focal communities in Iowa—including travel volumes, trip lengths, and origin-destination information—provided a basis for the analysis of bus travel in the state. Additional data were made available from a metropolitan station to indicate seasonal and daily variations in travel demand and the proportion of on-time service.

Patronage of intercity buses was at essentially the same level in 1975 as it was in the late 1940s in both passengers and passenger kilometers. However, intercity travel increased by approximately 200 percent during that period. The bus share of intercity passenger kilometers decreased from 5.6 percent in 1948 to 1.9 percent in 1975 (1).

There are several reasons for the relative decline in importance of buses as carriers of intercity passengers. Travel by automobile offers substantially more flexibility and is generally perceived as more comfortable and as having other advantages, and air travel saves time. Consequently, these modes have experienced substantial increases in use during the past 30 years.

A large proportion of current intercity bus users are captive to the bus mode. The captive group includes, for example, a disproportionate number of persons without access to an automobile and those who are elderly, handicapped, or economically disadvantaged.

Transportation planners frequently express a desire to increase bus use by elective riders—those who have a choice of modes and are attracted to buses in the interest of economy or efficiency. This desire arises in part from the need to slow down the rate of growth in vehicular use of highways in response to reductions in the amount of improvement that can be effected under current highway funding programs. Concern about the consumption of energy also favors the increased use of buses. Although many factors influence comparisons of modal energy efficiency, such as circuity of routing and passenger load factors, research efforts generally have demonstrated that buses have pronounced advantages in terms of energy consumption per delivered passenger kilometer. Conclusions from one study, for example, were summarized as follows (2): "Buses are the most fuel efficient mode for all city pairs." Figure 1 (2) shows a comparison of modal fuel efficiencies for passenger modes and indicates clearly the inherent advantage of bus travel on the basis of fuel consumption.

It is possible for changes in government policies to exert a significant influence on the attractiveness of intercity bus travel. The amount of subsidy provided to competitive modes—rail and air—may be decreased. In respect to highway fuels, government-induced price changes or limitations on their availability will tend to decrease highway travel. The traditional government role in regulation provides additional opportunities to affect the relative use of different travel modes.

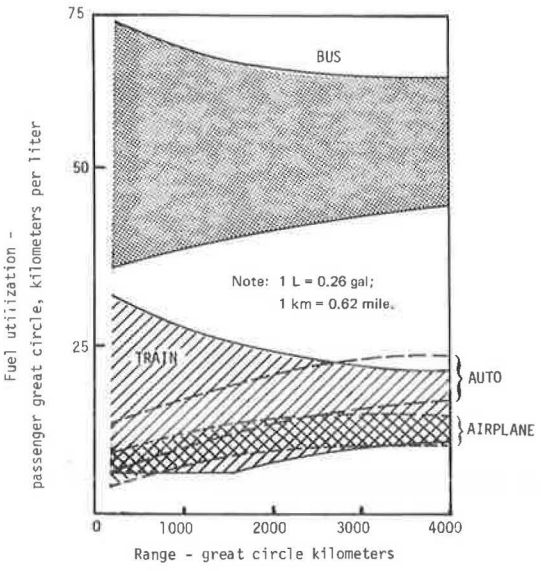
Unfortunately, transportation planners responsible for recommending policy changes are severely handicapped by limitations on the availability of data on the use of intercity buses. In contrast to the wealth of information available on most aspects of highway travel, little information is generally available on bus passenger movements on specific routes or from specific stations. Data comparable to highway origin-destination surveys, travel time and delay studies, or traffic volume counts simply do not exist in the context of intercity bus travel.

Data that do exist on bus passengers are usually aggregated to satisfy the needs of regulatory agencies and provide little information suitable for detailed planning. Some detail is available on vehicle movements (useful for highway planning) but not on person movements (essential for passenger travel planning). Nor are bus companies particularly concerned with gathering detailed passenger data. As profit-making enterprises, their concerns are directed toward the financial aspects of operations and result in the accumulation of data that may be adapted only with considerable difficulty to the needs of transportation planners. In addition, proprietary concerns about such data preclude their release in a form potentially useful to competitors. As a consequence, it was necessary to generate almost the entire data base concerning bus passenger movements from primary sources as part of the research effort reported here (3).

DATA ON INTERCITY BUS PASSENGERS

A duplicate of each intercity bus passenger ticket is retained by the manager of the bus station. These receipts constitute a record of passenger revenue that is the usual basis for payment of commissions to station managers. Periodically (weekly, semimonthly, or monthly), these receipts are forwarded to a central office of the carrier. Larger carriers normally will not provide re-

Figure 1. Modal comparisons of fuel efficiency.



searchers with access to these records.

One aspect of importance to transportation planners is that these records also identify the origin and destination of each bus passenger. With the permission of the carriers involved, this data source was made available for research on bus passenger travel by the station agents at 23 selected cities in Iowa. The cities were selected on the basis that they provided a regional focus for much of the travel that uses common carriers within the state.

A 100 percent sample of all bus tickets sold at each of the 23 stations during a summer month was processed for this research. Tickets were reviewed immediately before being forwarded to the carrier, and a destination was recorded for each ticket. Thus, a complete record was available of all bus tickets sold at 23 of the primary

Table 1. Bus tickets sold in selected Iowa cities in a typical summer month in 1976.

City	Destination			City	Destination		
	Iowa	Out of State	Total		Iowa	Out of State	Total
Ames	686	431	1 117	Iowa City	1 490	1 003	2 493
Atlantic	112	167	279	Marshalltown	271	143	414
Burlington	504	284	788	Mason City	651	520	1 171
Carroll	97	78	175	Muscatine	212	153	365
Cedar Rapids	2 302	795	3 097	Osceola	100	68	168
Clarinda	33	70	103	Ottumwa	492	227	719
Clinton	174	271	445	Sioux City	800	1 510	2 310
Council Bluffs	370	96	466	Spencer	110	139	249
Davenport	754	569	1 323	Waterloo	1 038	740	1 778
Decorah	149	231	380	West Union	47	9	56
Des Moines	3 947	3 479	7 426	Total	15 608	12 266	27 874
Dubuque	877	1 050	1 927				
Fort Dodge	392	233	625				

Table 2. Daily travel as a percentage of monthly travel for express and nonexpress bus service.

Month	Type of Service	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
January	Express	2.1	2.5	1.8	1.9	2.4	2.4	2.6
	Nonexpress	13.9	10.0	9.3	11.7	13.3	15.9	10.2
	Total	16.0	12.5	11.1	13.6	15.7	18.3	12.8
February	Express	3.3	2.3	1.9	1.9	2.4	2.9	3.0
	Nonexpress	17.5	11.1	8.2	9.4	11.0	16.1	9.0
	Total	20.8	13.4	10.1	11.3	13.4	19.0	12.0
March	Express	2.3	3.1	2.8	2.6	1.8	2.8	3.3
	Nonexpress	13.8	12.0	11.5	12.2	8.9	13.8	9.3
	Total	16.1	15.1	14.3	14.8	10.7	16.6	12.6
April	Express	2.3	2.7	2.2	2.0	2.2	3.5	2.8
	Nonexpress	11.7	11.5	8.5	9.1	14.4	17.6	9.7
	Total	14.0	14.2	10.7	11.1	16.6	21.1	12.5
May	Express	2.7	3.1	2.1	1.8	2.8	2.2	2.9
	Nonexpress	13.3	13.6	8.9	8.8	11.5	12.4	13.8
	Total	16.0	16.7	11.0	10.6	14.3	14.6	16.7
June	Express	2.7	2.7	3.0	3.4	3.0	3.2	3.5
	Nonexpress	11.2	11.1	11.7	11.3	10.1	13.0	10.1
	Total	13.9	13.8	14.7	14.7	13.1	16.2	13.6
July	Express	2.9	3.6	3.2	3.0	3.7	4.7	5.8
	Nonexpress	10.1	9.5	8.1	7.7	11.3	13.7	12.6
	Total	13.0	13.1	11.3	10.7	15.0	18.4	18.4
August	Express	4.6	4.5	3.9	3.1	3.5	2.9	4.1
	Nonexpress	11.5	10.9	11.1	8.7	9.9	11.9	9.5
	Total	16.1	15.4	15.0	11.8	13.4	14.8	13.6
September	Express	3.0	3.6	2.8	2.6	2.4	3.1	3.3
	Nonexpress	13.5	13.6	8.7	8.8	9.2	14.6	10.2
	Total	16.5	17.2	11.5	11.4	11.6	17.7	13.5
October	Express	2.2	2.4	2.1	2.3	2.0	2.5	2.4
	Nonexpress	12.1	10.0	9.3	11.0	12.5	19.5	9.5
	Total	14.3	12.4	11.4	13.3	14.5	22.0	11.9
November	Express	2.9	2.0	2.3	2.1	2.3	1.9	2.9
	Nonexpress	18.5	9.1	9.6	13.1	9.3	12.6	11.5
	Total	21.4	11.1	11.9	15.2	11.6	14.5	14.4
December	Express	2.7	3.9	3.2	2.6	1.9	2.5	3.2
	Nonexpress	10.1	14.2	12.1	12.3	8.1	12.5	10.8
	Total	12.8	18.1	15.3	14.9	10.0	15.0	14.0
Average	Express	2.8	3.0	2.6	2.4	2.5	2.9	3.3
	Nonexpress	13.1	11.4	9.8	10.3	12.5	14.5	10.5
	Total	15.9	14.4	12.4	12.7	15.0	17.4	13.8

Note: Data are taken from 1 year's bus passenger records (October 1975 through September 1976) obtained from Des Moines Union Bus Station.

intercity travel markets in Iowa in a typical summer month in 1976. These data are given in Table 1. Note that, although specific destinations have been recorded for each ticket sale, data in the table are summarized to indicate only the totals of interstate and intrastate sales.

Certain other data required to aid in understanding the characteristics of bus travel were obtained from the analysis of all arrivals and departures for a major carrier at a large terminal in Des Moines. A total of 166 126 passengers were recorded as boarding or disembarking as part of this survey. One of the parameters determined from this analysis was the seasonal and daily variation in bus travel. For example, bus loadings tend to peak in July, August, and December. During a typical week, passenger volume is highest on Friday. A summary of travel by day of the week and month and a further breakdown between express and nonexpress services are given in Table 2, and monthly travel as a percentage of total annual travel is given below:

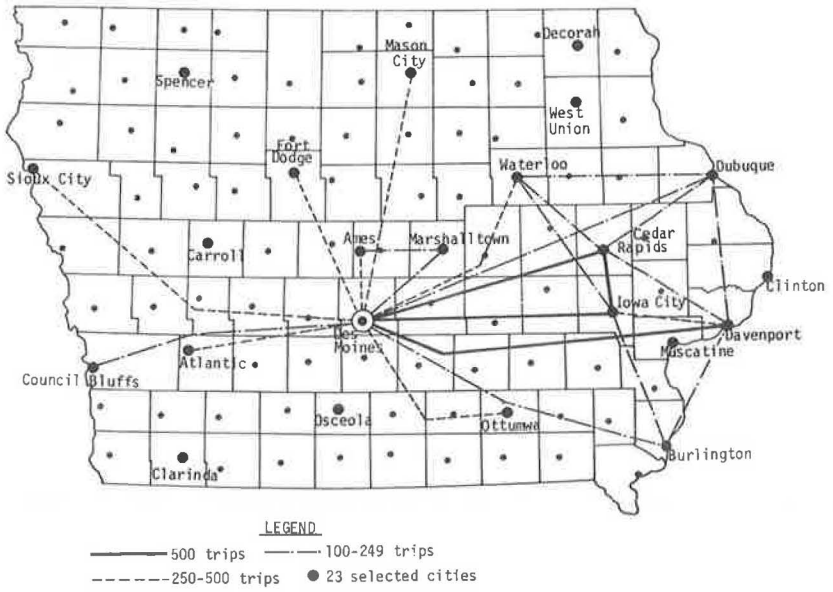
Month	Travel (as percentage of total annual travel)
January	7.26
February	6.42
March	7.72
April	7.39
May	7.43

Figure 2. Matrix of monthly trip interchanges among 23 selected Iowa cities in 1976.

	Ames	Atlantic	Burlington	Carroll	Cedar Rapids	Clarinda	Clinton	Council Bluffs	Davenport	Decorah	Des Moines	Dubuque	Fort Dodge	Iowa City	Marshalltown	Mason City	Muscatine	Osceola	Ottumwa	Sioux City	Spencer	Waterloo	West Union
Ames	5	5	24	159	0	12	14	14	3	395	27	47	59	37	61	0	3	12	18	6	41	0	
Atlantic		0	0	8	0	0	13	6	0	290	0	5	14	4	5	0	0	0	0	0	3	0	
Burlington			0	54	1	7	3	114	0	220	9	10	108	5	6	26	0	36	27	0	15	2	
Carroll				32	0	0	8	2	1	40	6	4	7	4	3	0	0	4	2	2	6	0	
Cedar Rapids					0	63	16	147	51	523	187	37	504	90	80	23	3	65	5	9	171	21	
Clarinda						0	35	1	0	12	0	1	0	0	0	0	0	0	0	0	0	0	
Clinton							5	24	1	59	5	3	30	7	1	2	0	2	1	0	5	0	
Council Bluffs								3	2	159	0	1	18	8	1	2	2	5	19	13	11	0	
Davenport									2	504	127	8	327	7	23	90	0	35	4	0	53	0	
Decorah										14	8	2	18	0	19	0	0	1	0	0	20	1	
Des Moines											119	350	752	155	336	58	95	319	263	26	491	5	
Dubuque												21	77	7	26	3	0	13	50	4	241	2	
Fort Dodge													42	7	9	0	2	0	66	7	46	3	
Iowa City														15	61	30	2	64	37	5	127	5	
Marshalltown															7	3	2	3	3	3	53	0	
Mason City																8	13	5	17	30	70	0	
Muscatine																	0	5	0	0	7	1	
Osceola																		0	0	0	1	0	
Ottumwa																			6	1	8	0	
Sioux City																				3	25	0	
Spencer																					4	0	
Waterloo																						17	
West Union																							
Total		5	5	24	253	1	82	94	311	60	2216	478	489	1956	345	638	245	122	569	518	109	1398	57

Total Trips = 9986

Figure 3. Monthly intercity bus trips in Iowa in 1976.



Month	Travel (as percentage of total annual travel)
June	9.15
July	10.45
August	10.34
September	7.43
October	8.28
November	8.27
December	9.87

These factors were used to adjust the travel for a typical summer month to the same common base.

Records of bus arrivals and departures also provide a measure of on-time service. The results of this survey are given below:

Month	On-Time Arrivals (%)	On-Time Departures (%)
January	82.3	78.3
February	86.8	78.9
March	85.2	75.3
April	90.2	79.7
May	83.2	73.6
June	80.4	69.7
July	80.0	68.2
August	85.2	71.4
September	88.2	76.2
October	85.4	74.4
November	76.1	65.4
December	73.8	59.8
Average	83.1	72.9

Day	On-Time Arrivals (%)	On-Time Departures (%)
Sunday	87.7	76.9
Monday	86.4	78.1
Tuesday	83.8	72.6
Wednesday	82.5	73.5
Thursday	80.9	71.1
Friday	77.9	67.0
Saturday	80.0	67.9
Average	82.7	72.5

An on-time arrival or departure was defined for this purpose as one that operated not more than 10 min later than its scheduled time.

These surveys illustrate the point that carriers or station agents do maintain certain records that are helpful to transportation planners involved with intercity bus travel. However, such data are not widely disseminated and are not commonly available to planners. The surveys described above provided a foundation on which to build a planning effort directed to the improvement of intercity bus travel in Iowa.

ANALYSES

An initial application of the data on intercity bus passenger destinations for the 23 study cities was to quantify the monthly trip interchanges among city pairs. The trip interchange matrix is shown in Figure 2. The next step was to plot these passenger demands as desire lines on a map of the state. Monthly volumes in excess of 100 trips between study cities are shown in Figure 3, which graphically identifies the principal corridors for intrastate bus travel demand. A distinct focus on Des

Figure 4. Monthly bus-passenger route volumes for intrastate travel between 23 Iowa cities.

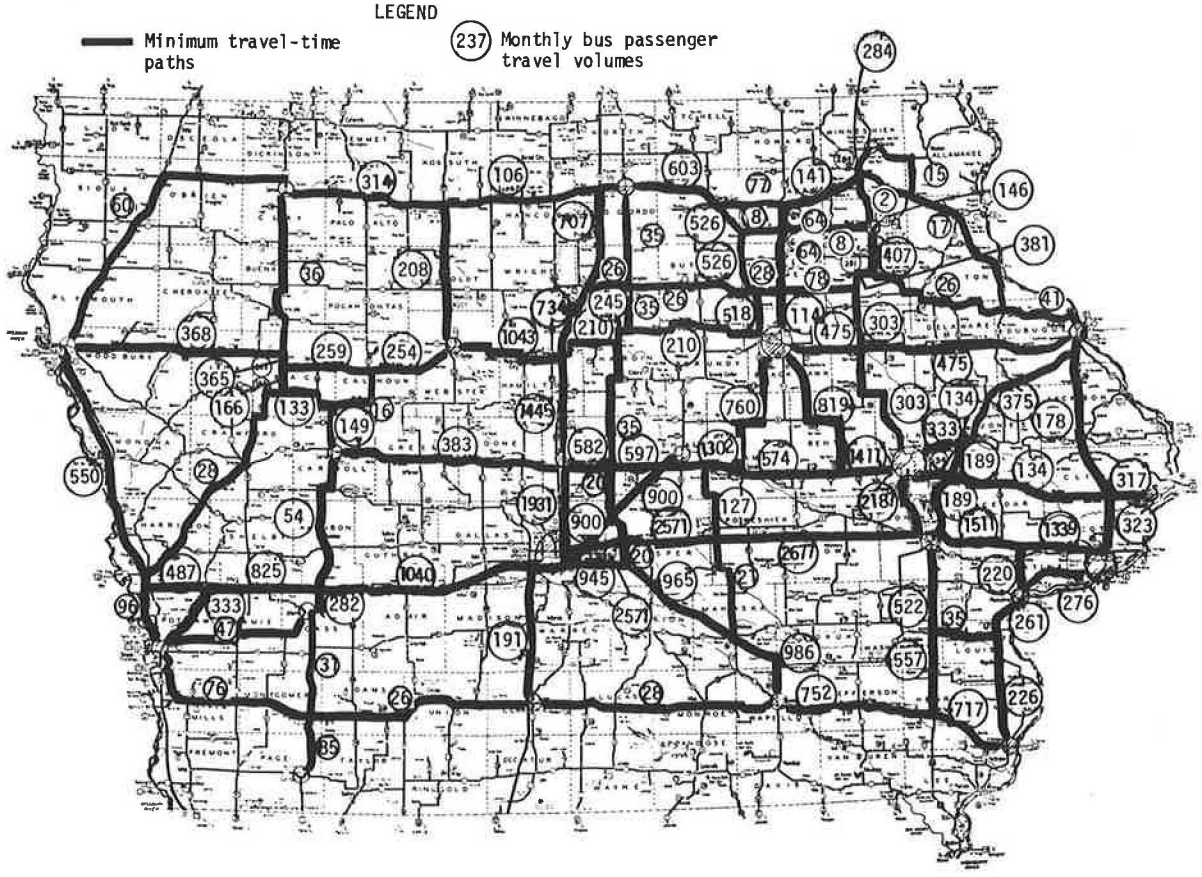
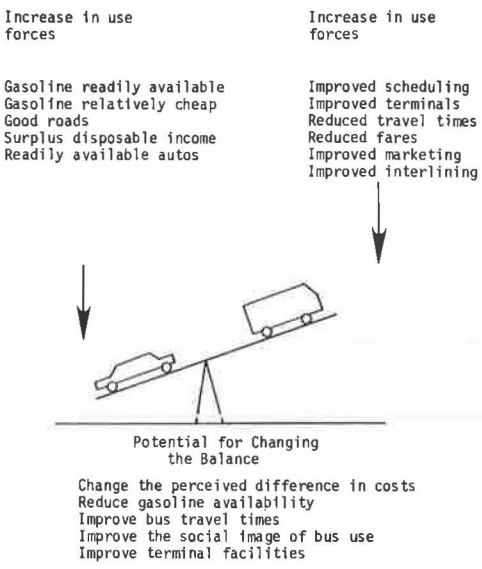


Table 3. Analysis of trip-length frequency.

City	50 Percent of Tickets Sold for Travel Distance <x km (km)	Percentage of Tickets Sold for Destination Distance Greater Than		
		241 km	322 km	644 km
Ames	177	44	30	7
Atlantic	177	40	29	18
Burlington	177	44	24	10
Carroll	193	41	23	14
Cedar Rapids	177	29	23	6
Clarinda	209	45	44	18
Clinton	225	41	29	13
Council Bluffs	193	35	28	9
Davenport	241	46	21	11
Decorah	193	45	16	6
Des Moines	225	47	34	12
Dubuque	225	47	19	8
Fort Dodge	209	48	36	14
Iowa City	209	48	42	9
Marshalltown	145	38	27	10
Mason City	225	42	36	26
Muscatine	290	52	39	12
Osceola	257	51	38	11
Ottumwa	145	28	23	9
Sioux City	241	50	38	18
Spencer	306	67	23	10
Waterloo	177	42	33	9
West Union	161	25	9	5

Note: 1 km = 0.62 mile.

Figure 5. Potential for increasing use of motor buses.



Moines is also evident in Figure 3.

In a subsequent step, travel trees were developed for travel from each study city to all other 22 cities based on a minimum travel-time path along primary highways. By combining 23 minimum travel-time trees, composite volumes were assigned to specific highway links. The resulting composite tree and total volumes for each link are shown in Figure 4.

Table 3 gives certain summary information from trip-length frequency analyses of the monthly ticket sales for each study city. Most trips were shorter than 644 km (400 miles). Median trip lengths, with few exceptions, were 806 km (500 miles) or less.

The data generated in this study were also used to develop a forecasting model for intercity bus use. The monthly ticket sales in 1976, as given in Table 1 and adjusted to reflect monthly variations given in Table 2, were used as the dependent variable. Independent variables were representative of various social, economic, and demographic characteristics of the communities or of the level of bus service and quality of terminal facilities available to travelers. Several forms of regression equations were tested to evaluate the relation between the independent variables and the dependent variable.

ROLE OF GOVERNMENT

Various options are available to a government that may elect to foster and support travel by intercity bus. An objective of government concern in such a case would be to increase the motor-bus share of an intercity passenger travel market. However, several factors tend to inhibit extensive use of buses today. Abundant automotive fuel at relatively low costs and an extensive highway network significantly enhance the relative attractiveness of the automobile as a travel mode. The current imbalance and the forces that influence the use of buses and automobiles are shown graphically in Figure 5.

A state government can exert relatively little influence on many of the factors that affect modal use. The amount of disposable income available for transportation and the cost and availability of fuel are factors that are largely beyond state control. However, a state can influence a choice to travel by bus among elective riders by inducing improvements in the level of service, through changes in routes and schedules, or by upgrading terminal facilities. This suggests a financial inducement to carriers by the state.

Even in the absence of a policy of subsidizing intercity bus carriers to reduce the current imbalance in factors of modal choice, it is possible that such a policy may arise as a result of limitations in the supply of motor fuel. In this case, an objective would be to reduce the adverse impact on the life-style of a highly mobile society that was developed on the basis of affluence and an abundance of energy.

In either case, an enlightened decision as to the appropriate role of government must be based on facts concerning bus use and travel characteristics. These facts are not currently available to transportation planners in suitable form. The types of data that can be obtained and used to analyze changes in policy were demonstrated by this study. Without data that indicate bus use in terms of volumes, trip lengths, and various measures of service level, there is little basis on which policy makers can justify significant expenditures to assist intercity bus carriers.

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