Choice of Access Mode to Intercity Terminals

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Disaggregate demand models are developed for Canada's national capital region (Ottawa-Hull and vicinity) for the choice of access mode to intercity transportation terminals. Models that consider a choice of five alternative access modes are reported for the airport, railroad station, and intercity bus terminals. The results show that considerations of convenience (walking time, schedule frequency, and baggage handling) are dominant factors in the choice of access mode. The models are applied to test passenger preference for several proposed strategies for improving access to intercity transportation terminals in the region. The evaluation indicates that, although more direct and faster public limousine and transit services will produce a modest increase in mode share, shared-ride taxi services offer a better compromise between the low cost of public transportation and the convenience of the private automobile and conventional taxi service.

Municipal transportation and planning authorities are often asked to formulate policies and provide service for access to intercity transportation terminals. Indeed, the need for access to major terminals such as airports and railroad stations is often used as a justification for major investments in roadways and rapid transit facilities. This paper reports on the development of disaggregate demand models for choice of access mode to intercity transportation terminals [see also Rassam and others (1)]. We will give separate models for air, rail, and intercity bus terminals, stratified by personal and business trip purposes. In addition, we report on the application of the models to the prediction of the impact of several strategies for improving access to intercity terminals in Canada's national region (Ottawa-Hull and vicinity).

The results of our investigation, although compatible with professional intuition, have not been previously confirmed in the literature and therefore bear emphasis. In particular, our results show that the most important factors that determine use of public transportation modes for access to intercity terminals are the schedule frequency and the ease of access to pickup points for the service. Comparatively speaking, improvements in line-haul travel times are ineffective in increasing the use of public transportation modes for access to intercity terminals. Major investments in infrastructure to improve the travel time for public transportation to intercity terminals are unlikely to be justified on a cost-effective basis as compared to policies that promote taxi, limousine, and flexible bus service to the terminals. Shared-ride taxi offers a compromise between the low cost of public transport and the convenience of the private automobile and conventional taxi and could attract a significant share of passengers if provided in all parts of the catchment area of the region's terminals.

The results reported are based on travel surveys performed in April and May of 1978 on departing passengers at the airport, railroad station, and intercity bus terminals that serve the national capital region. The purpose of the study was to develop models for access mode choice for each of the terminals and to apply the models to test passenger preference for several strategies proposed for improving access to the intercity terminals. The technique used for calibrating the demand models was the familiar multinomial logit model, which has been extensively documented elsewhere (2, 3).

DATA

The set of access modes considered in this study are automobile driver, automobile passenger, taxi, limousine, and public transit (either regular or special bus). Not all these modes are available for each of the intercity transportation terminals we considered. For example, because of the absence of long-term parking at the bus terminal in Ottawa, drive alone was not considered to be a feasible alternative. Because only limited bus service to the airport is available, only 0.1 percent of survey respondents used this mode and it was deleted from our calibration data set for the airport. Neither the intercity bus terminal nor the railroad station is serviced by limousine.

Table 1 summarizes the variables used for our calibration.

Cost

Travel cost figures for automobile were estimated by adding an assumed operating cost of \$0.09/km to any long-term parking charge (i.e., \$2.50/day at the airport terminal). Total parking charges were determined by multiplying the per diem rate by the reported trip duration from the survey. Transit cost consisted only of the fixed \$0.55 flat fare. Similarly, limousine travel was figured at the set trip cost of \$2.75. The fare structure for taxi was \$0.80 plus \$0.44/km. In addition, a 10 percent surcharge was added to the taxi fare to account for standing charges and tipping.

Line-Haul Time

Line-haul travel times for automobile, taxi, and limousine were obtained from skim-tree values provided by the regional municipality of Ottawa-Carleton. These times were based on an average speed of 19 km/h plus an extra 3 min when passing downtown. Transit travel times were derived from current bus schedules and routes.

Waiting Time

Waiting time for limousine and transit was computed as half of scheduled headways to a maximum of 10 min plus the expected waiting time for transfer when required. No waiting time was assigned to the automobile and taxi modes.

Walking Time

Total walking time includes walking at both ends of the trip. Terminal walking times from park-and-ride lots were estimated as 7 min at the airport and 4 min at the railroad station. For driver-served passengers,

Table 1. Variables used for model development.

Abbreviation	Variable	Driver	Passenger	Taxi	Transit	Limousine	Comments
COST	Cost	X	X	X	X	X	Terminal dependent
WALK	Walking time	X	0	0	X	X	Terminal dependent
WAIT	Waiting time	0	0	0	X	X	Terminal dependent
LINE	Line-haul time	X	X	X	X	X	Terminal dependent
HBRES	Resident-home-based	1	0	0	0	0	Drive-specific variable
HBVIS	Visitor-home-based	0	1	0	0	0	Passenger-specific variable
NHBVIS	Visitor-non-home-based	0	0	1	0	1	Taxi-limousine-specific variable
BAG	Baggage	0	0	0	1	0	Transit problem = 1, other = 0
SEX	Sex	0	1	0	0	0	Female = 1, other = 0
ALT1	Alternative-specific dummy	1	0	0	0	0	Drive alone = 1, other = 0
ALT2	Alternative-specific dummy	0	1	0	0	0	Passenger = 1, other = 0
ALT3	Alternative-specific dummy	0	0	1	0	0	Taxi = 1, other = 0
PUR1[a]	Taxi purpose	0	0	1	0	0	Business = 1, other = 0
PUR2[a]	Transit purpose	0	0	0	1	0	Business = 1, other = 0

Note: X = calculated value; 0 = unaffected alternative.

[a] Alternative-specific dummy variables used for bus terminal only to account for trip purpose.

terminal times were assumed to be zero.

HBRES, HBVIS, NHBVIS

HBRES, HBVIS, and NHBVIS are dummy variables designed to account for the effects of residential status and trip origin. Three principal trends were identified in the analysis of these data and were incorporated into dummy variable definitions.

1. HBRES—Ottawa area residents who initiated their trips from home were more likely to drive alone than any other group of travelers.
2. HBVIS—Visitors to the area who began their trips to the terminal from a private residence were more likely to be automobile passengers.
3. NHBVIS—Visitors who began their trips to the terminal from a hotel or business location were more inclined to travel by taxi or limousine.

Baggage

The survey elicited information on the difficulty of using public transit because of baggage-handling problems. Passengers who responded that baggage considerations made the use of public transit difficult were identified by a dummy variable.

Sex

Female travelers showed a higher likelihood of making their trips as automobile passengers. This information was included in the model as a dummy variable.

Alternatives 1-4

Alternative-specific dummy variables were included in all models to capture the average influence of unobserved attributes for each mode.

Purpose 1, 2

Separate models were developed for business and personal travelers for the air and rail terminals. This was not possible for the bus terminal because of the small number of business travelers in the sample. The samples were therefore combined for the bus terminal only, and dummy variables were included to capture the alternative-specific effects of business trip purpose.

Besides the variables discussed above, extensive experiments were made with several other variables. Our failure to find any consistent influence of these variables is as instructive as our more positive results reported below, and these conclusions are briefly summarized here.

Household Income

In the initial analysis of our data, travelers from higher-income households (more than $20 000) appeared to have a higher propensity for using single-occupant automobiles or taxis as an access mode. Once we stratified our models by terminal and trip purpose, we were unable to identify any consistent effect of household income. Numerous experiments were made that treated household income interactively with the time and cost variables, as a dummy variable classification, and as an imputed wage rate. Our inability to find any consistent results indicates that income primarily determines choice of intercity mode and trip purpose. Conditional on these decisions, access mode choice is relatively free of income effects.

Automobiles per Driver

We initially felt that family competition for the automobile would be an important variable in determining the use of the automobile as an access mode. Once our models were stratified, however, the variable "automobiles per number of drivers in the household" lost virtually all explanatory power.

Transfers

Because of the inconvenience associated with transferring between vehicles, particularly with baggage in hand, a variable was defined equal to the number of transfers required to use public transportation. This variable was insignificant when waiting times were included in the model.

THE MODELS

Table 2 summarizes the stratifications used in defining the models calibrated. Because the number of business travelers who used the intercity bus terminal was small, business and personal travelers were combined for this terminal only. For the other terminals, separate models were estimated for each trip purpose.

The strategy used in the selection of variables for inclusion in the models was whether the coefficient of the variable had the predicted sign and whether the variable enhanced the predictive capability of the model. If variables passed these tests, they were included regardless of their statistical significance. These

Table 2. Model segmentation.

Terminal	Model Number	Market Segmentation	Sample Size	Modal Choice Set
Bus	1	Business and personal	556	Automobile passenger Taxi Transit
Rail	2	Business	96	Automobile driver Automobile passenger Taxi Transit
	3	Personal	222	
Air	4	Business	670	Automobile driver Automobile passenger Taxi Limousine
	5	Personal	198	

criteria were deemed a reasonable search procedure in an exploratory study such as this one.

Because transit service to the airport is virtually nonexistent, we were not able to include any of the time variables in either of the airport models. Without transit service as a standard of comparison, the time variables either showed no difference between the remaining modes (line-haul time) or were virtually dummy variables for one or another of the modes (walking and waiting time). Because we were able to obtain reasonable time coefficients for the other two terminals, these coefficients could be added to the air terminal models for predictive purposes.

Table 3 presents the most successful model calibrations for each terminal and market stratification.

Bus Terminal Model

This model contains a complete set of level-of-service variables (walking, waiting, line-haul travel time, and travel cost). Of the time components, travelers are most sensitive to walking time, display moderate sensitivity to waiting time, and are least sensitive to line-haul time. They also display moderate sensitivity to trip cost, as can be seen by examining the implied values of time for the model.

Bus Terminal	Values of Time ($/h)
Walking time	27.31
Waiting time	6.12
Line-haul time	3.97

In addition, transit handling difficulties are a strong negative influence on the use of public transit, and there are significant differences in modal choice probabilities based on trip purpose and being a home-based visitor to the Ottawa-Hull region.

Rail Terminal Models

These models also contain a full set of level-of-service variables, except that line-haul time has been deleted from the personal travel model because of a positive but statistically insignificant coefficient. The magnitudes of the time coefficients are compatible with those of the bus terminal model and also indicate that travel choices are most sensitive to walking time, are somewhat less sensitive to waiting time, and are relatively insensitive to line-haul time. The magnitudes of the cost coefficients are smaller than for the bus terminal. The values of time for business travelers who go to the rail terminal reflect a rather high sensitivity to time considerations as compared to travel costs.

Rail Terminal	Values of Time ($/h)
Walking time	74.24
Waiting time	41.06
Line-haul time	20.82

For personal travelers, the very small coefficient for trip cost would imply unreasonably high values of time if interpreted literally. A more conservative interpretation is that personal travelers are relatively insensitive to trip cost considerations as compared to travel time. We also note no significant difference between business and personal travelers in their sensitivity to the components of travel time. This result is at odds with the common statement that business travelers worry about time and personal travelers worry about cost.

As noted for the bus terminal model, the necessity to handle luggage is a strong deterrent to transit use for personal travelers. The failure of this variable to enter for business travelers probably reflects the shorter length of business trips and the correspondingly less luggage required. We also note that trip origin, residence status, and sex are important influences on modal-choice probabilities.

Air Terminal

As noted earlier, we were not able to obtain independent coefficients for any time variables for the airport models because of the absence of transit as a feasible airport access mode. Therefore, the only level-of-service variable that enters this model is trip cost. Although statistically significant for both the business and personal trip purpose models, the magnitude of the cost coefficient is small in absolute value and would imply implausible values of time if computed by using time coefficients from either the rail or bus model. In addition, as with the rail models, the cost coefficient for personal travelers is smaller than that for business travelers. The absence of the baggage variable from the air terminal models is due to the lack of transit as a feasible alternative. Otherwise, we see that residence status, trip origin, and sex are important determinants of modal choice. The alternative-specific dummy variables are almost all significant. We note that the difference in sign for the alternative-specific dummy variables as compared to the signs for the other terminals is due to the use of limousine as a base mode for the air terminal; transit was used as the base mode for the rail and bus terminals.

Cross-Model Comparisons

Comparisons between the five calibrated models in Table 3 yield interesting implications. First, we note the uniformity of the implications of the time coefficients in the three models where they could be estimated. In each case, walking time is the most important trip time component that influences modal choice, followed by waiting time; line-haul time is relatively least important in its effect. In addition, there is no significant difference in the travel time coefficients between business and personal travelers for the rail terminal or with travelers to the bus terminal.

In contrast, the cost coefficients show significant differences by terminal and by trip purpose. Cost considerations are most important for travelers to the bus terminal, are somewhat important for business travelers to the rail terminal, and have a small effect on

Table 3. Model calibrations.

Variable	Model 1		Model 2		Model 3		Model 4		Model 5	
	Number	t-Value	Number	t-Value	Number	t-Value	Number	t-Value	Number	t-Value
COST	-0.003 9	-4.09	-0.001 7	-1.28	-0.000 3	-0.30	-0.000 9	-4.19	-0.000 5	-2.17
WALK	-0.180	-1.63	-0.207	-1.75	-0.200	-3.52				
WAIT	-0.040	-1.80	-0.115	-1.06	-0.146	-2.60				
LINE	-0.026	-2.26	-0.058	-0.72						
HBRES					0.44	0.80	0.35	1.26	1.07	1.48
HBVIS	1.25	3.19			1.77	3.18	1.27	2.19	1.26	1.57
NHBVIS			1.03	1.76			0.65	2.44	2.92	3.60
BAG	-2.03	-6.35			-1.41	-3.00				
SEX			1.35	1.95	0.45	1.09	0.84	2.68	0.96	2.71
ALT1			-1.20	-0.91	-2.17	-2.46	1.15	4.18	1.54	1.77
ALT2	-1.64	-1.53	-3.82	-2.56	-3.96	-4.13	-0.39	-1.62	1.68	2.95
ALT3	-0.24	-0.24	-2.23	-1.44	-3.25	-3.57	1.43	9.01	1.20	2.30
PUR1	1.05	2.29								
PUR2	-1.18	-3.51								
ρ^2	0.184		0.229		0.129		0.203		0.190	
Percentage correctly predicted	65		63		58		61		63	

modal choice for air travelers and personal travelers to the rail terminal. These differences are probably due to the relative magnitude of terminal access costs as compared to the total cost of the intercity trip. Since intercity bus is the least expensive intercity mode, terminal access costs are a larger proportion of total trip costs and, therefore, play a larger role in determining access modal choice. On the other hand, air travel is the most expensive intercity transport mode, particularly because of the generally longer trip lengths and, therefore, terminal access costs are a smaller proportion of total costs and are relatively less important to the traveler. Rail represents an intermediate cost case between air and bus.

With respect to the fact that personal travelers exhibit smaller cost coefficients than do business travelers going to the same terminal, this result at first glance appears to be unintuitive. There are two considerations that make it reasonable, however. The first is that personal travel is generally of longer duration than business travel, so again the cost of access to the terminal is relatively smaller as a proportion of the total trip costs. In addition, personal travel often requires the carrying of more baggage, which is a strong dissuasion from using transit, as is evidenced by the baggage variables in two models. These considerations act together to suggest that personal travelers may be less sensitive to access costs and more concerned about baggage convenience than are business travelers. Our results suggest that trip cost considerations are not unimportant to business travelers, even if many of them will be reimbursed for out-of-pocket charges.

POLICY IMPLICATIONS

Walking and waiting times are more important factors than line-haul time in determining access modal choice. Therefore, policies and programs that encourage greater service frequencies and convenient access at the trip origin should lead to an increased market share for the mode under consideration. Policies that focus on faster line-haul travel time alone (e.g., exclusive transit lanes or expressways) will be less successful in achieving modal objectives.

Baggage-carrying considerations are a strong dissuasion from using public transit for personal travelers. Therefore, public transit is unlikely to compete satisfactorily with private automobile, taxi, and limousine for this market.

The use of an access model is strongly correlated with trip origin (home versus nonhome based) and residence status of the traveler (resident versus nonresident). Therefore, the best market for public access modes to intercity terminals will continue to be in the employment center and around hotels.

These conclusions are neither surprising nor controversial. They have definite implications about public policies for providing access to intercity terminals, however. The policies most likely to be successful will stress convenience, flexibility of service, and ease in baggage handling. Capital investments to improve transit line-haul times to intercity terminals are unlikely to attract a significant number of new passengers.

ACCESS TO INTERCITY TERMINALS IN THE NATIONAL CAPITAL REGION

The models were developed to predict access mode choice to the intercity terminals in Ottawa-Hull for different arrangements of access services and terminal locations. This is a key element in a study currently being done to evaluate alternative strategies for improving access to intercity services in the national capital region.

Current Situation

The location of the existing bus, rail, and air terminals in Ottawa-Hull and the access services provided are illustrated in Figure 1. There are no terminals of significance in Hull and nearly all passengers who originate in Hull and other areas north of the Ottawa River must use the Ottawa terminals. Currently all major intercity bus and rail services to and from Ottawa-Hull, even those to points east of the region, radiate from Ottawa on the south side of the Ottawa River because of superior highways and rail corridors. Only a few local bus and rail services pass through Hull and pick up passengers at satellite stops.

All of the Ottawa terminals can be reached by transit from most of the urban area although it may require a prolonged trip, involving several connections, especially from fringe areas. Moreover, the bus terminal is located one city block west of the major north-south arterial that carries several of the busiest north-south transit routes. These transit services do not deviate to serve the bus terminal except on weekends, so bus passengers must walk from the nearest transit stop to the bus terminal. The transit route that serves the airport is not an express service and is intended for airport employees.

Limousine services are provided between the major hotels in the central business district (CBD) and the rail station and the airport. The limousine service to and from the rail station crosses the Ottawa River and terminates in the Hull CBD, but the airport limousine service terminates in the Ottawa CBD and does not serve Hull.

Long-term parking is provided at the rail station and airport but not at the bus terminal. The nearest off-street pay lot for the bus terminal is located several blocks away.

Future Situation

A transitway is to be developed to serve the Ottawa urban area south of the Ottawa River. Initially, this transitway will be a busway, but it is designed to be upgraded to light rail transit at some future date. The transitway will not pass through any of the intercity terminals. During the planning phase, the possibility of running the transitway through the rail terminal was evaluated but rejected on the basis of the low number of trips generated by the rail terminal (relative to other trip generators to be served) and the high cost of traversing the rail lines in the terminal area. The transitway alignment selected is approximately 1.3 km west of the rail terminal. Alternative transit corridors, which would have located the transitway nearer to the bus terminal, were rejected during the planning phase due to a combination of demand, cost, environmental, and other practical considerations. The southeastern end of the transitway terminates approximately 2 km from the airport, near the limits of the urbanized area, and it was not considered feasible to extend the transitway to the airport.

It is planned to operate only regular transit services on the transitway. Approval would be required before the limousine services between the CBD and the rail station and airport would be permitted.

OPTIONS FOR IMPROVING ACCESS

The options recommended for improving access to the bus, rail, and air terminals are listed below

Terminal	Option
Bus	More direct transit New limousine Shared-ride taxi Optimum terminal locations
Rail station	Reduced transit and limousine line-haul times Shared-ride taxi
Airport	Extended limousine service and reduced line-haul times Shared-ride taxi

Bus Terminal

Rerouting the high-frequency north-south transit services through the bus terminal is not practical because it would impose an unacceptable time penalty on the majority of transit users. However, a bus service that runs east-west along the crosstown expressway has been introduced recently and will connect with all major transit lines that radiate from the CBD at each interchange. The new bus service also serves the bus terminal that is located near one of the expressway interchanges. The service will allow a large number of bus passengers to avoid having to travel first to the CBD in order to connect to the bus route that passes nearest to the bus terminal.

A limousine service similar to the rail station limousine, which will link the bus terminal with principal points in the Ottawa and Hull CBDs, is being considered.

Shared-ride taxi is an alternative access mode that satisfies many of the requirements to which passengers are particularly sensitive when selecting the access mode. Compared to exclusive-ride taxi, passengers must trade off cost versus a certain amount of delay (if

Figure 1. Current situation.

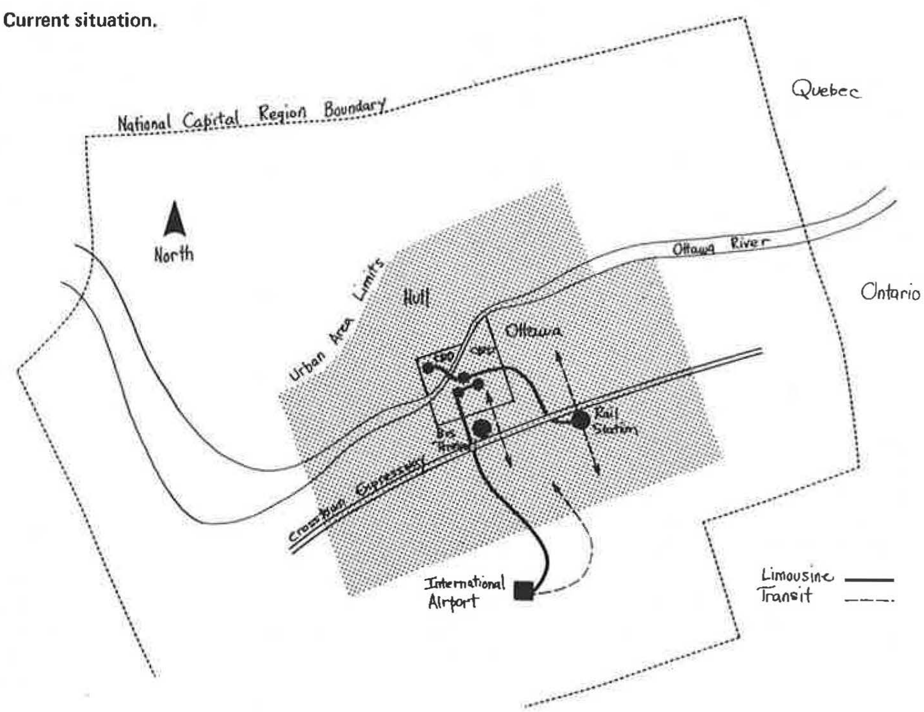

Table 4. Access mode shares for national capital region.

Terminal	Option	Automobile (%)	Taxi (%)	Limousine (%)	Transit (%)	Shared-Ride Taxi (%)
Bus	Current	34	37		29	
	More direct transit	34	31		35	
	New limousine	32	28	9	31	
	Shared-ride taxi	21	18	5	21	35
Rail	Current	44	42	5	9	
	Reduced transit and limousine line-haul time	43	39	5	13	
	Shared-ride taxi	30	28	3	9	30
Air	Current	45	47	8		
	Extended limousine and reduced line-haul time	43	42	15		
	Shared-ride taxi	41	34	8		15

not picked up or dropped off first), convenience (need to prebook a trip to the terminal), and privacy (however, Ottawa-Hull is much more socioeconomically homogeneous than most large North American cities). Most importantly, shared-ride taxi services can be provided to all areas in the region.

Another means of improving access is to relocate or add new bus terminals to bring the intercity trip end nearer to passenger origins and destinations. This can be done in a combination of ways, including moving the bus terminal to a more central location (ideally on the transitway) or establish satellite bus terminals to pick up or drop off passengers in fringe areas en route. Another possibility would be to begin and terminate some of the intercity bus routes in Hull with an en route stop at the main Ottawa bus terminal to pick up and drop off passengers.

Rail Station

The rail station is served by several transit routes that stop directly at the station and by a limousine service to hotels in the Ottawa and Hull CBDs. Access transit has been improved by the same crosstown transit service that was introduced recently at the bus terminal. When the transitway is developed, the line-haul portion of limousine and transit trip times are expected to be reduced significantly.

Airport

The limousine service that currently links the airport with the major hotels in the Ottawa CBD could be extended to serve the new hotels and commercial complexes now being developed in the Hull CBD. This service would be a simple extension to the existing service during off-peak periods and a separate direct service in the peak periods. When the transitway is developed, these services could operate along this facility to avoid road congestion and reduce line-haul time.

MODE CHOICE FOR OPTIONS

The mode choices of different categories of passengers represented in each of the models (e.g., home-based residents on a personal trip, non-home-based visitors on a business trip) were determined by dividing the national capital region into zones, determining representative values of the explanatory variables for each model and zone, and then applying these values to the models. The overall mode share for the region was calculated as the average mode share weighted by the number of passengers in each category and zone. These results are presented in Table 4.

Bus Terminal

The current share of transit to the bus terminal is fairly high at 29 percent because a large number of bus passengers originate in the center of the city or are transit dependent. The provision of more direct transit services will increase transit's share from 29 to 35 percent; most of this increase will come from taxi. New limousine services to Ottawa and Hull CBDs will attract more passengers from taxi and a few from automobile and (improved) transit.

Assuming that shared-ride taxi services would be operated as specified, they would be highly favored by passengers and could attract a large number of passengers away from the other modes (including improved transit and new limousine services) to become the predominant mode.

The results of relocating or adding new bus terminals are inconclusive and are not presented in Table 4. It was found that changes in the terminal location tend to affect all modes more or less equally and, therefore, the mode shares remain almost unchanged or change in favor of taxi, whose costs are reduced relative to transit. The mode share is also heavily dependent on whether or not long-term parking is provided at the new bus terminals.

Rail Station

Reduced transit and limousine line-haul times for using the transitway will increase transit's mode share from 9 to 13 percent but will not affect the limousine's share. The transitway affects transit line-haul times from a large number of zones within Ottawa, but it produces only a minor reduction in the limousine line-haul time. Shared-ride taxi services are expected to attract a significant number of passengers from all modes.

Airport

Extended limousine services to the Hull CBD and reduced line-haul times due to using the transitway for part of the trip will increase limousine's mode share by almost 100 percent. Shared-ride taxi is not expected to attract as large a share as at the bus and rail terminals.

CONCLUSIONS

The majority of intercity passengers in Ottawa-Hull currently use private automobile or taxi for access to the intercity terminals; however, the evaluation demonstrates that there are several ways in which public transportation services can be improved and thereby attract significant numbers of passengers. These results bear out the policy implications previously drawn from the developed models.

Improvements in transit services that provide more direct access to the terminals by reducing walking and waiting times and the number of connections can produce further modest gains for transit as an access mode. The difficulty is, of course, in providing a high level of service to the intercity terminals from all points in the terminals' catchment area.

Limousine services that provide express service between hotels and other central points in the CBD and specifically cater to passenger baggage requirements can attract a majority of passengers whose origins and destinations are in the CBD. These passengers can form a significant portion of the total trips in the catchment area.

Shared-ride taxis offer a compromise between the lower cost of public limousine and transit services and the convenience and speed of private automobile and taxi. They also provide service to nearly all parts of the catchment area of the Ottawa-Hull terminals. As a result, the evaluation estimates that shared-ride taxis can capture a substantial share of bus and rail passengers and a smaller share of air passengers. They offer a clear alternative to existing public transport services.

ACKNOWLEDGMENT

The research reported was performed under contract to the National Capital Commission. The views and conclusions are ours and not those of the National Capital Commission or of the World Bank or its affiliated organizations.

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Publication of this paper sponsored by Committee on Passenger Travel Demand Forecasting.

Use of the Gravity Model for Pedestrian Travel Distribution

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Knowledge of pedestrian travel behavior is very important to attempts to improve congestion problems in central business districts. This paper describes the results of the use of a traditional gravity model for predicting pedestrian trip distribution. The model is calibrated by using a data set from downtown Chicago. The results indicate that the traditional gravity model closely reproduces the characteristics of pedestrian trip distribution and might be a useful tool in the analysis of downtown travel.

A great deal of discussion is now taking place on how to improve the central business districts (CBDs) of our major cities. Many proposals that are being evaluated and implemented deal with malls, personal rapid transit, downtown people movers, and sky walks. All of these systems have implications for the mobility of people in the CBD. Since much, if not most, of the CBD mobility is provided through pedestrian journeys, these proposals will certainly affect the number and length of such journeys and compete with them for patronage. An understanding of pedestrian trip distribution is, therefore, necessary in order to evaluate the potential impact of some new suggestions for the CBD.

The purpose of this paper is to review the calibration and application of a standard gravity model for a data set collected in Chicago in 1963 (1). This data set offers more than 10 000 origin-destination interviews in the Chicago CBD and presents the opportunity to test the gravity model on pedestrian travel behavior.

THE PEDESTRIAN SURVEY

The pedestrian survey was conducted by the Chicago Area Transportation Study (CATS). The interviews were conducted by people from various city departments in Chicago's downtown, known as the Loop, due to the elevated transit line that defines it. The survey was taken during the period from 7:00 a.m. to 7:00 p.m.; each interviewer collected a predetermined number of interviews. Interviews were collected randomly along 98 stations on one side of a street about three blocks in length for each hour in the time period.

The survey collected data for each station by hour, including purpose of trip, direction of travel, and whether the respondent was coming from work. The interviewer also obtained origin and destination addresses. The total number of people interviewed was 11 632. The sample rates for each station were based on pedestrian volume counts done by regular traffic counters the previous year.

The sampling techniques employed resulted in a sample that was uniformly distributed across the Loop area (i.e., an approximately equal number of interviews at each station). This distribution has two beneficial effects from a statistical standpoint.