Ridership Forecasting for Chicago Transit Authority's West Corridor Project

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The Chicago Transit Authority is reviewing existing West Corridor rail services. A spreadsheet version of the Chicago Area Transportation Study's mode choice model was developed for the project to estimate the impact of service revisions on ridership. Ridership calculations are carried out for Chicago community areas, a level of detail that permits the model to be implemented within a reasonably sized spreadsheet. The spreadsheet's organization is discussed, and procedures to estimate inputs to the mode choice model—access and line-haul characteristics faced by riders—are outlined. This approach is critiqued and contrasted with conventional network-based travel demand models.

The West Corridor project focuses on Chicago Transit Authority (CTA) rail service. Two of the corridor's three rail lines date from the turn of the century and need structural rehabilitation. Total ridership on the west-side lines has declined at a faster rate than CTA rail ridership on the whole (*1*). Operating costs per passenger have escalated because of lost ridership.

A spreadsheet version of the Chicago Area Transportation Study's (CATS's) mode choice model estimates how alternatives to current west-side service affect ridership. Existing and revised characteristics of a service plan are entered into the spreadsheet, and time and cost impacts projected for riders. A mode choice calculation estimates the transit ridership lost or gained. Remaining ridership is then allocated to bus, commuter rail, and west-side rail lines.

MODELING CONSIDERATIONS

Considerations for selecting this approach were as follows:

1. Detailed ridership forecasts. Ridership forecasts were needed to estimate revenue and cost implications of alternative operating plans.
2. Available project resources. Available resources were CTA staff, personal computers, and spreadsheet or data base management software.
3. Previous work. Trip tables were prepared in previous CTA strategic planning (*2*).

PROJECT ZONES

Figure 1 zones were developed from Chicago community areas. Zone 1 is the central area; Zones 2 through 10 are corridor community areas; Zones 11, 12, and 13 cover western suburbs served by CTA; and Zone 14 includes all remaining western suburbs. The balance of the study area is covered by 12 zones arranged in rings and sectors.

Also shown are the Lake Street, Congress, and Douglas rail lines. In addition, there are 12 CTA east-west bus lines and 2 commuter rail lines in the corridor.

ORGANIZATION OF SPREADSHEET

A spreadsheet includes seven sections for one corridor zone's ridership calculations:

1. Zone trips,
2. Existing line-haul and access characteristics,
3. Line-haul and access characteristics for the revised service,
4. Impacts,
5. Automobile-transit mode shift calculations,
6. Transit submode shift calculations, and
7. Summary tables.

Trips

Trip tables include movements from West Corridor origin zones 2 through 14 to all 26 destination zones. Tables were prepared for home to work, work to home, home to nonwork, nonwork to home, and nonhome to nonhome trips.

Work trip tables for automobile, commuter rail, CTA bus, and CTA rail were created from the 1980 census journey to work files (*3*) and factored to 1985. Nonwork tables for CTA modes were tabulated from a 1979 CTA origin-destination survey (*4*). CTA rail trips were further subdivided into Douglas, Congress, Lake Street, and other rail lines using factors from the 1979 survey. One row from each modal table produces the spreadsheet's zone trip table depicted in Figure 2.

One alternative requires 13 (origin zones) × 5 (trip purposes) spreadsheets, but fewer than 65 spreadsheets are usually needed. Origin zones and purposes can be omitted when they contribute little ridership.

Line-Haul and Access Times and Costs

Service characteristics are time in transit vehicles, time outside the vehicle, and fares paid. Out-of-vehicle time has three components: walk time to the first stop or station, half the

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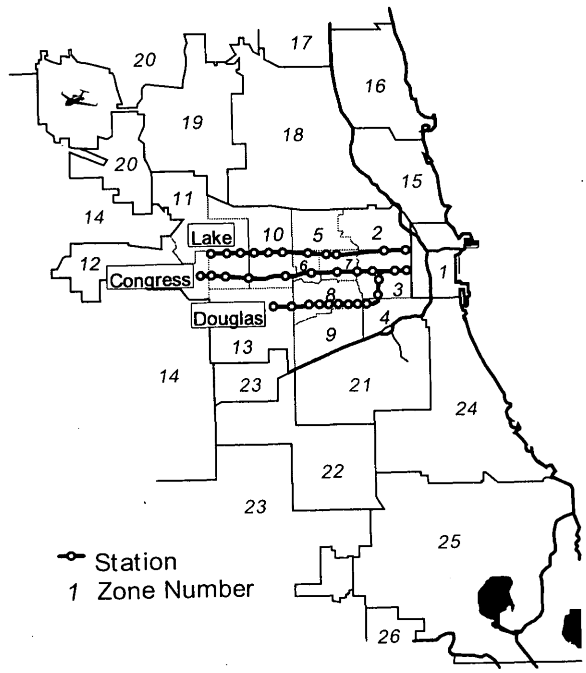

FIGURE 1 West Corridor project zones and rail lines.

headway of the first boarded line, and transfer time, if any, between rail lines. Peak service characteristics are paired with work trips, and nonwork trips, with off-peak characteristics.

The spreadsheet treats rail line-haul and access characteristics separately. Line-haul quantities are measured between stations. Access characteristics are determined by the trip to the station. Bus line-haul and access characteristics are combined, because nearly all CTA bus riders walk to stops. Times and costs of automobile and commuter rail are assumed constant.

Line-Haul Times and Costs

Zone-to-zone line-haul characteristics were measured between pairs of stations. Within the corridor, reference stations were selected on each west-side rail line for each zone. Outside of the corridor, one station was also identified per zone. Rail line-haul times came from CTA Operating Facts (*5*) and

	Destination Zones												
Mode/Line	1	2	3	4	5	6	7	8	...	24	25	26	Total
Auto													
Bus													
Commuter Rail													
Lake Street													
Congress													
Douglas													
Other Rail Lines													
Total													

FIGURE 2 Organization of spreadsheet zone trip table.

crew assignment supervisor guides. Bus line-haul characteristics were measured between street intersections. Interchanges requiring transfers between lines were identified to determine applicable fares and transfer times between zones.

If a rail line is eliminated, line-haul characteristics of the best remaining rail line are substituted. Potentially eliminating the Lake Street line is reproduced by replacing its line-haul characteristics with those of the Congress line.

Access Times and Costs

Access characteristics were estimated by sample trips from a small 1988 CTA home interview survey (*6*) and the 1979 CTA survey.

1. Ten to 20 survey trips are selected for bus and for rail riders on each line serving a zone.
2. Access characteristics for sample trips are determined.
3. Weighted average access characteristics are calculated by line and access mode within a zone.

Access characteristics for proposed services are also estimated by this procedure. Elimination of a station or line means that access characteristics must be adjusted to reflect use of the best alternative station.

Changes in Access Times and Costs

Changes in access characteristics are more complex than line-haul characteristics because riders will often change access modes. An intermediate table keeps track of the access impacts for all combinations of access modes used before and after rail service is altered and the number of survey trips affected. Six table columns—walk to walk, walk to bus, walk to automobile, bus to bus, bus to automobile, and automobile to automobile—account for all before and after access modes.

Impacts on Line-Haul and Access Times and Costs

Two tables summarize impacts of a service alternative, one for the transit-automobile pivot-point mode shift calculation and one for the transit submode allocation. Since automobile characteristics remain unchanged, transit-automobile impacts are only the changed transit characteristics.

Each line's transit impacts are measured relative to all other services for the transit submode pivot-point calculation. When the Lake Street's impacts are determined, they are tabulated for the Lake Street versus bus, commuter rail, Douglas, Congress, and noncorridor rail lines. These pairings allow for shifts in ridership among corridor transit services.

Pivot-Point Mode Shift Calculations

Two tables estimate the transit-automobile and submode shifts in mode choice. The transit-automobile pivot-point table is organized by transit mode and rail line, whereas the transit

TABLE 1 CATS Mode Choice Model Coefficients

Variable	Work Trips: CBD Destination	Work Trips: Non-CBD Destination	Non-Work Trips: CBD Destination	Non-Work Trips: Non-CBD Destination
Transit-Auto Mode Choice				
In-Vehicle Time	0.0159	0.0186	0.0114	0.0114
Out-of Vehicle Time:				
First Headway	0.0173	0.0811	0.0610	0.0610
Transfer Time	0.0290	0.0399	0.0589	0.0589
Walk Time	0.0468	0.0584	0.0663	0.0663
Fare/Cost	0.0085	0.0072	0.0329	0.0329
Transit Submode Choice				
Total Time	0.0220	0.0119	0.0207	0.0127
Total Fare/Cost	0.0175	0.0200	0.0347	0.0493

submode pivot-point table includes paired transit modes and rail lines.

The following equation performs the pivot-point calculation:

$$DMSm = MSm * (1 - MSm) * DCm * Fm,C \quad (1)$$

where

$DMSm$ = change in mode share for mode m;
DCm = impact on service characteristic C for mode m; and
Fm,C = coefficient in mode choice model that weights service characteristic C for mode m.

Table 1 gives the coefficients for transit-automobile mode choice and transit submode choice from the CATS model (7).

FINAL COMMENTS

The spreadsheet model estimated ridership after lengthening headways on the Lake Street line to accommodate a new Southwest rail line. The project is now examining ridership effects from potential elimination of either the Douglas or Lake Street line. The model produces reasonable results when a line is eliminated. Some ridership is shifted to competing automobile, commuter rail, or bus, but most is allocated to the remaining corridor rail lines.

Experience with the model confirms the importance of transit access. Line-haul characteristics often vary only slightly between alternatives. When a line is eliminated, the line-haul characteristics of the substitute line are sometimes superior, but access characteristics are typically worse.

Each spreadsheet is customized according to the available transit services, the interchanges in the trip table, and the access calculations for eliminated lines. Although custom spreadsheets are cumbersome, they force the analyst to understand the spreadsheet calculations.

The spreadsheet remains manageable because the project deals with one corridor and evaluates limited network changes. System planning involves more extensive alternatives, which must be addressed by network-based models. The choice of either analysis method should be driven by the nature of the planning problem.

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